Water Quality Monitoring Network Annual Report 2022/23

ANGLING TRUST

ANGLING TRUST ANGLERS AGAINST POLLUTION

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INTRODUCTION

I am delighted to present the inaugural annual report on the remarkable efforts of the Angling Trust Water Quality Monitoring Network (WQMN), which is an integral component of our wider Anglers Against Pollution campaign.

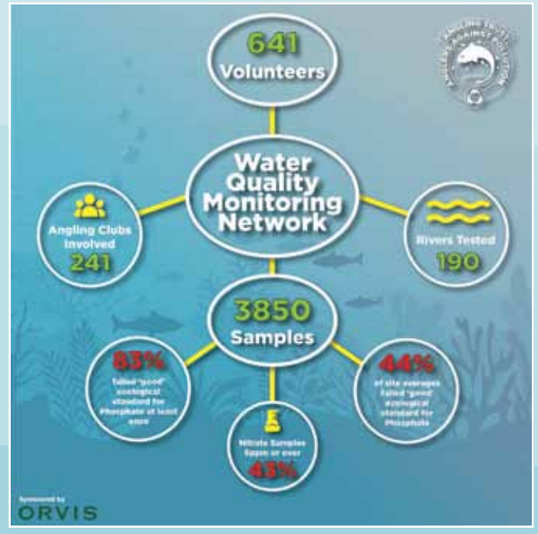
For too long, anglers have been deeply troubled by the decline in water quality of our rivers, which impacts not only the fish, but also the very essence of the angling experience. We have faced obvious pollution issues, right across the country yet there has been a hugely frustrating lack of information and transparency from regulators, the water industry, and the agricultural sector. Successive Governments have cut funding for monitoring work and angling clubs have found it almost impossible to properly understand what is happening to the rivers they love with regards to pollution and the true state of our waters.

Recognising the urgency of the situation, the Angling Trust took the pivotal step of launching the WQMN in May 2022. This rapidly expanding community of citizen scientists harnesses our members' energy, enabling them with the tools to monitor, understand, and actively contribute to the preservation of the local rivers they care so passionately about.

Actor, comedian, angler, and clean water campaigner Paul Whitehouse praised the initiative:

"The chronic mismanagement of our rivers and waterways by organisations and bodies specifically tasked with protecting them has received a lot of attention recently. The Angling Trust has mobilised its army of volunteers to safeguard and improve the quality of our waterways by gathering evidence to hold polluters to account. Hats off to them."

Paul Whitehouse
Angling Trust Ambassador



As of December 2023, 641 anglers from 240 angling clubs have stepped up to the plate, and are monitoring pollution on 190 rivers across more than 60 catchments. The Angling Trust has distributed over 400 WQMN Monitoring Kits to volunteers and more than 3,800 samples have been recorded highlighting the pollution crisis on our waterways.

With each additional club and volunteer, the Angling Trust is unravelling the full extent of the pollution affecting our rivers. Some of our members have been fishing in, and caring for, their local waters for 20, 30, even 50 years. Transforming these anglers' innate knowledge and experiences with evidential data will underscore the pressing need for urgent action to improve water quality. As we look ahead to 2024, we acknowledge and applaud the crucial role played by anglers in safeguarding our waterways.

Jamie Cook,
Angling Trust CEO

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FOREWORD

Our rivers face a myriad of threats, the biggest of which is from pollution. In 2022, 375,157 sewage spills were reported on English and Welsh rivers with sewage discharged for over 2 million hours. Excess nutrients from agriculture, along with pesticides and herbicides, are enriching our rivers contributing to eutrophication and algal blooms, whilst soils washed off fields clog precious spawning gravels, and slurry storage failures wipe out whole rivers. Over 1,600 river, lake and groundwater sites across England have a mixture of harmful chemicals within them and not a single river in England meets good chemical status with only 14% of rivers meeting good ecological status. In Wales only 44% of rivers and canals were assessed as good or better in 2021 and 61% of assessed Special Areas of Conservation (SAC) water bodies failed their phosphorous targets.

The analysis provided in this report highlights that *"44% of site averages for phosphates exceeded the England-wide upper standard for good ecological status"* and that *"As we use the conservative overall upper standard, it is likely that more samples would exceed site-specific limits if they were available".*

The regulators approach is to focus on phosphate as the main cause of river eutrophication and the nutrient they are most able to reduce to levels that will improve the ecology. However many ecologists are increasingly concerned about the role of elevated levels of nitrate in eutrophication. But it is also difficult to assess nitrate enrichment as there is no Water Framework Directive (WFD) standard for Nitrate in rivers, only lakes. In the absence of a WFD standard the report assessment of nitrate levels is against the EU Nitrates Directive, but there is some concern that *"this is not stringent enough, and historical nitrate levels indicate that concentrations have been much lower in the past."* WQMN volunteers are provided with guidance that indicates that nitrate levels ≥ 5 ppm are excessive and on that basis 43% of samples exceed that level.

Overall the report's findings underline the need to address the agricultural and water industry pollution blighting our rivers.

Anglers are passionate about the places they fish and are deeply concerned about poor water quality impacting fish, fishing, and the environment. But they have often found it difficult to understand the state of their waters due to either a lack of information or a lack of transparency on behalf of the regulators and the water industry.

To engage anglers in better understanding the quality of their waters and to empower them to improve their waters in May 2022 the Angling Trust launched the Water Quality Monitoring Network (WQMN) with a pilot on the Severn catchment. Following the success of the pilot the WQMN was rolled out across England and Wales in July 2022.

This first interim report has been prepared by Dr Eleanor Kean (Independent Environmental Researcher) and Dr Liz Bagshaw (Associate Professor, University of Bristol) and analyses the first year's WQMN data. This first year has been one of rapid growth for the WQMN. At the end of July 2022 69 clubs had signed up to the WQMN with just 120 volunteers registered and we were monitoring on 25 rivers. In the interim we have recruited a further 500 volunteers and extended the coverage of the WQMN to 190 rivers. That means that in many cases we are only just establishing a clear understanding of the pollution impacting our rivers. As we continue to sign up more clubs and further volunteers, we look forward to our first full report which will provide a fuller, broader, and more in-depth understand of the pollution crisis facing our precious rivers.

Kris Kent
Angling Trust, Campaigns & Advocacy Manager

"The success of the pilot and consequently the national rollout has been amazing. Anglers are now able to monitor their local river and very quickly identify water quality issues. Like my fellow anglers we all care passionately about the state of our waterways and with the help of the Angling Trust, we are doing something about it. The testing that I do in Worcester has uncovered some worrying issues and with the help of Fish Legal we are trying to find out more about the discharges into the river. Through the WQMN anglers are not only the eyes and ears of our waterways but now we have become citizen scientists too."

Glyn Marshall
WQMN Volunteer

CASE STUDY

Medway Catchment Case Study

Why did the Royal Tunbridge Wells Angling Society join the Water Quality Monitoring Network?

RTWAS members working with the South East Rivers Trust

The Royal Tunbridge Wells Angling Society (RTWAS) is a small angling club of around 350 members. It has been concerned about the ecology of their precious Upper Medway ever since a near catastrophic pollution incident some 15 years ago. From that very low point, over the last 8 years they have embarked on a programme of habitat improvement and restocking, with advice and funding from the Environment Agency (EA). They have made great progress, but from the very occasional and expensive specialist private surveys they had undertaken they knew that the water quality itself was far from perfect. One of the main concerns was the disappearance of much of the aquatic weed and insect life along pretty much the entire length of the Medway!

So, when the Angling Trust WQMN was launched in 2022 RTWAS felt that this was the ideal opportunity to really understand the quality of their waters and joined immediately.

Derek Reader, RTWAS Secretary, says … *"We at Royal Tunbridge Wells Angling Society have long suspected problems with water quality on our stretches of the Upper Medway but, aside from testing dissolved oxygen and water temperature on an ad hoc basis, we were never going to pinpoint any issues to the satisfaction of scientific analysis. WQMN, along with the database being built, has allowed our excellent band of dedicated volunteers to do just that through their diligence and hard work."*

Clive Meers Rainger, RTWAS chairman, added … "RTWAS has been trying to improve the nine miles of the upper Medway which is under the club's control. We have been working with the EA who have given us advice and funding. Our remit was to improve our river by putting in 180 tons of gravel to enhance the spawning gravels, and to reintroducing plants, both sub aquatic and marginal, to help invertebrates and provide refugees for fry and younger year groups of fish. Unfortunately, the plants have slowly died off. So, when the Angling Trust launched the WQMN and started supplying water quality monitoring kits we immediately purchased five, as we felt it was water quality that was the problem."

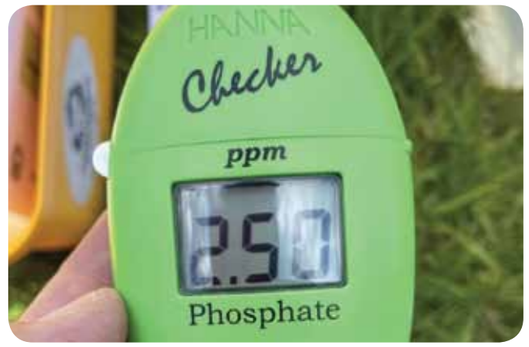
There are six volunteers within RTWAS who work alongside volunteers from other local angling clubs, other ecological groups, and with local landowners to monitor the Medway and its tributaries.

What is the data showing?

RTWAS knew there were issues but were truly shocked and saddened at what they found.

- Extremely high phosphate, nitrate, and ammonia levels in normal and low water conditions. After coordinated testing and a lot of detective work RTWAS isolated the main sources of pollution on the upper catchment to three wastewater treatment works, situated with three miles of each

Pollution sources on the Medway



other, and a number of combined sewer overflows (CSOs) discharging untreated sewage.
- Extremely high E. coli levels not dependant on weather and river conditions. RTWAS have proved that the vast majority of these incidents were directly associated with Southern Water wastewater treatment works releasing untreated sewage into the rivers in a very ad hoc fashion.
- Evidence of herbicide misuse affecting the whole catchment. The once lush weed beds, present only a very few years ago, have all but gone. Due to the local land use we believe these herbicides to originate from agriculture, but it is very hard to prove.
- Evidence, through expert external ecological surveys, of chemicals, heavy metals, human drugs & hormones, micro plastics etc . These are obviously very difficult to eliminate but better to know what we are dealing with.

Statistics on water quality for the Medway catchment make grim reading...

- Of the almost 300 water quality samples taken 74% of samples had concerning levels of phosphate, nitrate, ammonia, or all three.
- Over 75 water samples were taken to incubate and test for E coli on over 50 miles of the Medway catchment. Every sample taken shows signs of E. coli, with over 85% over the maximum limits for safe swimming (< 9 CFU/1ml). The highest levels recorded were >300 CFU/1ml in times of severe rainfall in the winter.

Actions so far

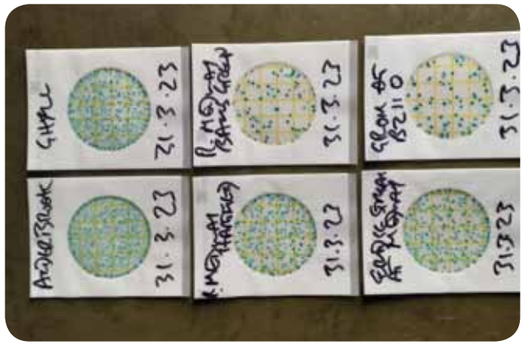
As a result of the WQMN data and the E. coli testing, the club has...

- Produced a detailed plan to ensure volunteers sample and test regularly at two locations each over the 9 miles of catchment RTWAS control. As and when issues are noted RTWAS then try to pinpoint the source and take appropriate action.
- Raised to date a total of 19 EA emergency incident reports for the following issues-
  - Extremely high Phosphate levels >2.5ppm (maximum calculated at 4.3ppm)
  - Extremely high Nitrate levels of >20ppm
  - High Ammonia levels of >1.5ppm
  - Off the scale E. coli counts of >300cfu/1ml
  - Herbicide misuse
- Cultivated good working relationships with the EA, South East Rivers Trust, Angling Trust, Medway Catchment Partnership, Local MP Greg Clark, local ecology groups, riparian owners and of late with Southern Water
- Major organisations such as the EA , Southern and SE Water, SE Rivers Trust etc see us as major stakeholders for ecology in the Medway Catchment
- Face to face meetings with the EA on the riverbank, and formal office meetings resulting in agreed actions and target timescales.
- Had on site meetings with local conservative MP Greg Clark who has now taken up their cause and working with us.
- Cultivated relationships with six other local angling clubs and societies to cover as much of the Medway catchment, including six tributaries.
- Purchased incubators, associated equipment, and test mediums so that we can monitor the E. coli levels.

Results so far

As a result of the actions above, in no particular order...

- Early successes including repairing old sewage culverts, surveying, and cleaning of a once private sewage networks by Southern Water.
- Southern Water admitting that they had a serious process issue (Ferric Dosing failure) lasting for many days at the South Tunbridge Wells WWTW.
- EA are funding a project to improve habitat and water quality for the Upper Medway catchment. This is in the planning stage but close to fruition.
- 4 BBC news items. 3 with BBC Southeast and 1 with BBC National Weekend Breakfast News, with estimated viewing figures of >1,000,000
- Another BBC environmental feature in the pipeline to catch up on “progress” made.
- Heightened awareness of issues with local residents and businesses including presentations to local community groups in meeting places
- EA and Hadlow College Fisheries Dept have performed physical fish surveys at various points along the upper Medway
- SE River Trust are looking to perform eDNA surveys within the Upper Medway
- Have agreed and planning installations of 24/7 water quality monitoring equipment in 2023/24 with both EA and SERT. Spring 24
- We supply a monthly water quality report for the Upper Medway to the EA. They add this information to their own trend database.
- Through our efforts and those of the catchment team the local EA have employed another Environment Officer and a new position of Senior Environmental Monitoring Officer / Citizen Science Lead. These new employees have just stared in post and meetings being arranged for January 2024. This is such a very positive move.
- Working with the Southeast Rivers Trust, Southern Water and local land owners on a new long-term project to create a new wetland filter system linked with South Tunbridge Wells WWTW. Very exciting but very much in its infancy.
- Have been asked by EA to be on the steering committee of a new non-native species (North American Mink) eradication project within the Medway Catchment. Again, early days.
- One of our volunteers has embarked on a project to monitor water quality,



particularly E. coli, on two tributaries near to Crowborough on a daily basis for one year. It is a new initiative to give trends over time. We are sharing this information with the EA.

Ian Tucker WQMN Coordinator and 'Volunteer of the Year' Award winner said ... *"Joining the Angling Trust WQMN it has given our small band of dedicated volunteers the confidence, understanding, equipment, training, focus and support needed to try, with some success, to make a real difference."*

What next?

RTWAS plan to carry on chipping away and making a nuisance of themselves to try to promote the plight of the Medway, to make the public aware, and to make a tangible difference.

Finally, Derek Reader, RTWAS Secretary, commented... *"We have now identified the major causes and effects on poor water quality and, through our contacts with the EA, Southern Water, the local MP, and landowners, hope to be able to report further real progress soon".*

E-Coli warning sign on the Medway

CASE STUDY

Nidd Catchment Case Study

Why did the Harrogate Fly Fishers' Club join the Water Quality Monitoring Network?

River Nidd

Harrogate Fly Fishers' Club (HFFC) experienced a few sewage discharge events in 2021 associated with the Darley Sewage Treatment Works (STW) on their stretch of the river Nidd in North Yorkshire. The club did a water sampling survey on its waters and established that there were high concentrations of E. coli, especially below the STW. Their interest in the ecological health of the river led to a group of Nidd fly fishing clubs getting together and deciding to take monthly samples as part of the Water Quality Monitoring Network.

There are now ten volunteers from four clubs collecting monthly WQMN samples from thirteen locations across the upper and middle Nidd, and some clubs are keen to collect more frequent samples.

What is the data showing?

To date 135 samples have been collected. It's early days, as there isn't a full year's sampling, but so far:

- Electrical Conductivity increases downstream, especially towards the more heavily populated lower river.
- Increasing Nitrate concentrations from the top of the river above Pateley Bridge down to just above Knaresborough.
- Phosphate values show a similar pattern with peaks below two sewage works and below a beck leading from another sewage works. 37 of the 135 samples (27%) exceeding the Water Frame Directive standard.

Actions so far

The results are being discussed with club members, knowledgeable individual experts and with the Environment Agency. Raising concerns about nutrient chemistry levels and their likely sources. The group of local fly-fishing clubs has started a broader community group, the Nidd Action Group (NAG), concerned with the Nidd's Water Quality, and is sharing results with local citizens, the Environment Agency, and others: **www.niddactiongroup.org**

David Clayden, Secretary of Harrogate Flyfishers Club and Chair of Nidd Action Group, said ... *"I have learnt a lot about water quality over the last couple of years and believe that unnecessary pollution should be avoided like the plague that it is. I now know just how many excellent knowledgeable citizens there are locally – not just fly fishers! - who intend to get the water quality of our river into the state that it, and we, deserve."*

Results so far

Organising a community collaborative project - working with the Yorkshire Dales River Trust (YDRT), the University of Leeds, the Bilton Conservation group (BCG) and the EA - to undertake a 'tip to toe' survey of the river Nidd and some major tributaries on one afternoon in August 2023. There will be 45 locations with water samples being tested for E. coli, nutrient chemistry, and heavy metal concentrations in accredited laboratories.

Nidd Action Group testing

What next?

HFFC anticipate that the results of this, and other activities to raise community awareness and involvement in the water quality of our local river, will influence local regulators and Yorkshire Water to address pollution causes; contribute to an acceleration of involvement with the Nidd community and local investment; and inform the development of a Nidd Catchment plan, led by the Dales to Vale River Network (DVRN).

Rev. Brian Hunt, Chairman of Harrogate Flyfishers' Club, said … *"What I find most encouraging is that this year we have witnessed a growing outrage at river pollution not just in angling circles but right across the whole community. This issue has now forced itself into the national headlines and is not going away."*

Brian Hunt

CASE STUDY

Warwickshire Avon Case Study

Why did the Girling Angling Society join the Water Quality Monitoring Network?

Glyn Marshall, Andy Hammerton and Frank Bagley testing on the Warwickshire Avon

In November 2021 the club were alerted to a water quality issue when several matches on the Warwickshire Avon blanked, on the Fladbury left bank stretch and further below Jubilee Bridge. Glyn Marshall kindly offered to measure the phosphate level and reported an alarming level of 0.92 ppm. This was reported to the Environment Agency who said that they regularly measure 0.1 ppm at Jubilee Bridge and informing the club of ongoing improvements to a sewage treatment plant just upstream of Fladbury, completed in January 2022.

The Angling Trust Water Quality Measuring Network (WQMN) was launched in May 2022 and the club joined at the outset. They began a steep learning curve to understand the complexity of water quality. Thankfully, the fish were back at the start of the season in June 2022, but in November 2022 matches again completely blanked, clearly the fish were driven downstream two consecutive seasons by poor water quality.

Frank Bagley, Girling Angling Society Secretary, said … *"When we began reporting poor water quality at Fladbury we feared that it would affect membership however the opposite has occurred and membership is at record levels. We believe this is due to the high level of awareness that has been generated, anglers now accept the issue is nationwide and totally out of control. I understand that household wastewater from showers, washing machines, and run off from roads and motorways etc, has increased enormously in the last 30 or 40 years and the infrastructure cannot cope, yes, the issue is huge and complex. Nevertheless, regulators have failed to hold the water companies and farmers to account, citing lack of investment while water companies make huge profits. Clearly The government's plan to improve water quality by 2035 will result in rivers reaching the point of no return, becoming open sewers.*

Fladbury weir pool is a breeding area for Barble and currently there are shoals of big Roach throughout the stretch but Dace have been seen spewing slime. The fish are obviously struggling being regularly forced downstream to find clean water. The Warwickshire Avon is currently becoming choked with weed caused by water clarity and high levels of nutrients entering the river unchecked. The weed has become choked with filthy black slime and the Avon has never looked so unhealthy, we believe the ecology of the river is on the edge."

Andy Hammerton, Girling Angling Society Head Bailiff, said … *"I have lived in the village of Charlton for 33 years. My property is 400 yards from the river Avon at Fladbury. I have been a passionate river angler all my life and so purchasing a property in this location was not a difficult choice.*

As a member, and former bailiff, of the Birmingham Anglers' Association (who control several miles of the Warwickshire Avon in this area) I have learned the many

Andy Hammerton and Frank Bagley with WQMN Award certificates

moods of the river and the favoured pegs along its length. When I first moved to the area in 1990 the ecology of the river was excellent, the fishing was brilliant and early season fry would be visible in all areas. Unfortunately, there has been a noticeable decline over the years with the most significant being in the last decade. During the last few year's fish have disappeared from known hot spots. Fry are only visible in limited locations. Excessive weed growth and algal blooms have been visible in some areas and when wading putrid smelling black sediment is evident when the riverbed is disturbed.

The angling Trust appeared to be the only voice highlighting this growing problem. They were instrumental in maintaining participation in our sport during the Covid pandemic and genuinely have the Anglers interest at heart, however this issue goes much further than Angling. Therefore, as a member and bailiff of Girling Angling Association (one of the oldest angling clubs in the country) Frank Bagley (the club Secretary) and I sought committee approval to join the Angling Trust WQMN to monitor water quality in our area."

In July 2023 Girling Angling Society were awarded the WQMN Club of the Year Award for their efforts on the Warwickshire Avon.

What is the data showing?

Andy Hammerton began monthly measurements in May 2022 recording results on the WQMN Epicollect project and also on the club's website: **www.girlingas.co.uk**

Girling Angling Society sampling has shown the Phosphate level has remained alarmingly high throughout.

- Phosphate readings peaked at 1.29 ppm.
- 64 samples out of 69 samples (93%) exceeded the Water Frame Directive standard for phosphate (0.306 ppm)
- Nitrate readings peaked at 20 ppm.
- 59 samples out of 69 samples (86%) exceeded 5 ppm for nitrate.

Actions so far

In 2022 the club contacted Severn Trent, who have several outfalls upstream at Evesham, and they took various measurements upstream of Fladbury reporting that there was no single source, adding that their records show high Phosphate levels were present since 2009.

In early 2022 swimmers became ill and local resident Louise Bugg inspired by the results shown on the club website started the Avonvale River Action Group supported by Girling Angling Society. The group began measuring water quality above and below Fladbury reporting results to the WQMN Epicollect project and published on the group's website : **www.avonvaleriver.org**

Andy Hammerton said ... *Special thanks must go to Louise Bugg for her tireless work on raising wider awareness through the recently formed Avonvale River Action Group. Louise chairs the group and has secured local newspaper and television exposure taking awareness to new levels.*

Louise Jane Bugg, Avonvale River Action Group Chair and local resident, said ... "As a local resident of Fladbury and regular swimmer in the River Avon I am passionate about ensuring that our river is healthy and a safe environment for us all to enjoy.

I was contacted by a friend in the summer of 2022 as they were concerned that some children had become ill after swimming in the river. I made some contacts with local councillors and they helped me to make contact with the Environment Agency and Severn Trent Water to discuss the issue. I was also made aware of Girling Angling and their work with the Angling Trust Water Quality Monitoring Network. I offered to join and purchased a kit to start sampling further up the river in Fladbury and Evesham.

Avonvale River Action Group protest on World Rivers Day 2023

Andy Hammerton and Louise Bugg testing during the World Rivers Day protest

Since then I have set up Avonvale River Action Group to extend the monthly sampling of the river water quality along the River Avon from Evesham to Pershore working closely with Girling Angling. The group will gather local data to use to raise awareness in the area but will also contribute to the Angling Trust's Water Quality Monitoring Network (WQMN) national database. We are also working to raise awareness in the local community of the health of the River Avon and its importance to our environment.

We recently arranged a paddle from Evesham to Pershore to celebrate World Rivers Day gaining local and regional media coverage highlighting the issue of poor water quality of the River Avon."

"In the future, we want to work together with individuals and organisations who have a responsibility for the health of the river or who have a direct impact on river water quality. We want to see positive change in the water quality of the River Avon."

What next?

Andy Hammerton added ... *"It is truly commendable what has been achieved by The Angling Trust, Girling Angling Society and Avonvale River Action Group and I am proud to be a member of all three. But, we need to go further!*

The water companies need to be held to account. They have profiteered for years by leaning on the naivety of their customers and that of the Environment Agency through a ridiculous expectation for the water companies to monitor themselves and their discharges. The Environment Agency need to be held accountable for allowing this poisoning of our rivers to go unpunished for years. Why? So why am I volunteering?

I am a realist and I know that this problem which has been allowed to carry on unchecked for years will not be fixed in my lifetime, even if the clean-up were planned to start now.
Sadly, it will be us that will have to foot the bill for the clean-up (unreasonably) further lining the pockets of the water company shareholders who have created the problem.

I doubt there will be a noticeable improvement in my children's lifetime either, but I live in hope that my grandchildren will see the river habitat returned to its former glory. Once again a safe environment for all recreational users to have the benefit of rather than the unsafe polluted waterway where recreational users are exposed to personal health risk."

Frank Bagley concluded by saying ...
"Despite seeking help from anyone that would listen we have failed to make any progress in improving water quality at Fladbury. Going forward, one way or another, we have to reduce the levels of pollution entering the rivers. DEFRA and the Environment Agency must return to regulating and monitoring to control this national disaster before it's too late for our natural fisheries to recover. I believe this cannot happen without a collective determination to resolve the issue."

ANGLING TRUST

Water Quality Monitoring Network

First year report: Physical and chemical water testing Angling Trust Citizen Science

Data owners:
This report summarises the voluntary work of 259 WQMN monitors. The monitoring would not be possible without their efforts.

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Contents

Executive Summary

The Water Quality Monitoring Network (WQMN) is an initiative of The Angling Trust launched in 2022 to support anglers in understanding the quality of their local waters and to empower them to seek improvements. This report summarises the progress made in the first year of the WQMN, and provides some catchment results mapping for volunteers, local catchment managers and others to visualise local spatial trends.

Using low-cost, and tried and tested, water quality monitoring methods, volunteers have made over 2000 measurements of nitrate, phosphate, ammonia, electrical conductivity, temperature and turbidity on 64 catchments across England and Wales, along with visual observations and photographs. The majority of nutrient measurements were within ranges thought to not be indicative of pollution, and visual records of algal blooms and pollution were uncommon. However, comparison with the upper limit of standards used by the Environment Agency statutory monitoring for the Water Framework Directive (WFD) showed that overall 35% of phosphate readings were of concern, and 44% of site averages (based on 8 or more samples within the year) indicated some evidence of pollution. Nitrate and ammonia levels exceeded standards (EU Nitrates Directive and Environment Agency WFD respectively) far less frequently. It should be noted that there are five classification categories under the WFD: High, Good, Moderate, Poor and Bad. Therefore measurements or site averages in this report which are identified as above the upper limit of WFD good standard are not necessarily in "bad" condition.

As the scheme continues to expand, more data visualisation will be possible, with further identification of local trends in water quality. Integration with statutory monitoring data, and weather data could enhance the identification of hotspots and drivers of poor water quality within catchments.

Citizen science data, such as those collected here by anglers, is a powerful complementary and supportive measure to the statutory monitoring undertaken by the Environment Agency (EA), and Natural Resources Wales (NRW). The WQMN dataset serves as testament to the widespread concern about river health, and the dedicated efforts of angling clubs. Citizen Science data could be further utilised by the statutory bodies and water companies as an early warning system, highlighting areas of concern for further investigation and action. This requires investment in the development of processes for the rapid identification of readings that indicate pollution, and rapid pathways to escalate concerns.

Introduction

The Angling Trust launched the Water Quality Monitoring Network (WQMN) across England and Wales in July 2022, following a successful trial on the Severn catchment. The network of volunteers undertakes on site physical and chemical (including nutrients) measurements of water quality in streams and rivers. This report summarises the first year's results across all rivers and catchments monitored and aims to provide a high-level summary of the scheme efforts and brief visualisation of the results thus far. This report is for all the volunteers who have collected data, and it is hoped that it can inform national efforts (e.g. CaSTCo – the Catchment Systems Thinking Cooperative) to increase the value and utility of citizen science collected freshwater data.

Methods

The WQMN is formed from angling clubs, anglers and other volunteers who undertake regular monitoring activities on rivers across England and Wales. Angling clubs recruit and organise teams of local monitors who are allocated monitoring sites. On a regular and consistent basis, these monitors gather a range of data for each site.

The WQMN monitors used a variety of equipment from a standard list: Electrical Conductivity and Temperature probe, Hanna Phosphate Checker, Nitrate Strips, and Hanna Ammonia Checker (not available to all WQMN monitors). WQMN monitors were encouraged to test water samples on a monthly basis and make observations on the weather, river flow, river level, visual algal blooms and pollution and record their results using the Epicollect smartphone app, which reports to a central, freely- accessible database. No biological measures of water quality were made.

Monitors are provided with a comprehensive volunteer pack detailing a risk assessment, how to select a sample site, suggested monitoring frequency, kit care and maintenance, safety guidelines, methods for collecting and analysing a water sample, and guidance for recording measurements on Epicollect5. The pack also contains links to training videos prepared by Cardiff University scientists for the Wye Catchment Collaborative Monitoring Network.

All results reported on Epicollect were screened by the Angling Trust staff for anomalies. To eliminate errors caused by inaccurate data input, any anomalies were discussed with volunteers. Some clubs have made preliminary comparisons of their data to Environment Agency (EA) laboratory tested samples, and report consistent results, however this has not been quantified.

This first-year report summarises data collected between April 2022 and July 2023. Records that were clearly identified as having been taken from still waters (n=43) were excluded from this analysis, because still waters have different chemistry and ecology to flowing waters (streams and rivers). Eight records were identified as originating from transitional and coastal waters.

Comparison to environmental quality standards

Environmental quality standards displayed in figures and catchment maps are based on the following:

Phosphate and Ammonia: Under the Water Framework Directive (WFD), standards for phosphate and ammonia are calculated by Environment Agency (EA) and Natural Resources Wales (NRW) taking into account the natural variation based on altitude, alkalinity and stream order and they are therefore site specific. As site specific standards are not available for the sites sampled by the WQMN monitors (unless by coincidence they happen to also be the sites monitored by the EA or NRW), we needed another measure to interpret the levels recorded. The site-specific standards for England were requested from the EA who provided standards for 8349 sites across England. Within these standards: the maximum level for "good" classification for phosphate is 0.101 mg/l (PO_4-P) and for ammonia is 0.6 mg/l. For phosphate the EA standards are expressed as PO_4-P so it is necessary to convert to PO_4^{3-} to make it comparable with the measurements produced by the equipment used by the WQMN recorders: 0.101 mg/l PO_4-P = 0.31 ppm PO_4^{3-}. These upper limits of WFD good classification in England were used as a conservative guide to identify readings which may indicate some level of contamination and therefore sites of concern on the catchments maps. As we use the conservative overall upper standard, it is possible that more samples would exceed site-specific limits if they were available. It should be noted that there are five classification categories under the Water Framework Directive (WFD): High,

Good, Moderate, Poor and Bad. Therefore measurements or site averages in this report which are identified as above the upper limit of WFD good standard are not necessarily in “bad” condition.

Nitrate : Concern about nitrate pollution initially focused on drinking water supply, but there is now also recognition of nitrate’s role in eutrophication. The European Nitrates Directive (1991) set a maximum nitrate concentration of 50 mg/litre (equivalent to 11.3ppm NO3-N) which applied to all UK rivers. This limit is still used by the Environment Agency in England in their process of designating Nitrate Vulnerable Zones (NVZs), whereas in Wales, the Welsh Government replaced NVZs with Wales-wide regulations to tackle nitrate pollution from agriculture. There are no nitrate standards for rivers under WFD. In this report, citizen science measurements are compared to the 11.3ppm NO3-N standard. In the “Results by catchment” section, additional categories below the Nitrates Directive standard are given because there is some concern this is not stringent enough, and historical nitrate levels indicate that concentrations have been much lower in the past (EA, 2021).
All other levels may indicate some level of contamination. It should be noted that standards are site specific and based on an annual average, and as a growing season mean (March to September inclusive), and not intended to compare to one off readings.

There are tighter targets for protected rivers designated as Special Areas of Conservation (SACs) or Sites of Specific Scientific Interest (SSSIs) under Habitats Directive. It was not possible to obtain individual SAC/SSSI targets and compare to WQMN data from SAC/SSSI rivers within the scope of this report.

Confidence in the dataset

It is important to acknowledge the limitations and uncertainties of any dataset. Citizen science collected water quality data are intended to compliment the quality assured statutory monitoring. They have the potential to provide water quality insights in the temporal and spatial gaps that exist in statutory monitoring through more frequent monitoring over a great geographical range, and therefore greatly assist in the identification of pollution hotpots and the pressures on our river systems. **The data acquired through the use of low-cost equipment does not rival professional standard equipment in terms of accuracy and precision.** However their use has been tested by Cardiff University who directly compared results from the same low-cost equipment used by the WQMN to results from professional analysis and found them to perform well (von Benzon, 2022). Results were less precise than professional standard monitoring, but sufficiently accurate to identify trends and unusually high values. We can therefore be reasonably confident that the WQMN data are a sufficient level of accuracy for the purposes of this monitoring exercise – that is, to identify sites at highest risk or displaying unusual patterns.
It is possible that there is some bias in site selection, rather than sites being selected at random across the catchment. For the WQMN the following are potential sources of bias in the data:

- Skew in data collection towards pollution. People are more likely to volunteer where they think there is a problem.
- Conversely, skew in data to where people fish, which would be more likely to have good water quality, and to be in the middle and lower reaches.

The data collected by the WQMN in its first year are a mixture of ad hoc data collection, with some regular repeat sampling. One off samples at random locations carry more uncertainty than regular repeat sampling, and limits time trend analysis. Therefore in the section examining individual catchments we have focused on those sites that have been regularly sampled (8 or more samples at the same site).

Interpretation of concentrations and dilutions

The readings give a concentration – that is, a quantity of chemical per unit volume (for example mg phosphate per litre). A high concentration in a small volume of water is not necessarily of concern, if this water is discharged into a larger volume body of water that dilutes the high concentration (the same amount of chemical in a larger volume of water lowers the concentration). The environmental quality standards (WFD and Nitrate Directive) are predicated on larger rivers with comparatively high volumes of water. Many of the citizen science readings may be collected in small tributaries where standards have not been agreed. In a large catchment, small water bodies with high concentrations are not necessarily of concern since once the water reaches the main stem of the river, these concentrations could be diluted to fall within ‘good’ standards. We therefore suggest that the ‘good ecological status’ standards are useful for comparison, but recommend that citizen scientists note the relative discharge (volume of water per unit of time) of their stretch of water when making comparisons.

Conversely, small streams can maintain unique conditions providing habitat and refuge for a variety of organisms. The ecosystem functioning of small streams can also be significantly impacted by pollution. Interpreting the significance of nutrient concentrations is complex, with a large body of evidence to draw upon. Guidance from the academic community has already greatly supported the collection of citizen science water quality data (von Benzon et al.,2022). Additional guidance from across academic disciplines (physical, chemical and biological sciences) is now needed to support interpretation.

Overall dataset results

In this section all measurements made between May 2022 and July 2023 are collated to describe trends at the England and Wales scale in sampling effort, visual pollution and the main water quality parameters collected (phosphates, nitrates, ammonia and electrical conductivity).

Areas of concern:

- **Phosphates:** 35% of readings exceeded the England-wide upper WFD standard for good ecological status.

The good news:

- Sampling has increased (over time and areas covered).
- Visual records of algal blooms and pollution were uncommon.
- The majority of readings were below environmental quality standards for phosphates, nitrates and ammonia.

Sampling has increased (over time and areas covered)

The project has grown in popularity since its launch in May 2022, with now upward of 200 records regularly logged each month (Figure 1). WQMN monitors made a total of 2220 records up to 16th July 2023. The sampling effort across catchments was uneven, typical of ad-hoc citizen science monitoring schemes, but with clear potential for good coverage across England and Wales (Figure 2): the Water Quality Monitoring Network is now active in 64 catchments. Three catchments (the Medway, the Swale, Ure, Nidd and Upper Ouse, and the Severn Uplands, locations shown in Figure 2) have each been sampled almost 200 times by WQMN monitors in the first year of the project, and another eight catchments have been sampled over 70 times. A further 53 catchments have been sampled at least once (Figure 3). There are gaps in the reach of the network, and they are keen to recruit volunteer recorders in the remaining 37 catchments.

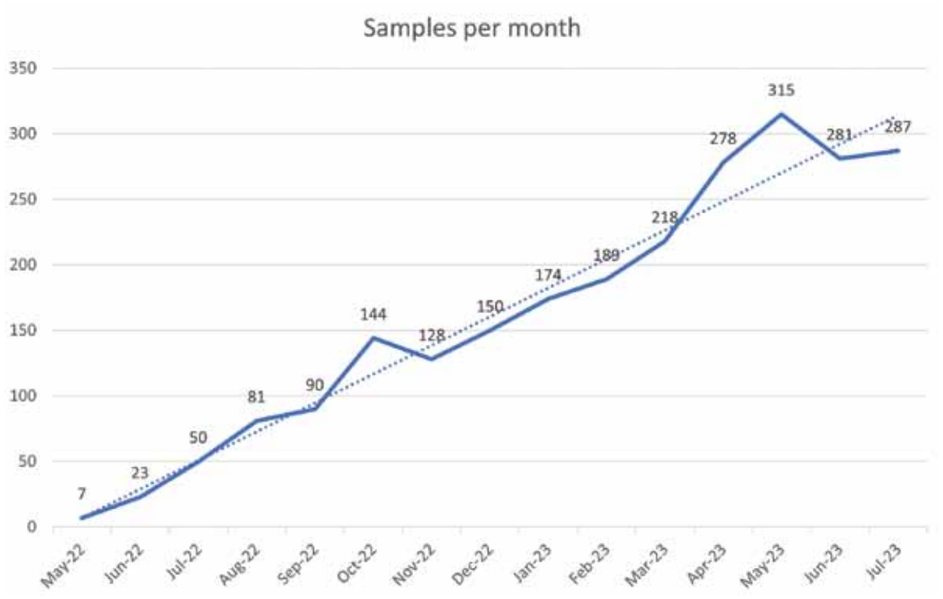


Figure 1 Increase in sampling effort over the duration of the project.

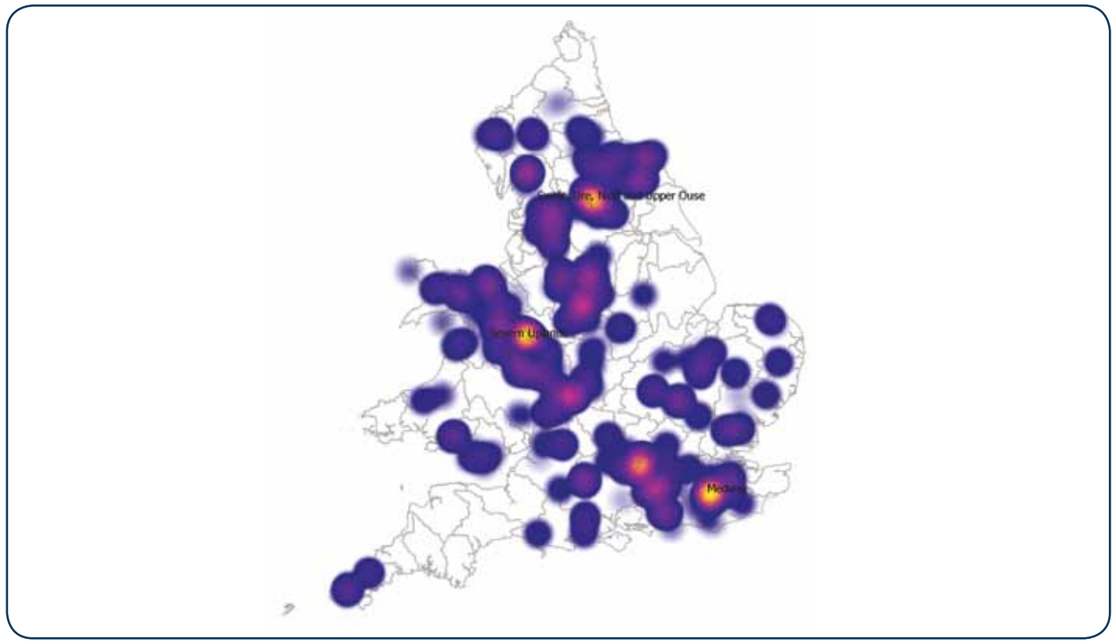


Figure 2 Heat map showing where samples were collected, the plot shows an uneven sampling effort across England and Wales hydrological units, typical of ad hoc Citizen Science data collection.

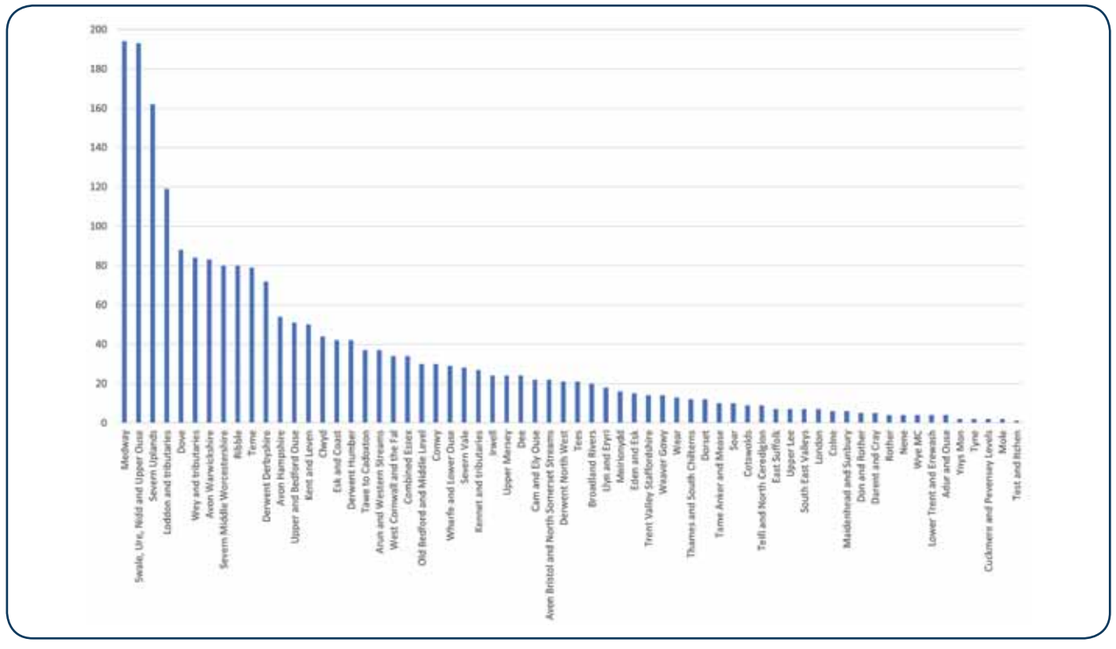


Figure 3 Number of records by catchment, not including 8 samples identified as being in transitional and coastal waters.

Visual Algal Blooms and Pollution

Observations of algal blooms and visual pollution were uncommon. Six percent of records (125/2220) recorded algal blooms, and six percent (110/2220) recorded visual pollution. Observations that were made were not spatially clustered, and instead were found in multiple regions of England and Wales (Figure 4).

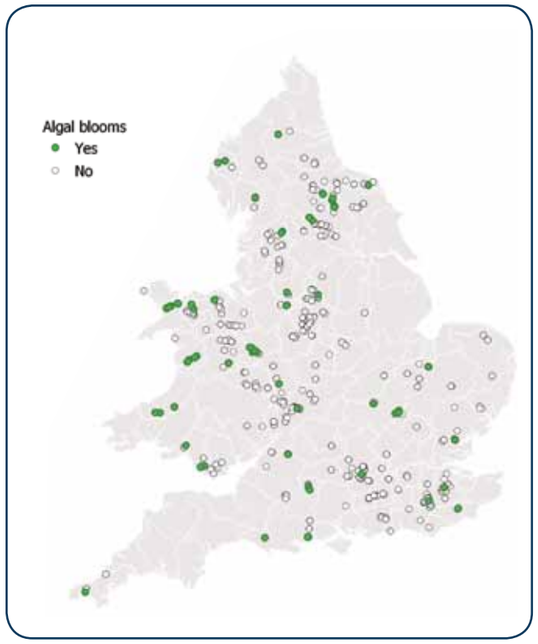
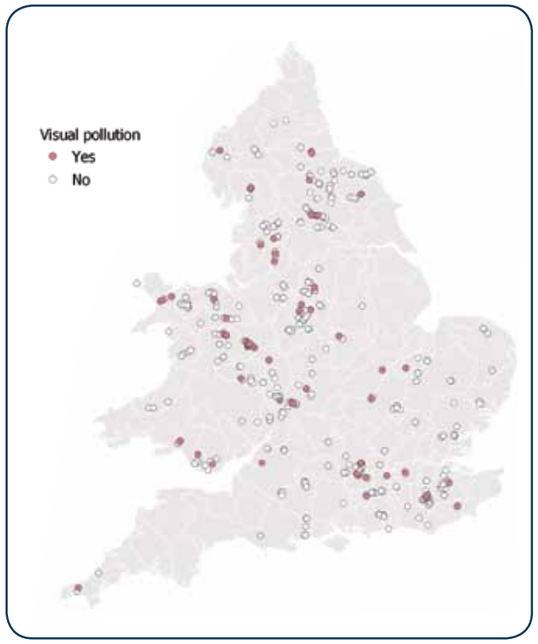


Figure 4 Sites where algal blooms or visual pollution were identified at least once during the recording period. Note that this map should not be used to interpret frequency, which was quite low at 5.63% of records (125/2220) for algal blooms and 5.95% (110/2220) for visual pollution.



Phosphate

Phosphate readings varied from 0 to 2.5 ppm* (Figure 5) which is the full range of the Hanna Colorimeter used by the WQMN. The majority of phosphate readings were below the England wide upper standard for good ecological status, however 35% (797 out of the 2220 readings) exceeded this level. The data demonstrate that phosphate concentrations varied greatly within, and between, catchments (Figure 6). Some of this variability is due to differing discharge, some because of natural processes (for example, biological activity), and some because of anthropogenic events. Outliers (white circles in Figure 6) are extreme values that could indicate individual pollution events (although that is not possible to confirm without further investigation).

**Note that the Phosphate Colorimeter upper limit is 2.5 ppm, the lower test limit is 0.00 ppm with an accuracy of ± 0.04 ppm, as stated by the manufacturer. So, a 0.00 ppm reading does not mean there is no phosphate present, it will be between 0.00 and 0.04 ppm. A 2.5 ppm reading does not mean that is the total phosphate, it means that it is in excess of 2.5 ppm. We note that there are uncertainties in the performance of the technique (von Benzon et al., 2021), particularly at very low concentrations, but we have confidence that measurements have adequate accuracy above 0.2 ppm.*

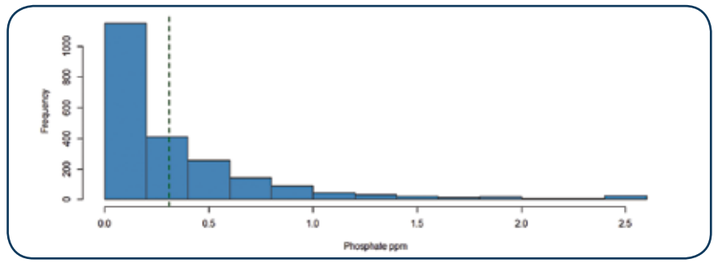


Figure 5 Frequency histogram of all phosphate readings. Green dashed line = upper limit of all WFD standards in England.

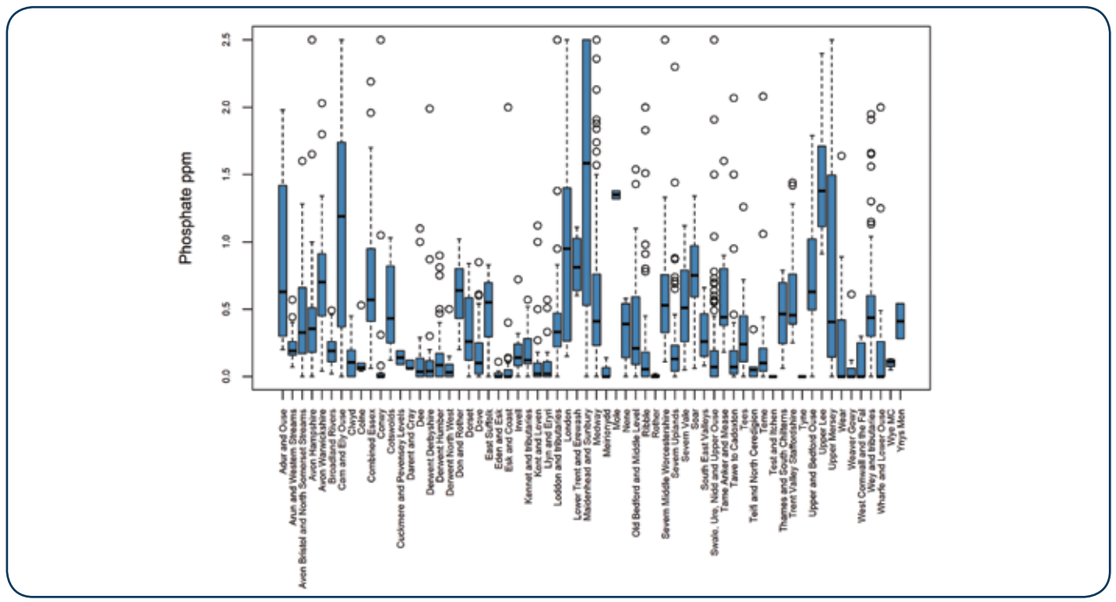


Figure 6 Range of phosphate readings in each catchment.

Nitrate

Nitrate readings varied from 0 to 50 ppm (Figure 7) which covers the full range of the test strips used. The majority were below the Nitrates Directive standard*, with fewer than 4% (86 out of 2217) of readings exceeded it. Nitrate readings were similar across most catchments (Figure 8), with most readings 10ppm or below, with a few exceptions. Cam and Ely Ouse, London, Severn Middle Worcestershire, Trent Valley Staffordshire and Upper and Bedford Ouse had more variable readings compared to other catchments. Outliers (white circles in Figure 8) are extreme values that could indicate individual pollution events (although that is not possible to confirm without further investigation).

** N.B. Nitrates Directive set an upper limit of 11.3ppm NO3-N for all rivers across the UK. Historical nitrate levels indicate that natural river conditions are often much lower (EA, 2021).*

Angling Trust note on nitrate assessment

The regulators approach is to focus on phosphate as the main cause of river eutrophication and the nutrient they are most able to reduce to levels that will improve the ecology. However many ecologists are increasingly concerned about the role of elevated levels of nitrate in eutrophication. But it is also difficult to assess nitrate enrichment as there is no Water Framework Directive (WFD) standard for nitrate in rivers, only lakes. In the absence of a WFD standard the report assessment of nitrate levels is against the EU Nitrates Directive, but there is some concern that *"this is not stringent enough, and historical nitrate levels indicate that concentrations have been much lower in the past."* WQMN volunteers are provided with guidance that indicates that nitrate levels ≥ 5 ppm are excessive and on that basis over 40% of samples exceed that level.

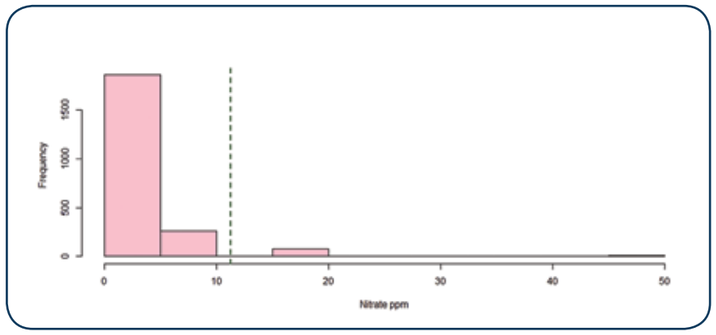


Figure 7 Frequency histogram of all Nitrate readings. Green dashed line = Nitrate Directive standard.

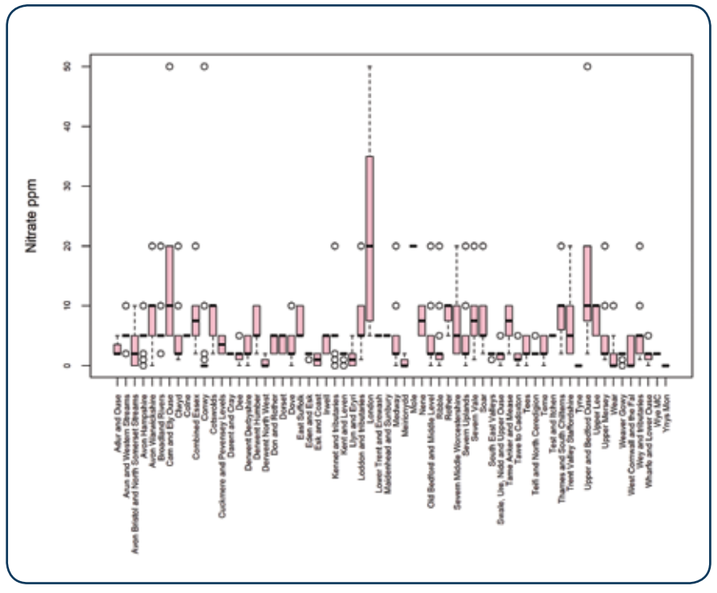


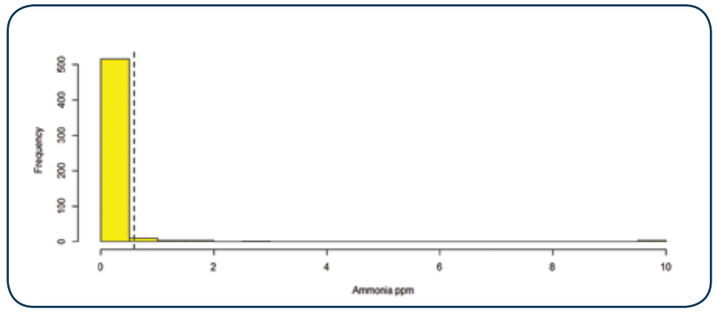
Figure 8 Range of nitrate readings in each catchment.

Ammonia

Ammonia readings varied from 0 to 9.99 ppm* (Figure 9) which is the full range of the Ammonia Colorimeter used. The majority were below the England wide upper standard for good ecological status, with less than 5% (25 out of the 546) of readings exceeding it. Ammonia readings were similar across most catchments, with only a very few exceptions (Figure 10); ammonia readings in the Derwent Derbyshire, Tawe to Cadoxton and the Teme catchments were more variable than in other catchments. Outliers (white circles in Figure 10) are extreme values that could indicate individual pollution events (although that is not possible to confirm without further investigation).

** The Ammonia Colorimeter upper limit is 9.99 ppm, the lower test limit is 0.00 ppm with an accuracy of ± 0.05 ppm ± 5%. So, a 0.00 ppm reading does not mean there is no ammonia present, it will be between 0.00 and 0.05 ppm ± 5%. A 9.99 ppm reading does not mean that is the total ammonia, it means that it is in excess of 9.99 ppm.*

Figure 9 Frequency histogram of all Ammonia readings. Green dashed line = upper limit of all WFD standards in England.



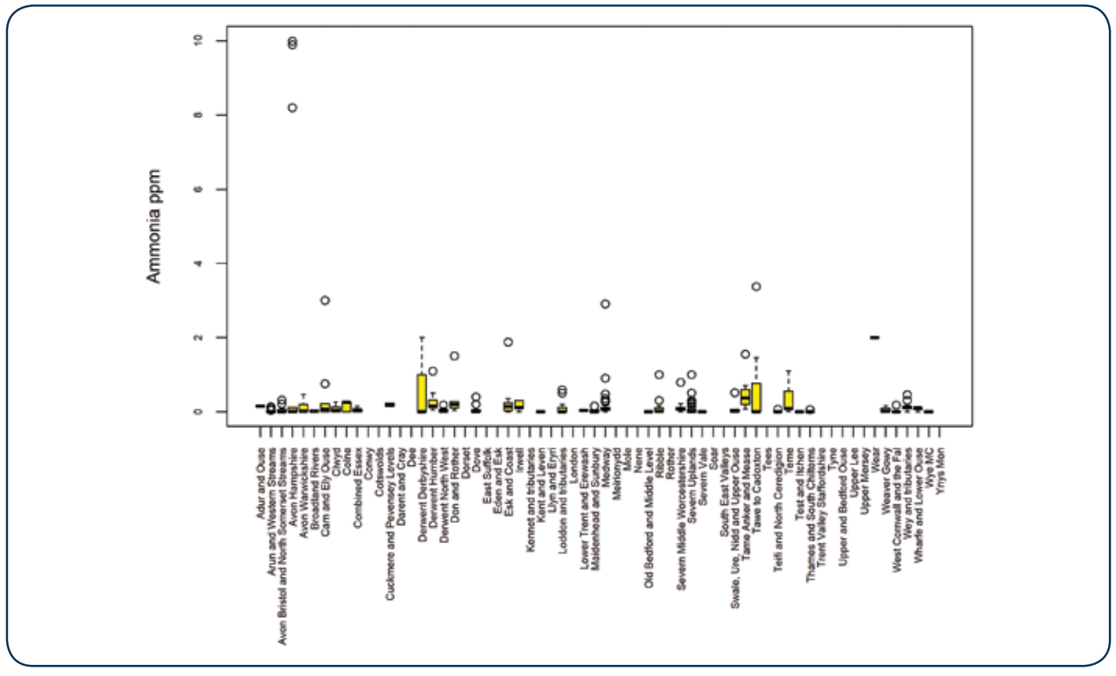
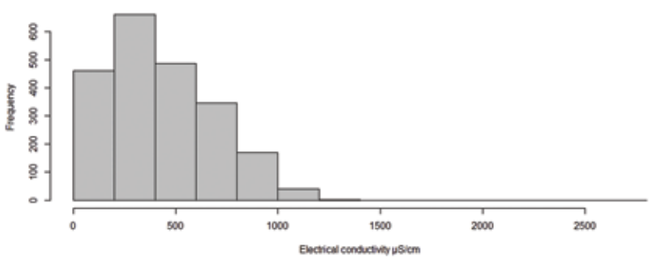


Figure 10 Range of ammonia readings in each catchment.

Electrical conductivity

Electrical conductivity (EC, measured in µS/cm = microsiemens per cm) can be an indicator of pollution, for example from sewage, agricultural run-off, or winter road runoff containing salt. EC gives us an indication of the total amount of dissolved solids (TDS) in the water. The higher the concentration of dissolved charged chemicals in the water, the greater the electrical current that can be conducted. EC varies naturally between different rivers due to differences in geology, temperature and stream discharge. For this reason there is not a national standard for which to compare the WQMN data to. However, collating EC measurements can help us to understand the natural range, and to help identify when readings are unusually high. In the WQMN data EC readings ranged from 34 - 2730 µS/cm, measurements over 1200 µS/cm were rare, just seven out of 2220 (Figure 11) and readings varied between catchments (Figure 12).

Figure 11 Frequency histogram of all Electrical Conductivity readings.



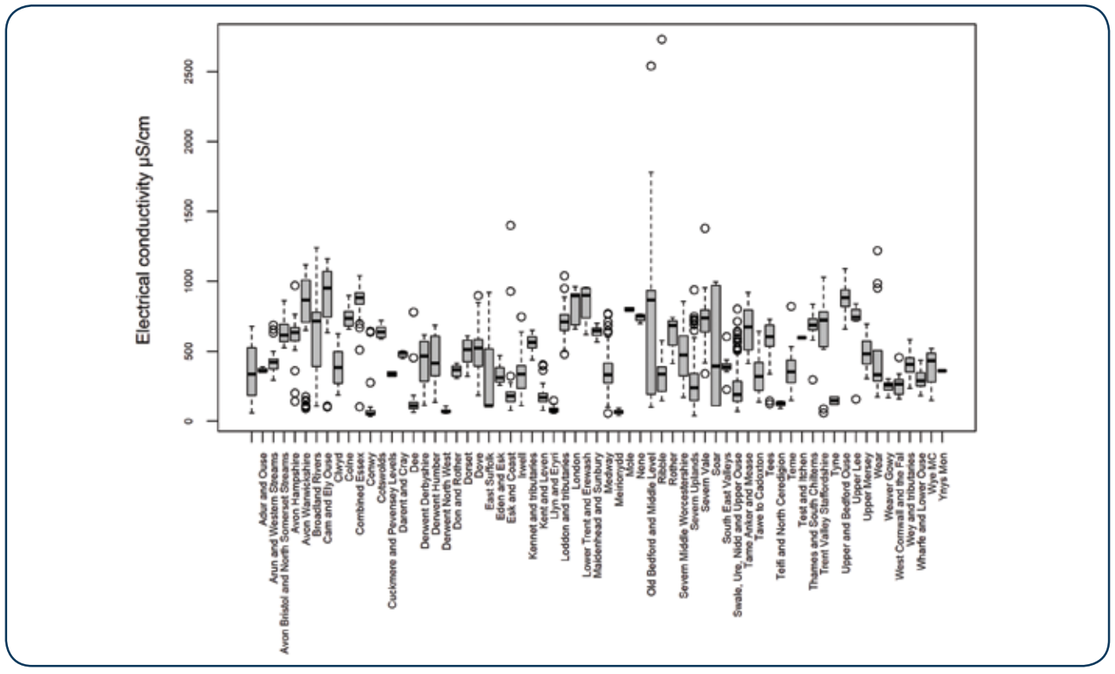


Figure 12 Electrical conductivity across catchments.

Results by catchment

The uptake of the WQMN has been variable and so the data available varies across the catchments of England and Wales. Some clubs have only just started collecting data while others have been regularly sampling sites since the start of the project. Therefore the data available for mapping, calculating site averages and starting to examine trends varies across catchments. In this section we mapped those catchments with sufficient amounts of data (>3 sites with 8 or more records within the 15 months of monitoring).

Areas of concern:

- **Phosphates:** 44% of site averages for phosphate exceeded the England-wide upper standard for good ecological status. Mapped catchments with high phosphate site averages were: the Medway (8/9 sites), Swale, Ure, Nidd and Upper Ouse (1/9), Severn Middle Worcestershire (4/4) Loddon and tributaries (5/8), Wey and tributaries (5/6), Avon Warwickshire (5/5), Ribble (1/5), Avon Hampshire (3/4) and Upper and Bedford Ouse (3/3). See catchments section for mapped details, and note that tributary size or discharge was not assessed in this classification.

- **Nitrates:** 5% of site averages for nitrate exceeded the Nitrates Directive standard. Mapped catchments with high nitrate site averages were: the Severn Middle Worcestershire (1/4 sites) and the Upper and Bedford Ouse (3/3 sites). See catchments section for mapped details.

The good news:

- No site averages for ammonia exceeded the England-wide upper standard for good ecological status, however far fewer ammonia measurements of ammonia were made compared to phosphates and nitrates measurements (approximately 4x more). See catchments section for mapped details.

All mapping was undertaken using QGIS, a freely-available spatial data visualisation tool. Sometimes samples will have been logged by the WQMN monitor on the river bank, or on a nearby bench, or during poor weather in their car, therefore we allowed for a small amount of spatial spread (200 m) between records for them to be considered from the same site.

For each catchment with adequate data (>3 sites with 8 or more records) five figures are provided:

1. A map of the distribution of records across the catchment
2. A panel of frequency histograms of results for phosphate, nitrate, EC and ammonia, showing standards above which may indicate some level of pollution, where applicable. Occasionally all data were below the standards, so the standard does not appear on the histogram.
3. Phosphate map: site averages below or above standard (based on the upper limit of WFD standards, see methods for details).
4. Nitrate map: site averages below or above Nitrates Directive standard. Additional categories below the Nitrates Directive standard are given because this standard is largely set with regards to risks to human health from drinking water, and natural river conditions are often much lower.
5. Ammonia map: site averages below or above standard (based on the upper limit of WFD standards, see methods for details).

The 15 catchments that met these criteria are listed in Table 1. We allow the reader to assess the figures and give brief interpretation in the Discussion, but individual site trends are not explored here.

Table 1 *Catchments for which calculation of site averages was possible. Those with more than three sites (show in bold) are mapped in the following section.*

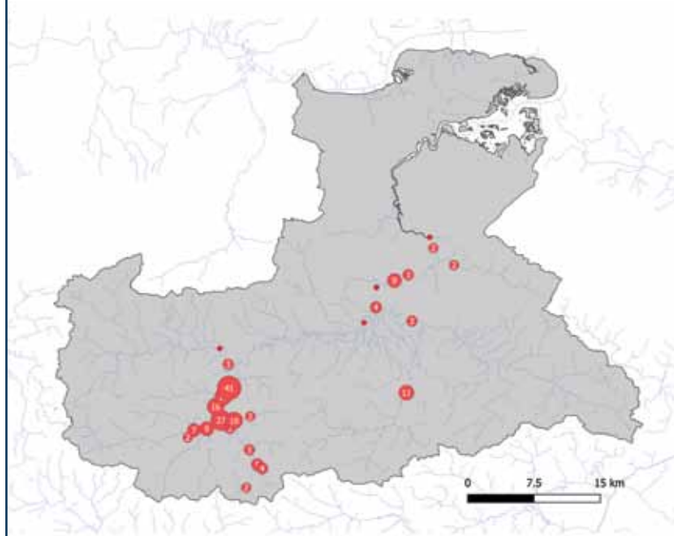
Catchment	Number of sites where site averages were calculated (sites with 8 or more records).
Medway	**9**
Swale, Ure, Nidd and Upper Ouse	**9**
Severn Uplands and Middle Worcestershire	**9**
Loddon and tributaries	**8**
Wey and tributaries	**6**
Dove	**5**
Avon Warwickshire	**5**
Ribble	**5**
Esk and Coast	**5**
Kent and Leven	**4**
Avon Hampshire	**4**
Tawe to Cadoxton	**3**
West Cornwall and the Fal	**3**
Upper and Bedford Ouse	**3**
Teme	**3**
Irwell	2
Derwent Derbyshire	2
Old Bedford and Middle Level	2
Cam and Ely Ouse	2
Broadland Rivers	2
Combined Essex	2
Upper Mersey	2
Derwent Humber	1
Derwent North West	1
Clwyd	1
Kennet and tributaries	1
Wear	1
Avon Bristol and North Somerset Streams	1
Cotswolds	1
Tees	1
	Total 103

catchment maps

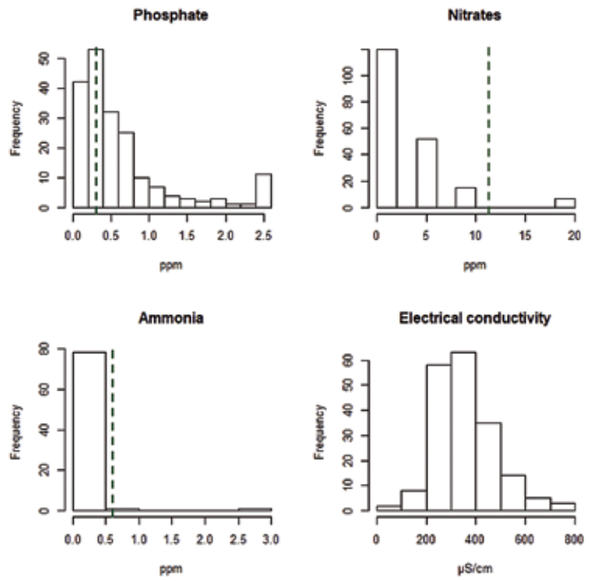
Medway

	Number of samples
Phosphate	**194**
Nitrate	**194**
Ammonia	**80**
EC	**188**
Temp	**194**

- 2 visual records of algal blooms
- 9 records of visual pollution
- Temp ranges 1.3-21.8°C

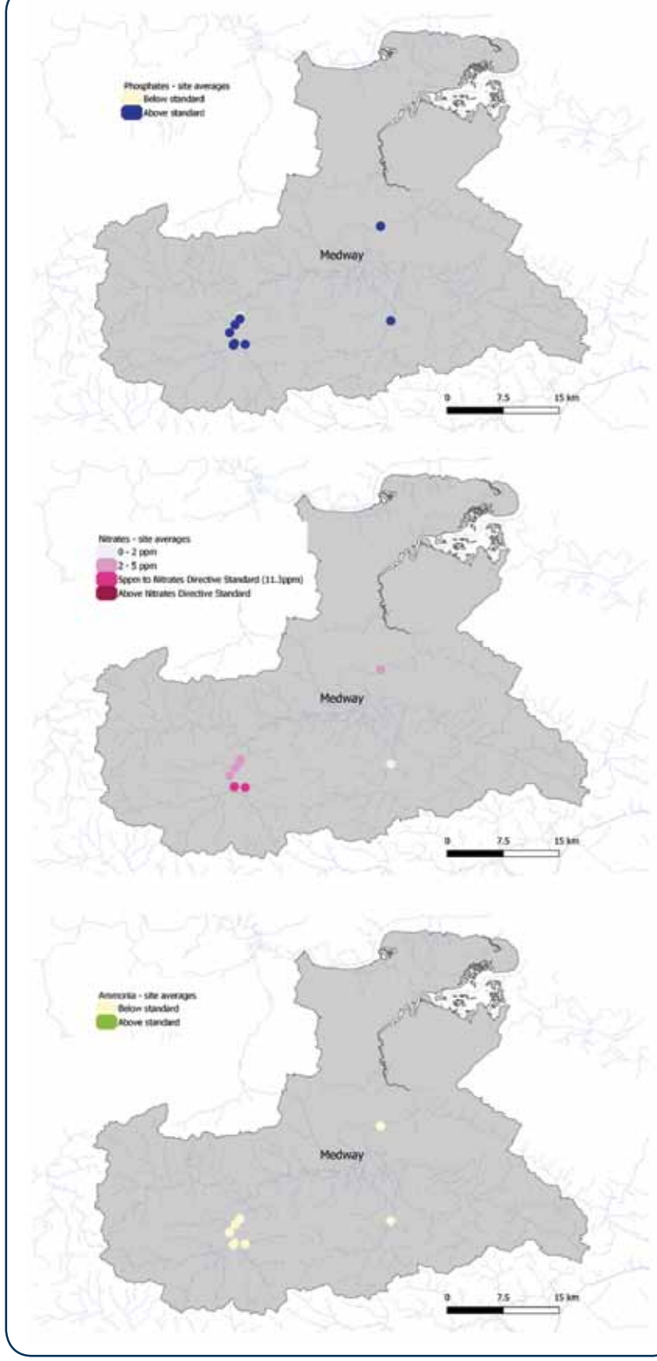


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Medway



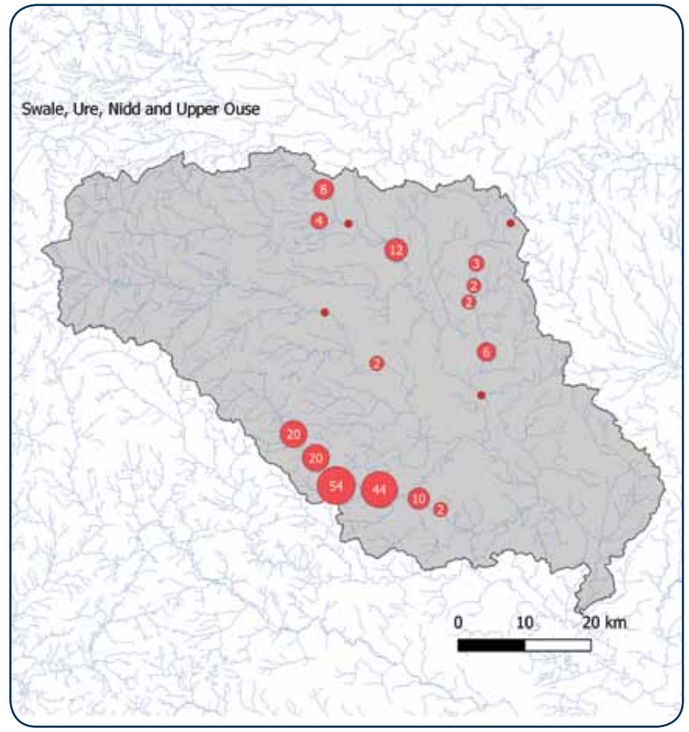
Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

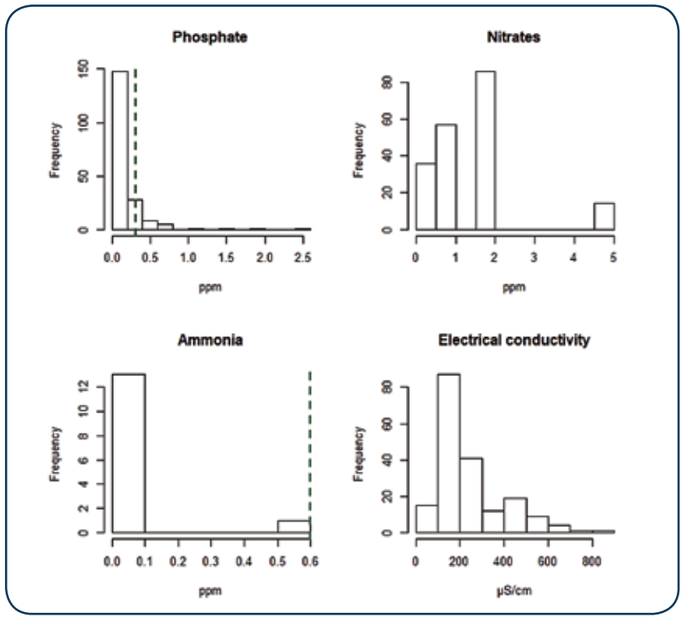
Swale, Ure, Nidd and Upper Ouse

Number of samples	
Phosphate	**193**
Nitrate	**193**
Ammonia	**14**
EC	**189**
Temp	**193**

- 12 visual records of algal blooms
- 6 records of visual pollution
- Temp ranges 0-22.2°C

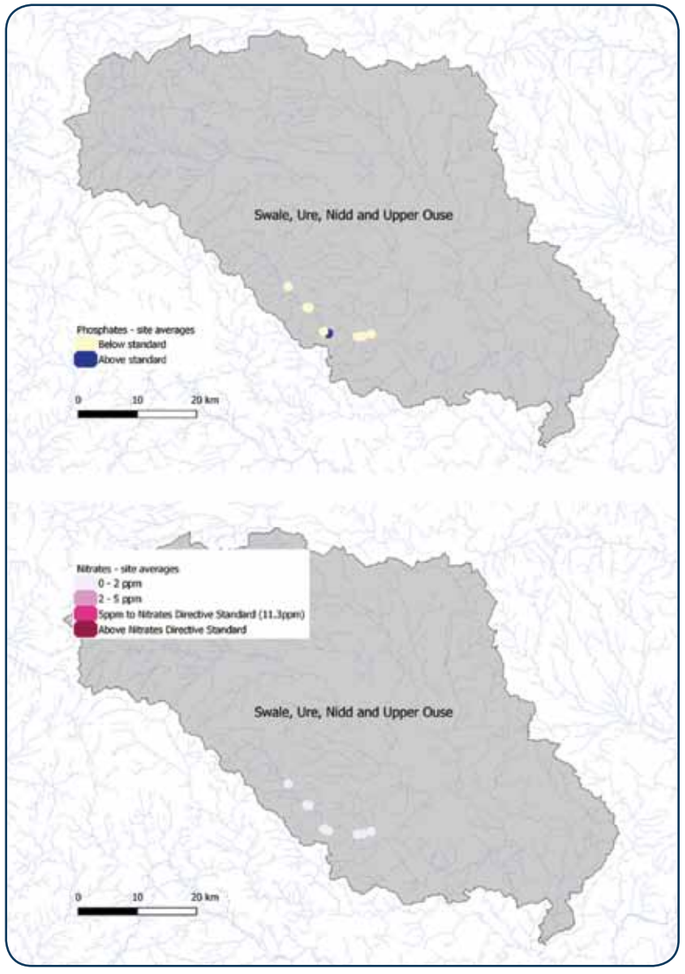
Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.





Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Swale, Ure, Nidd and Upper Ouse

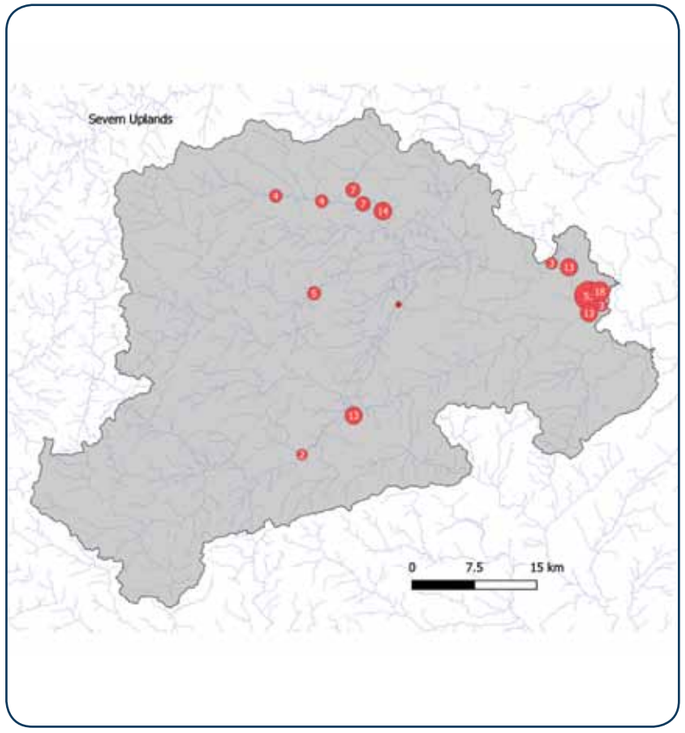


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

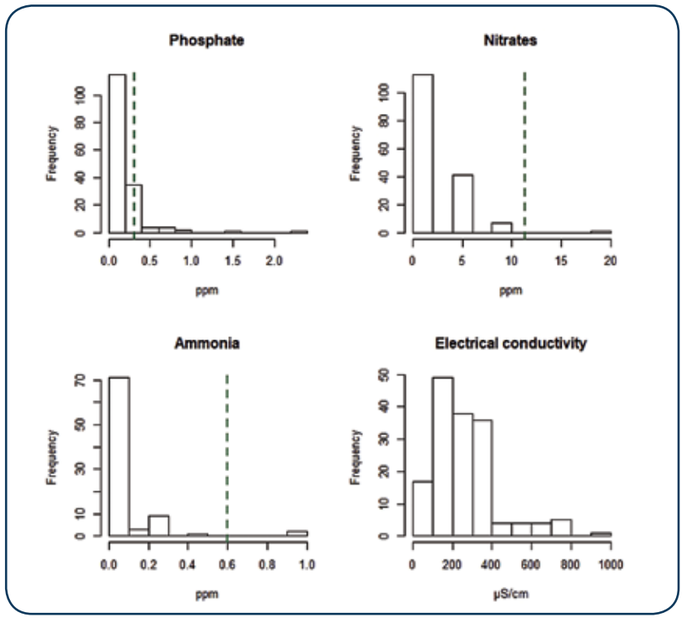
Severn Uplands

Number of samples	
Phosphate	**162**
Nitrate	**162**
Ammonia	**86**
EC	**158**
Temp	**162**

- 10 visual records of algal blooms
- 26 records of visual pollution
- Temp ranges 0-24.6°C



Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.

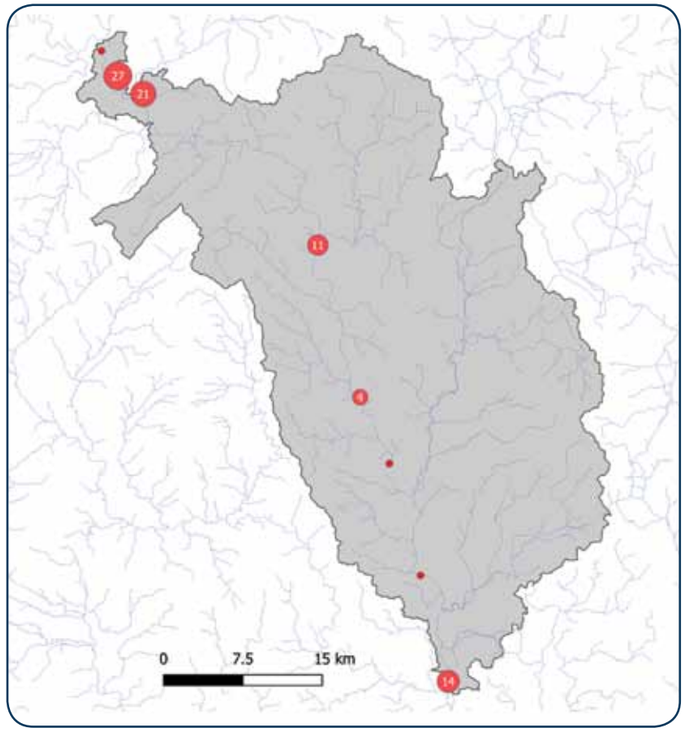


Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

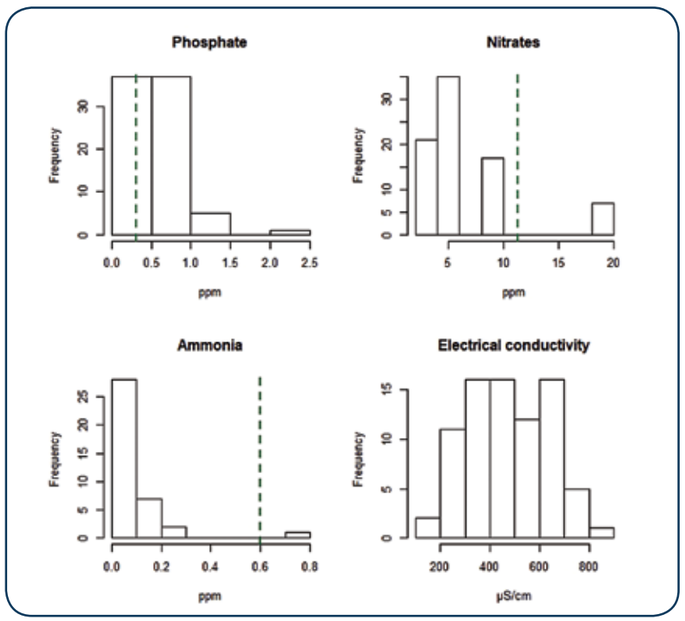
Severn Middle Worcestershire

Number of samples	
Phosphate	**80**
Nitrate	**80**
Ammonia	**38**
EC	**79**
Temp	**80**

- 3 visual records of algal blooms
- 10 records of visual pollution
- Temp ranges 3.9-23.2°C

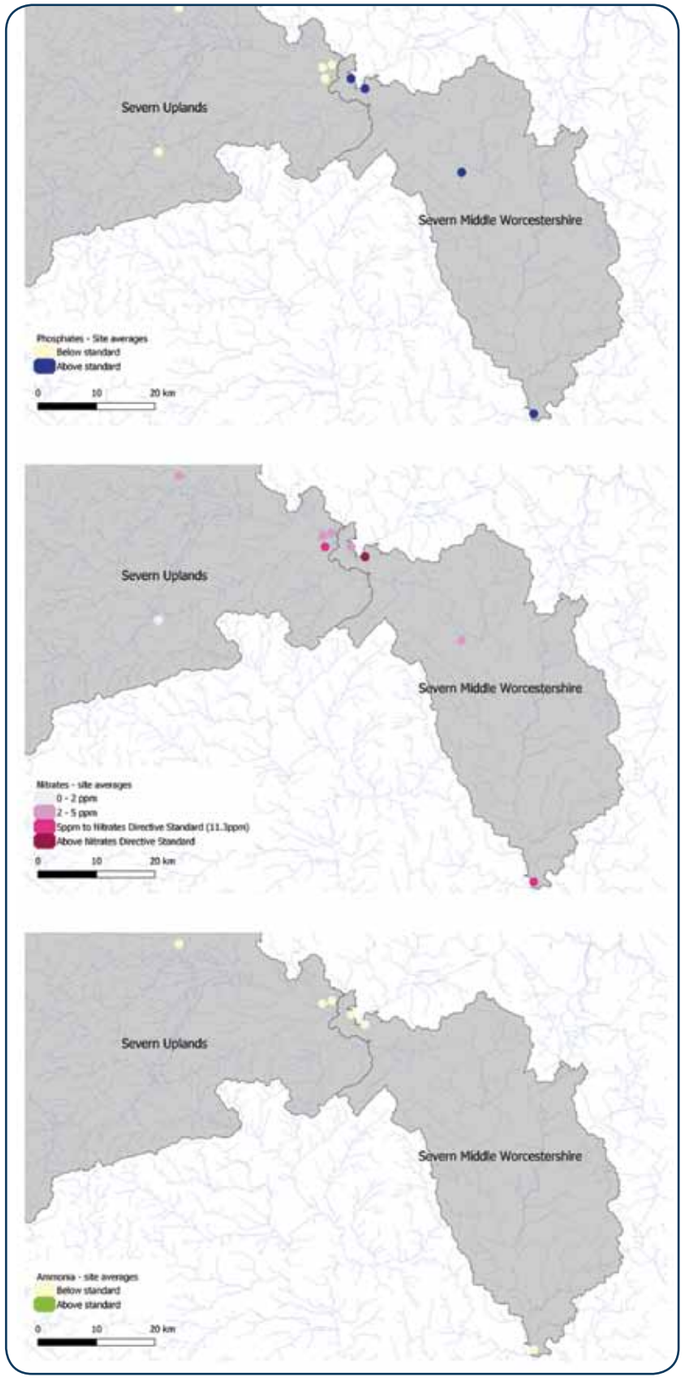


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Severn Uplands and Severn Middle Worcestershire

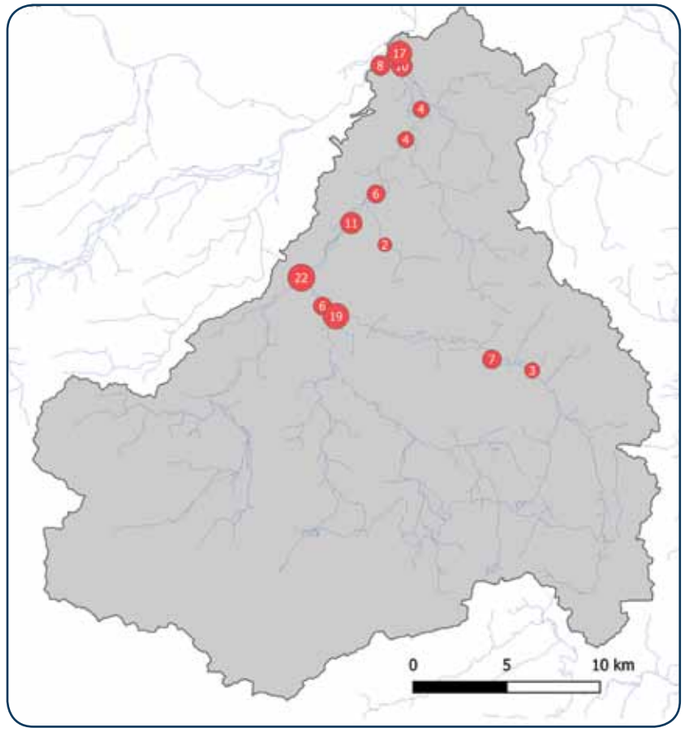


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

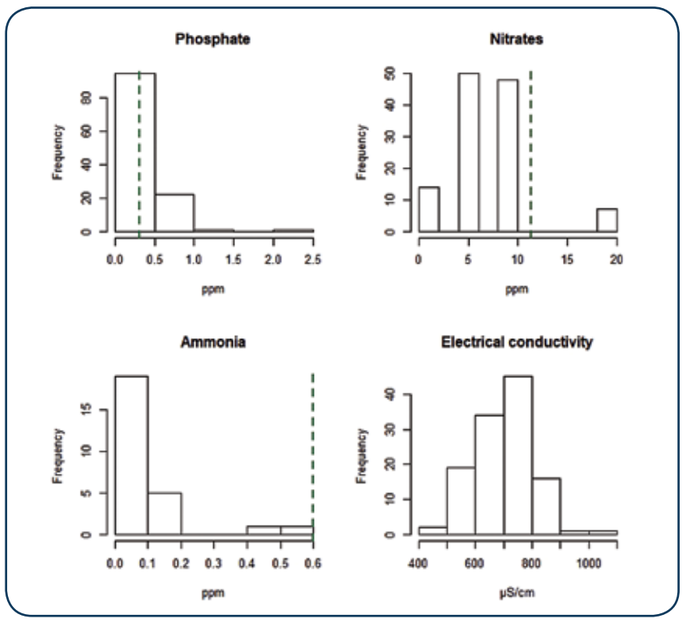
Loddon and tributaries

Number of samples	
Phosphate	**119**
Nitrate	**119**
Ammonia	**26**
EC	**118**
Temp	**119**

- 1 visual records of algal blooms
- 6 records of visual pollution
- Temp ranges 2.5-22.7°C

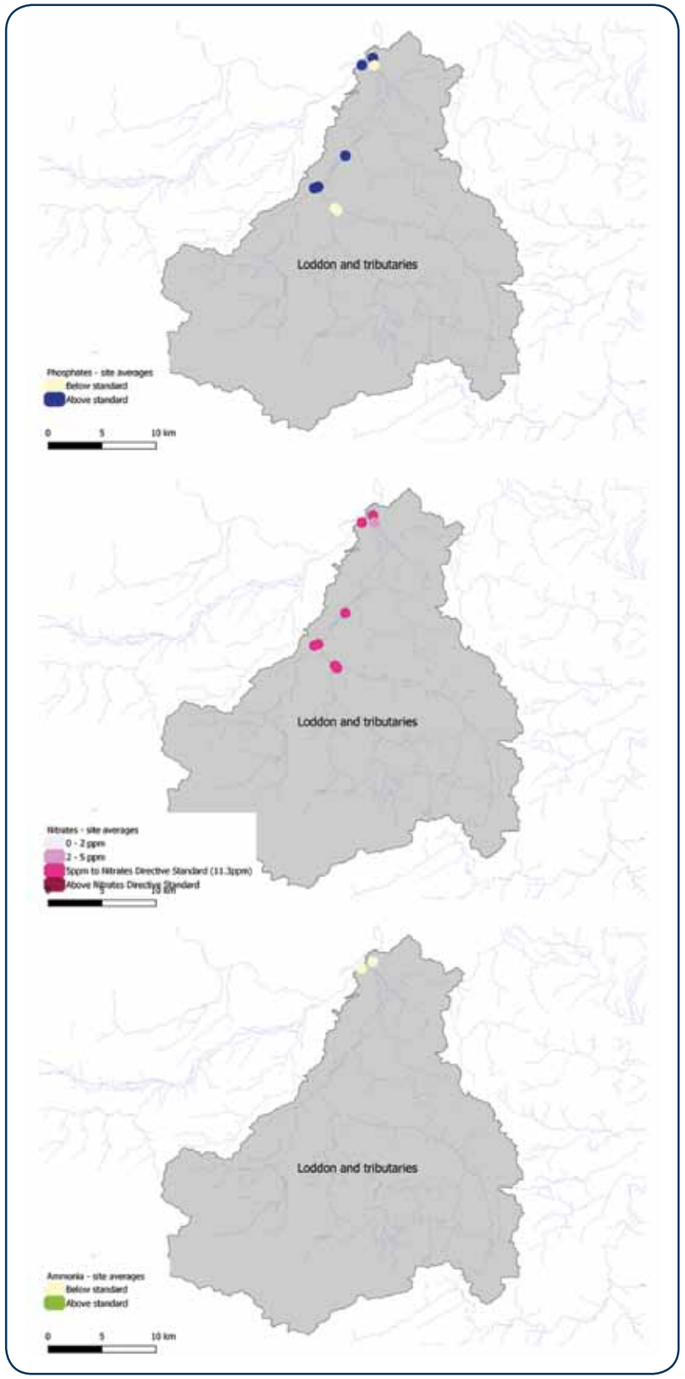


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Loddon and tributaries

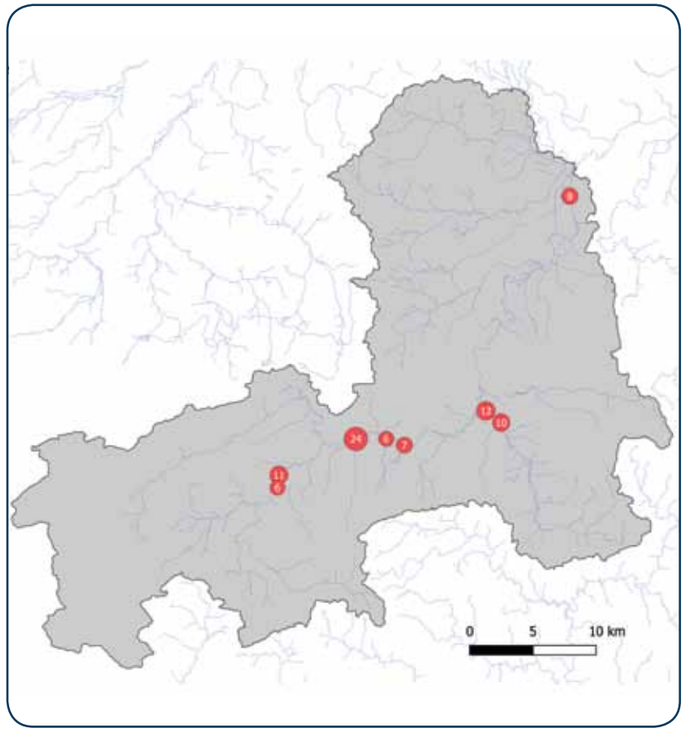


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

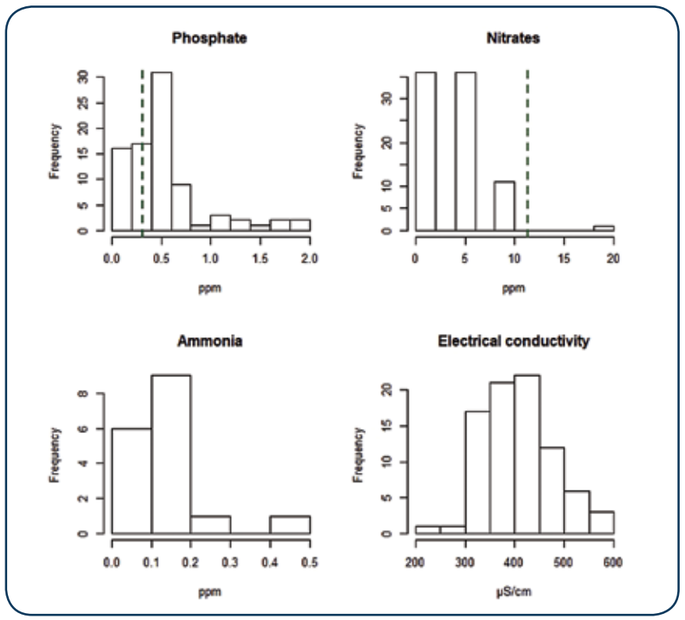
Wey and tributaries

Number of samples	
Phosphate	**84**
Nitrate	**84**
Ammonia	**17**
EC	**83**
Temp	**84**

- 0 visual records of algal blooms
- 3 records of visual pollution
- Temp ranges 2.5-23.4°C

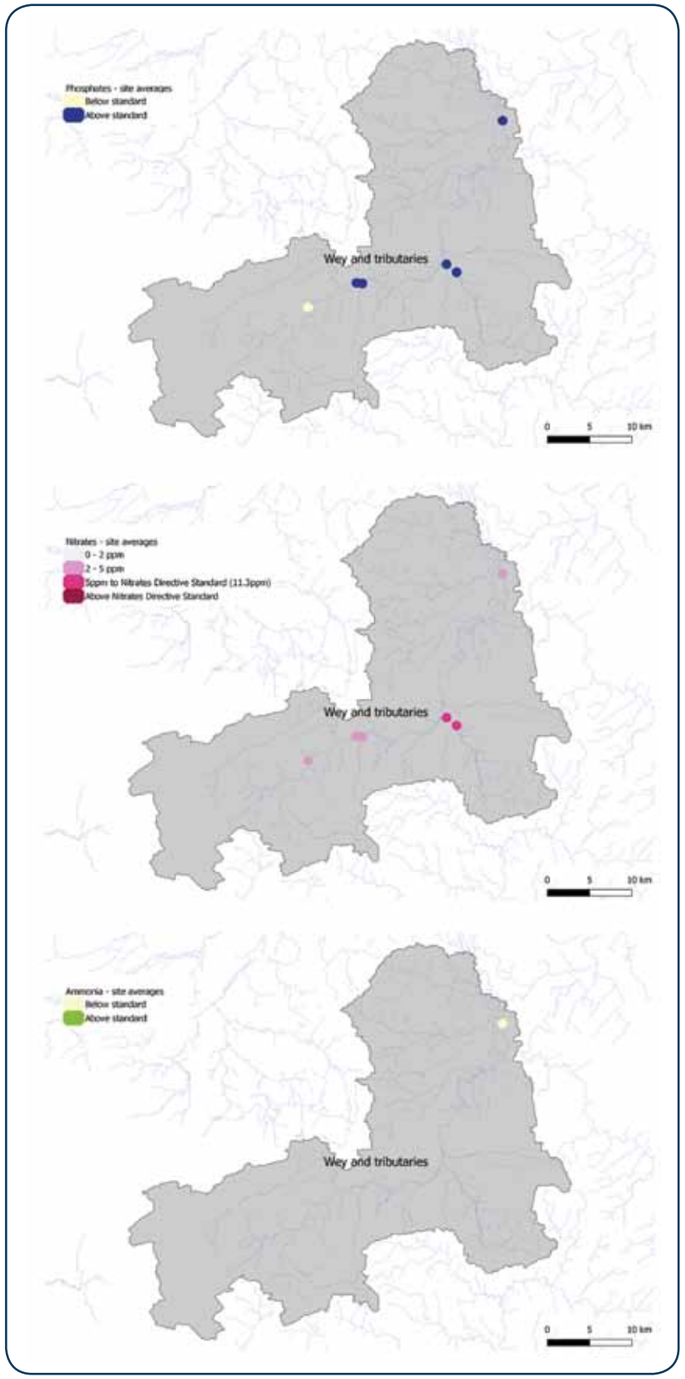


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Wey and tributaries

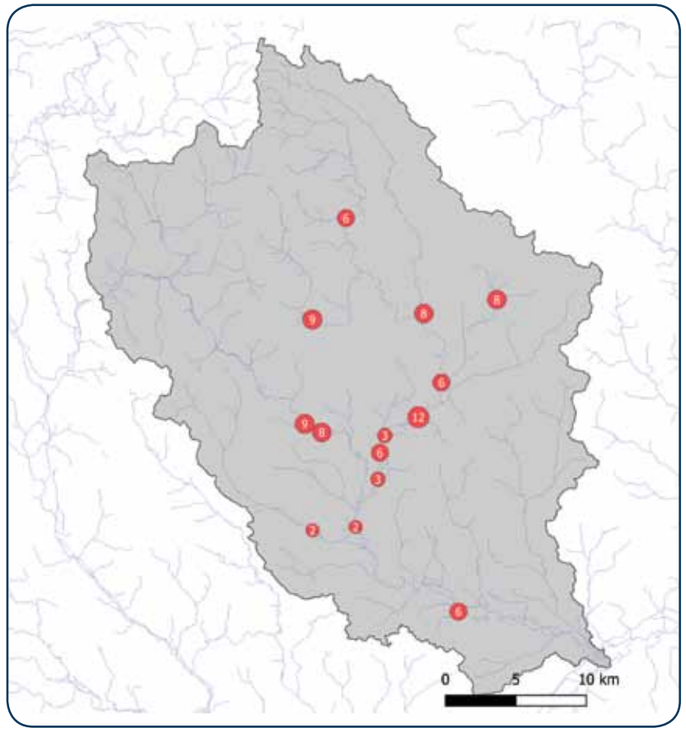


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

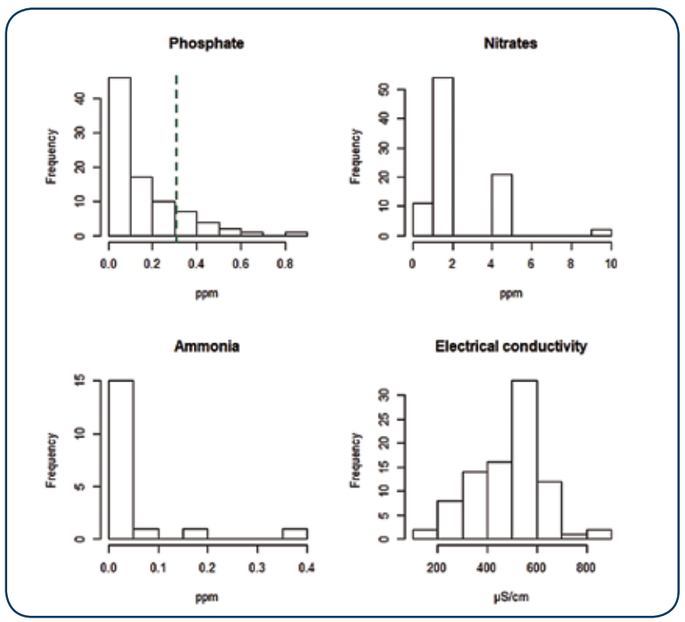
Dove

Number of samples	
Phosphate	**88**
Nitrate	**88**
Ammonia	**18**
EC	**88**
Temp	**88**

- 0 visual records of algal blooms
- 6 records of visual pollution
- Temp ranges 3.2-19.8°C

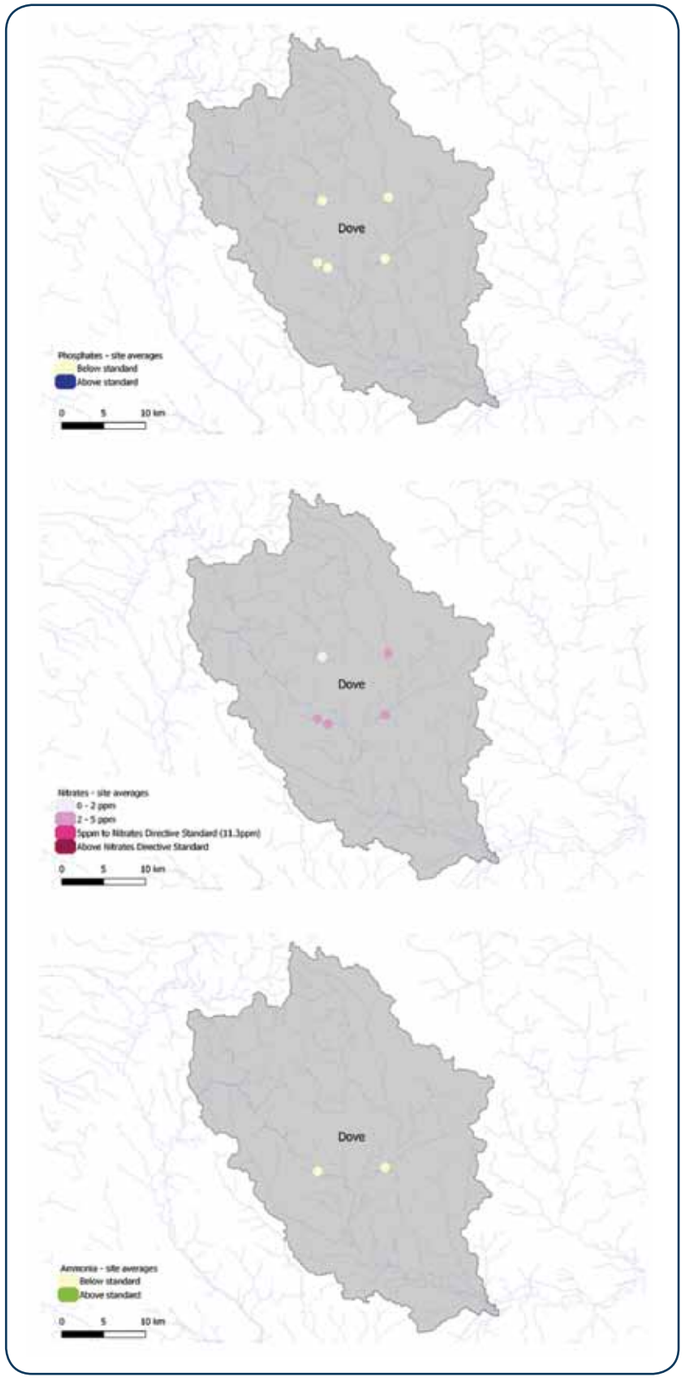


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Dove

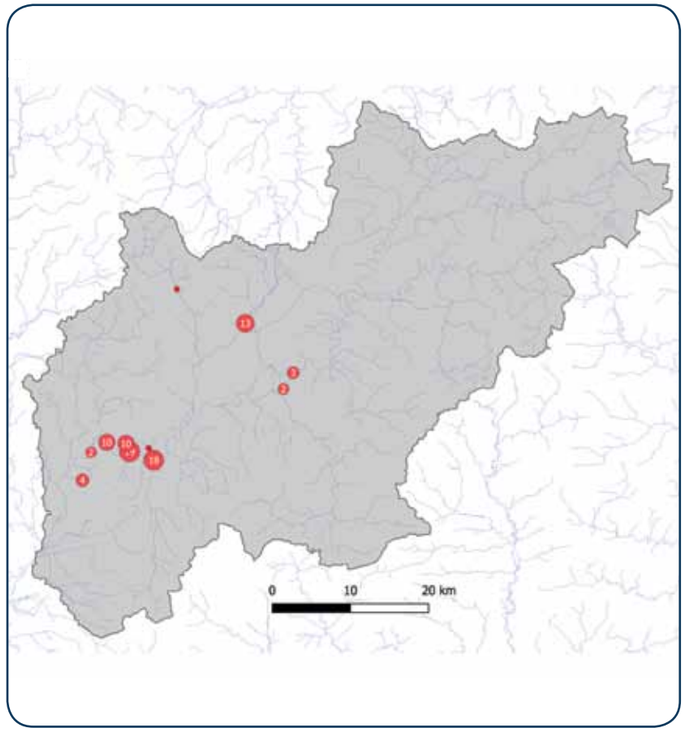


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

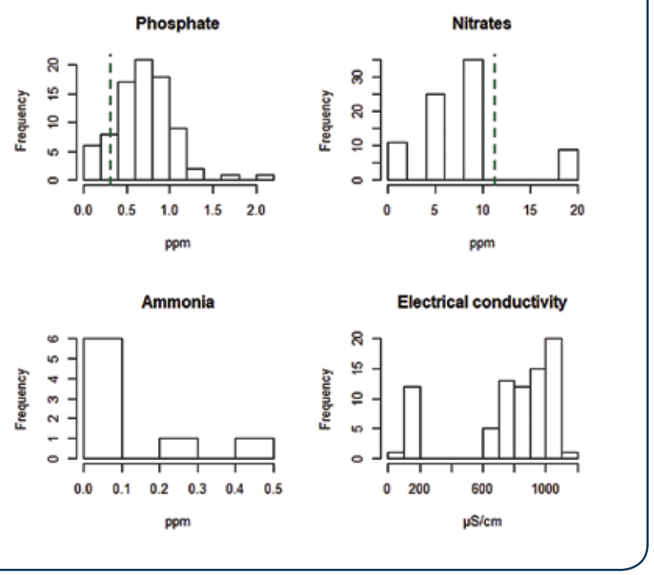
Avon Warwickshire

Number of samples	
Phosphate	**83**
Nitrate	**80**
Ammonia	**8**
EC	**79**
Temp	**83**

- 2 visual records of algal blooms
- 7 records of visual pollution
- Temp ranges 0-24°C

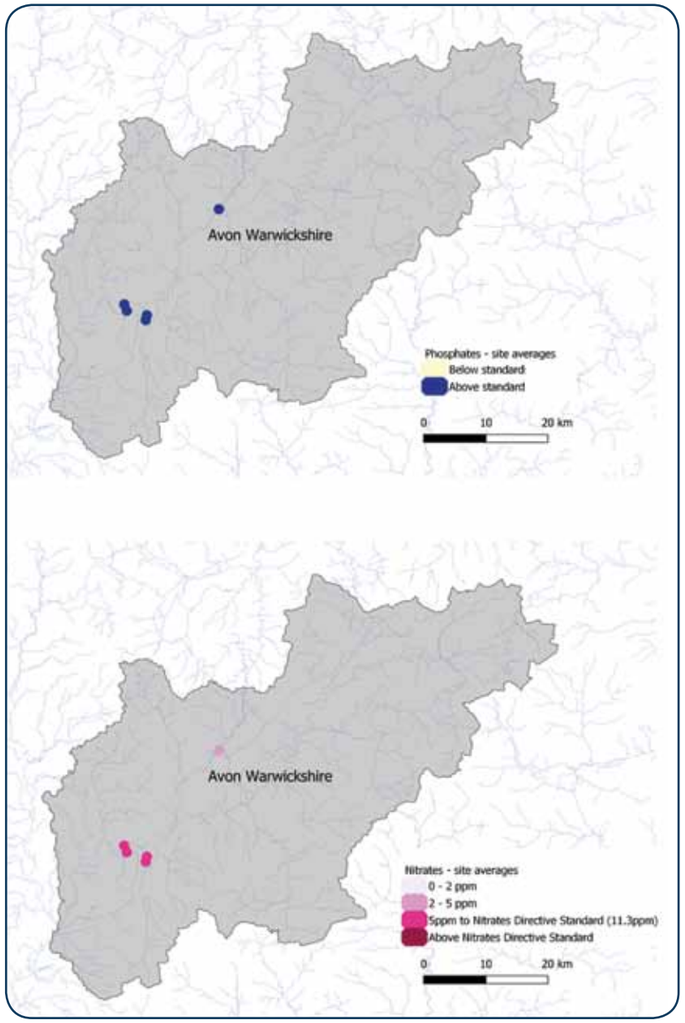


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Avon Warwickshire

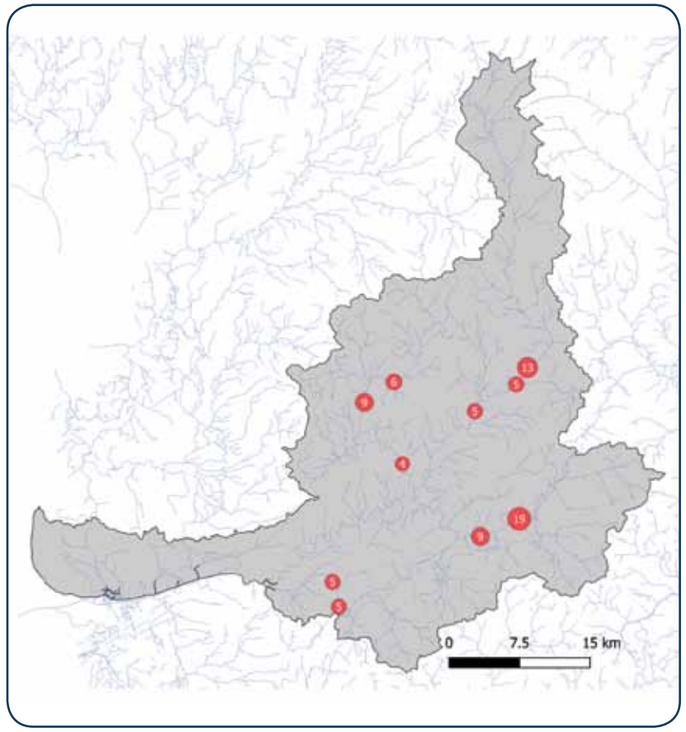


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

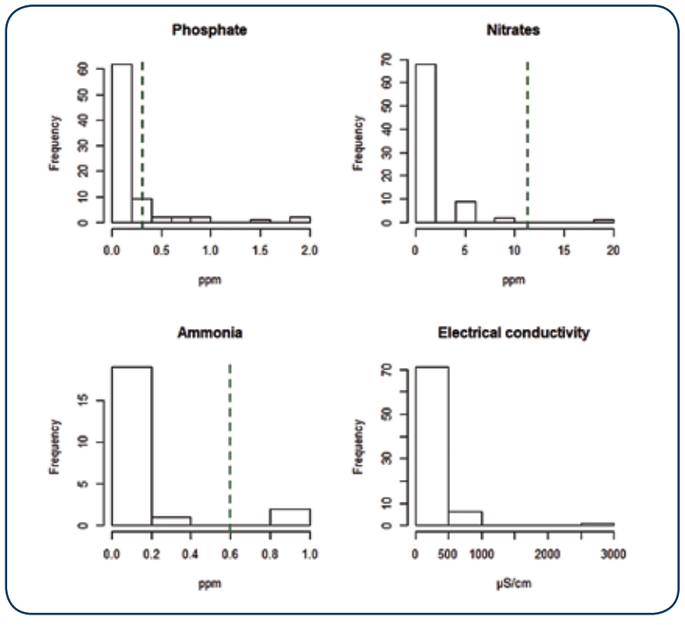
Ribble

Number of samples	
Phosphate	**80**
Nitrate	**80**
Ammonia	**22**
EC	**78**
Temp	**80**

- 3 visual records of algal blooms
- 2 records of visual pollution
- Temp ranges 4.5-25.2°C

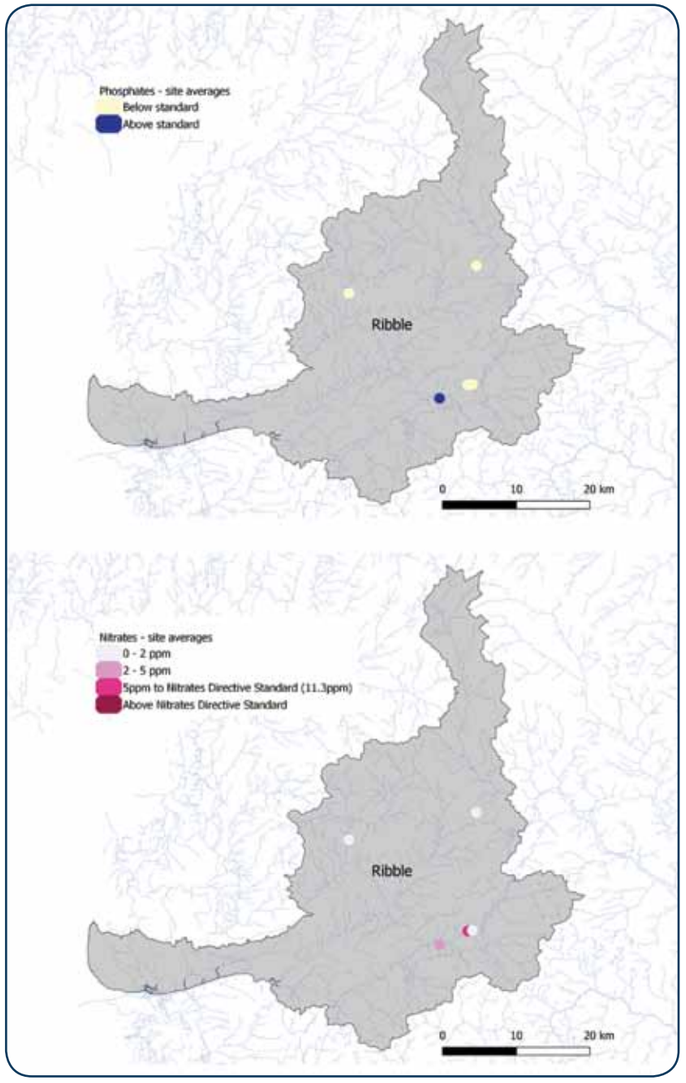


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Ribble

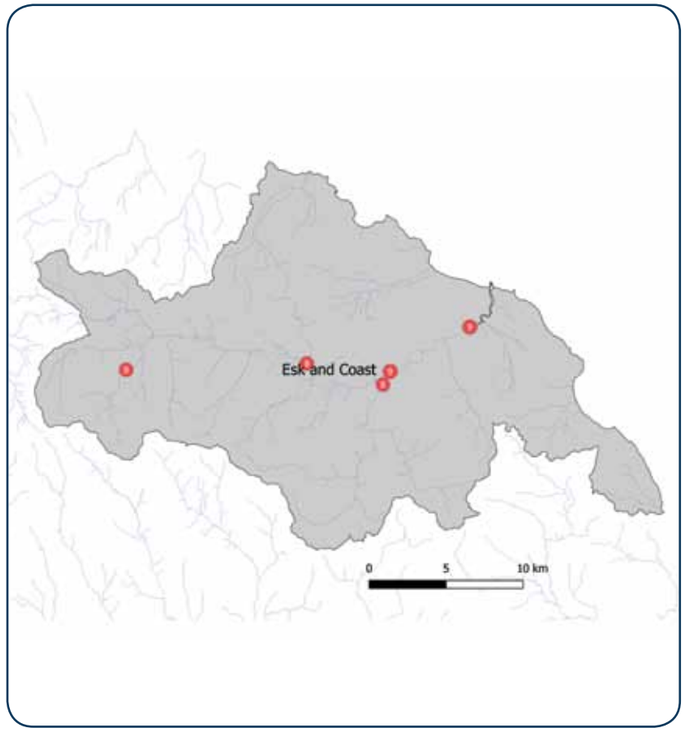


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

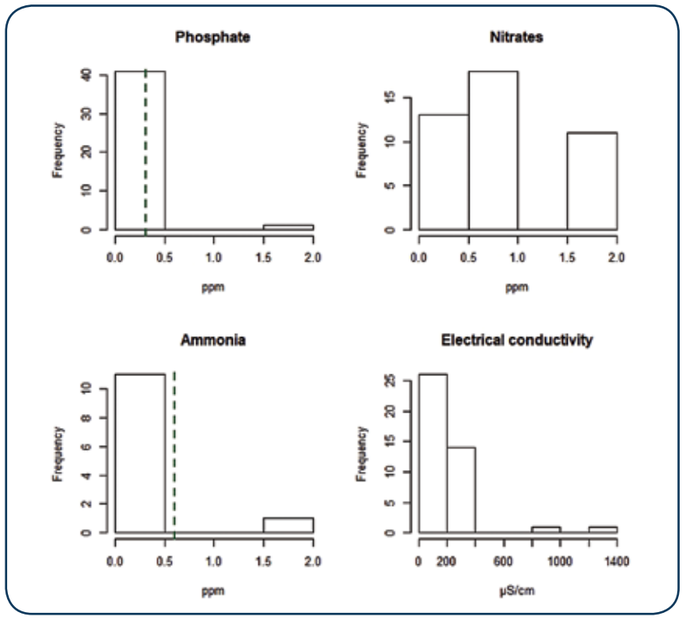
Esk and Coast

	Number of samples
Phosphate	**42**
Nitrate	**42**
Ammonia	**12**
EC	**42**
Temp	**42**

- 1 visual records of algal blooms
- 0 records of visual pollution
- Temp ranges 3.4-19.7°C

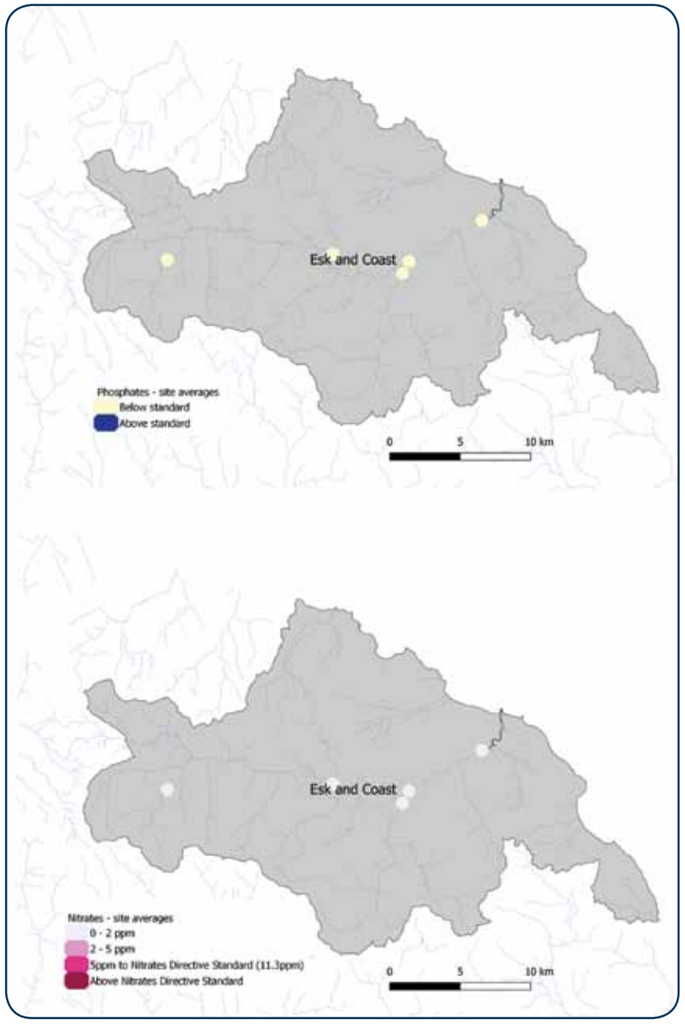


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Esk and Coast

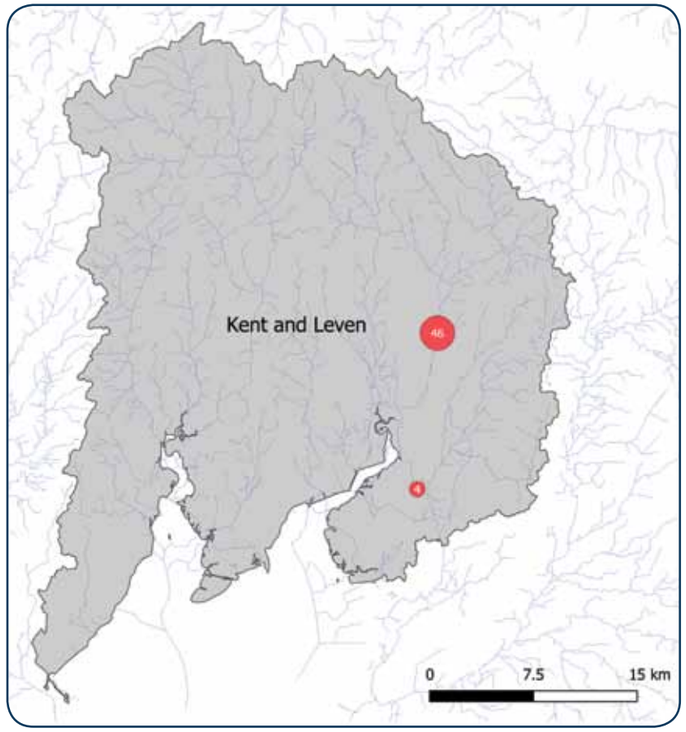


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

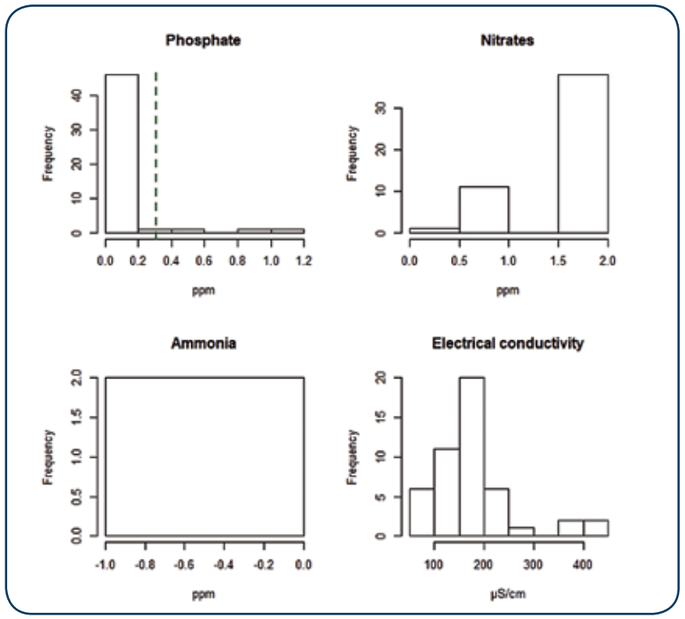
Kent and Leven

Number of samples	
Phosphate	**50**
Nitrate	**50**
Ammonia	**2**
EC	**48**
Temp	**50**

- 2 visual records of algal blooms
- 2 records of visual pollution
- Temp ranges 6.4-19.9°C

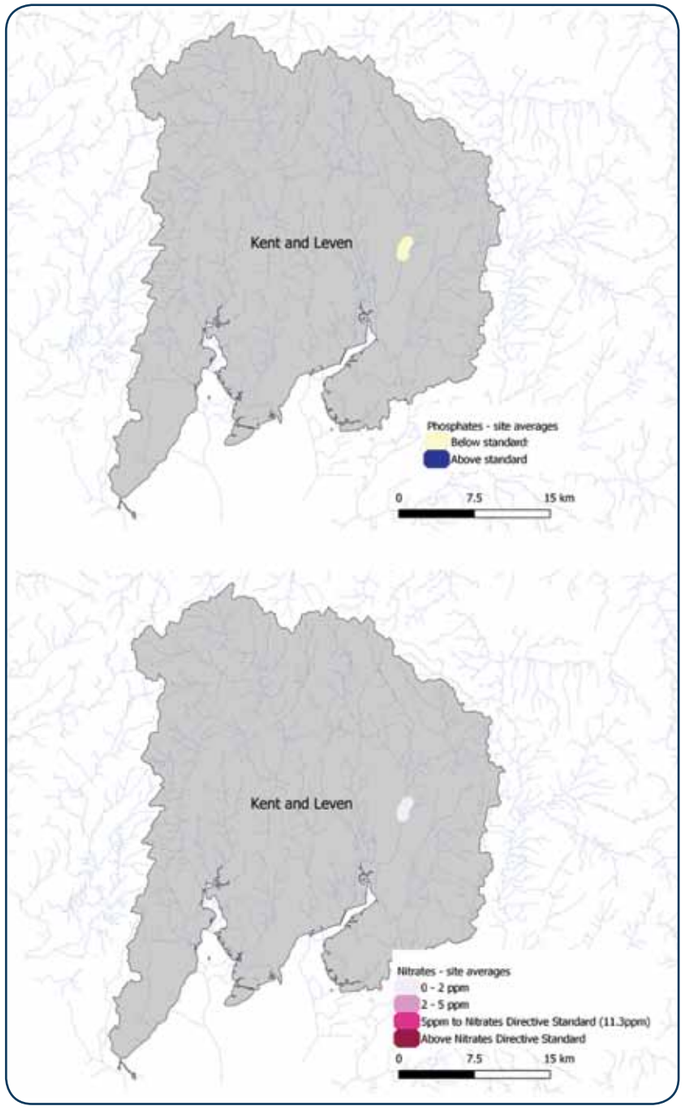


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Kent and Leven

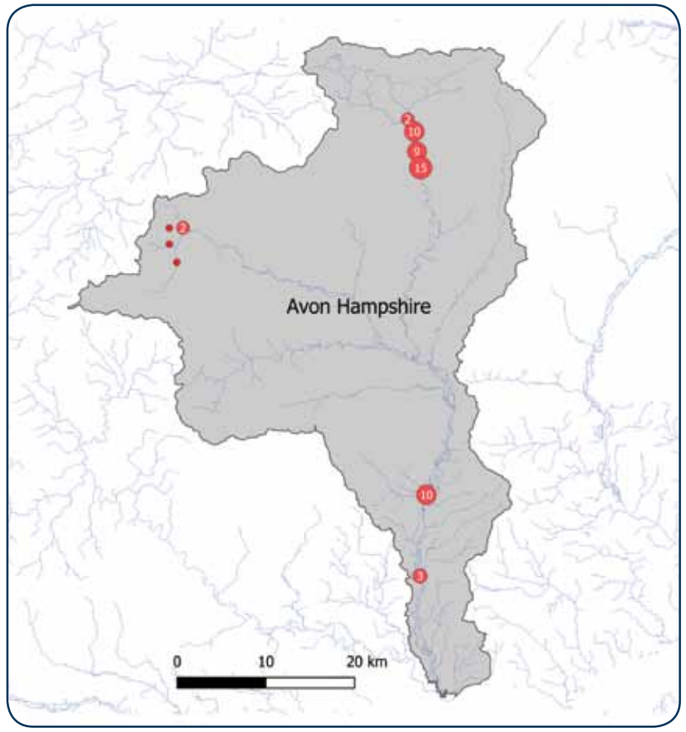


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

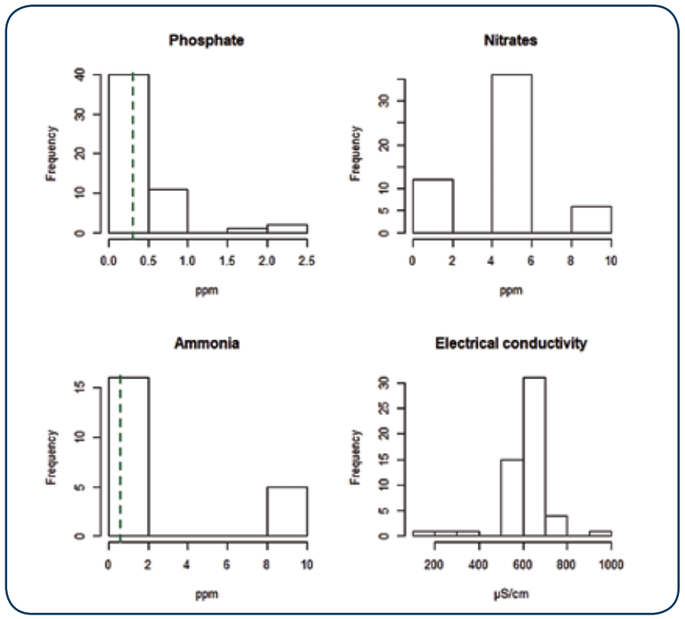
Avon Hampshire

Number of samples	
Phosphate	**54**
Nitrate	**54**
Ammonia	**21**
EC	**44**
Temp	**54**

- 2 visual records of algal blooms
- 0 records of visual pollution
- Temp ranges 4.1-23.3°C

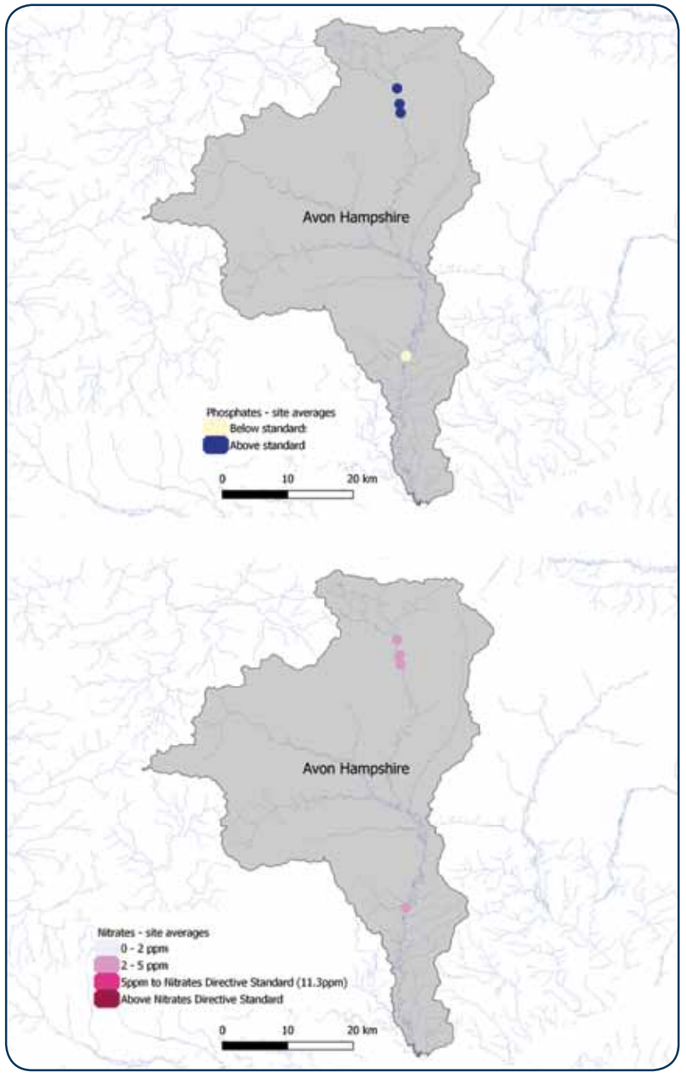


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Avon Hampshire

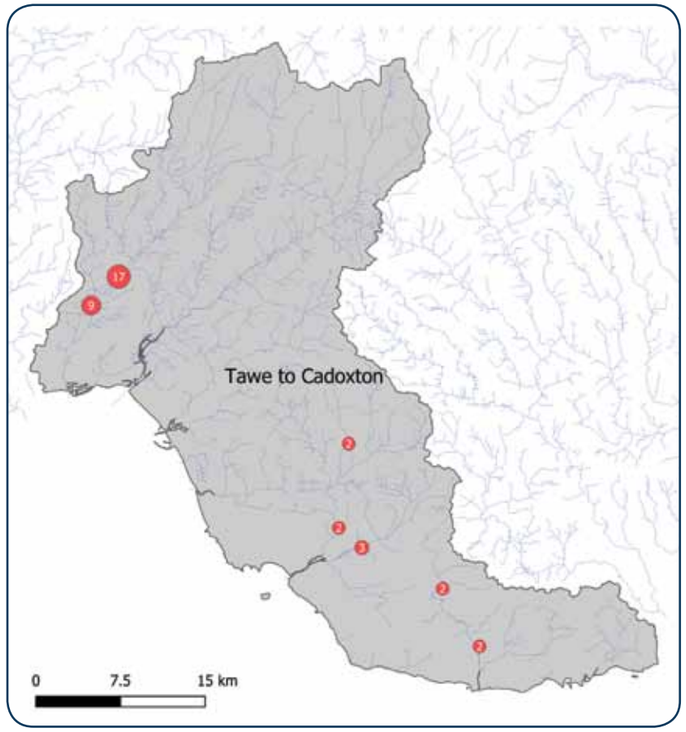


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

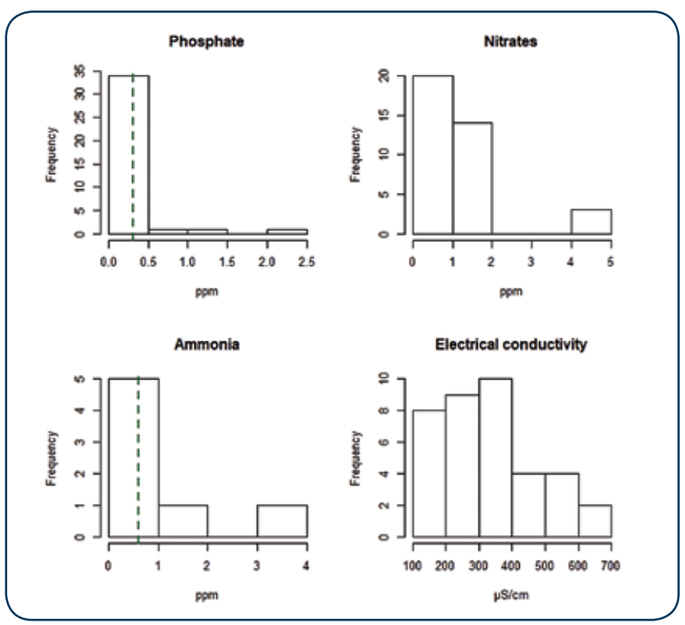
Tawe to Cadoxton

Number of samples	
Phosphate	**37**
Nitrate	**37**
Ammonia	**7**
EC	**37**
Temp	**37**

- 3 visual records of algal blooms
- 5 records of visual pollution
- Temp ranges 6.2-23.2°C

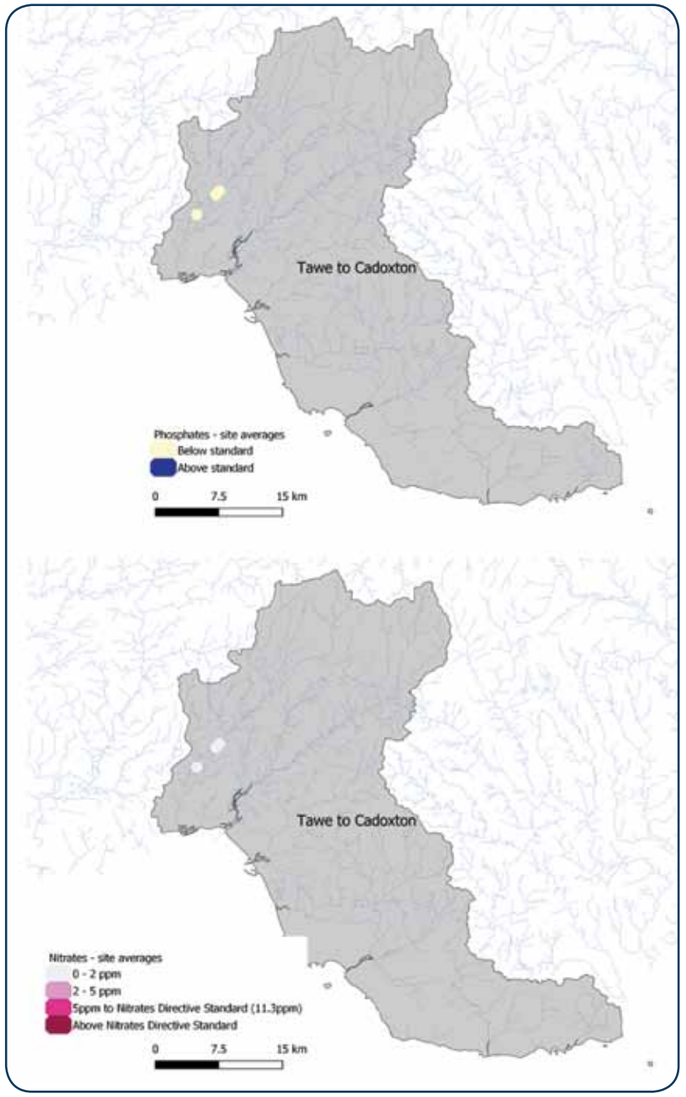


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

Tawe to Cadoxton

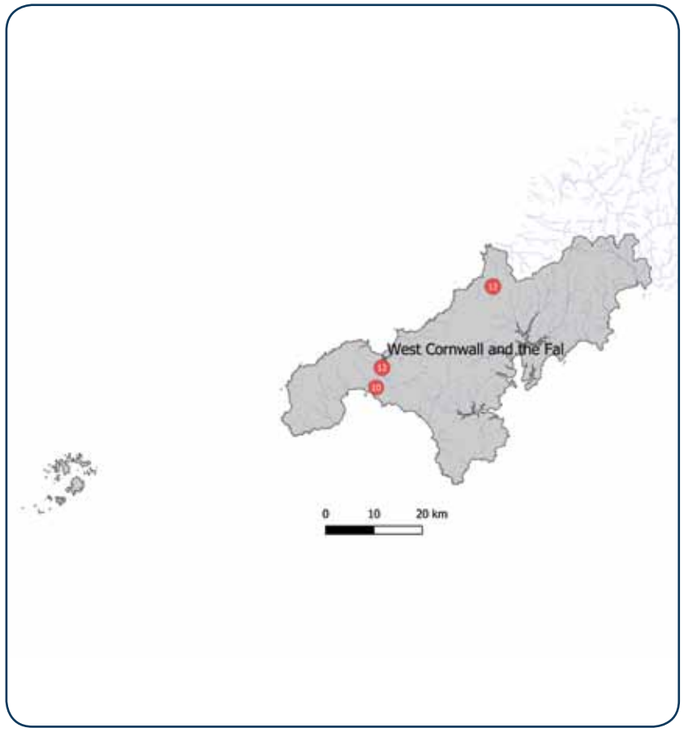


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

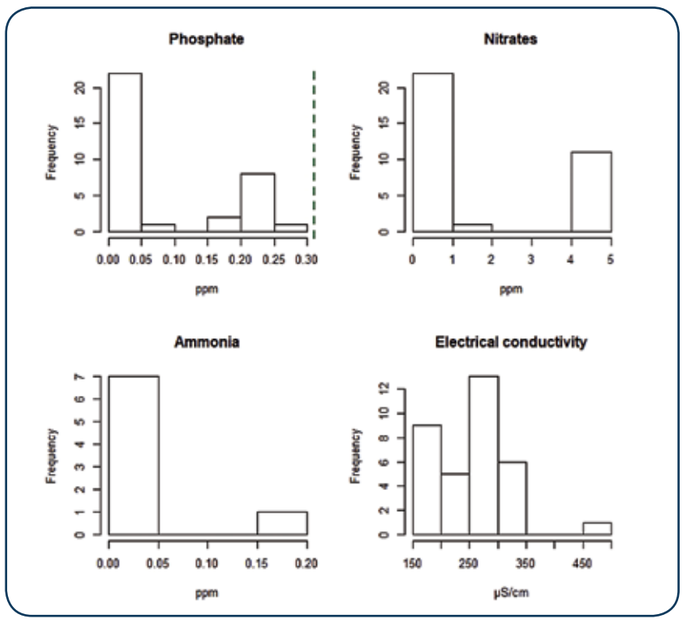
West Cornwall and the Fal

Number of samples	
Phosphate	**34**
Nitrate	**34**
Ammonia	**8**
EC	**34**
Temp	**34**

- 1 visual records of algal blooms
- 1 records of visual pollution
- Temp ranges 6.6-22.4°C

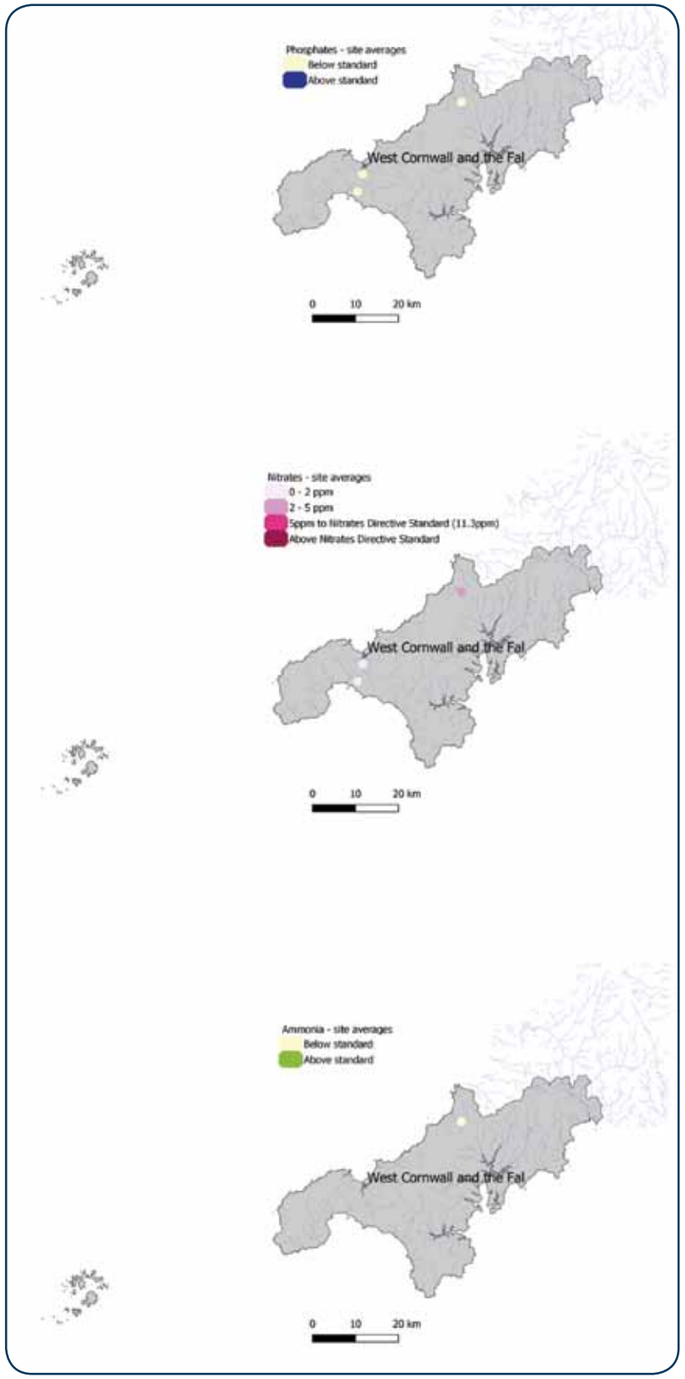


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

West Cornwall and the Fal

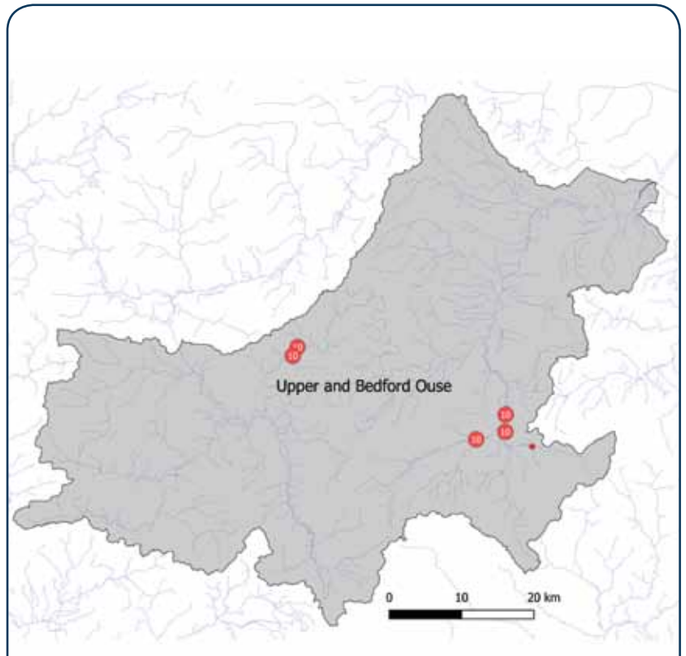


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

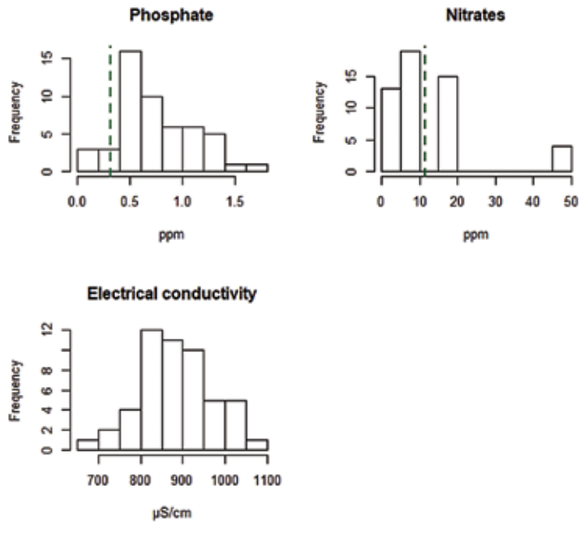
Upper and Bedford Ouse

Number of samples	
Phosphate	**51**
Nitrate	**51**
Ammonia	**0**
EC	**51**
Temp	**51**

- 17 visual records of algal blooms
- 1 records of visual pollution
- Temp ranges 4.7-20.6°C

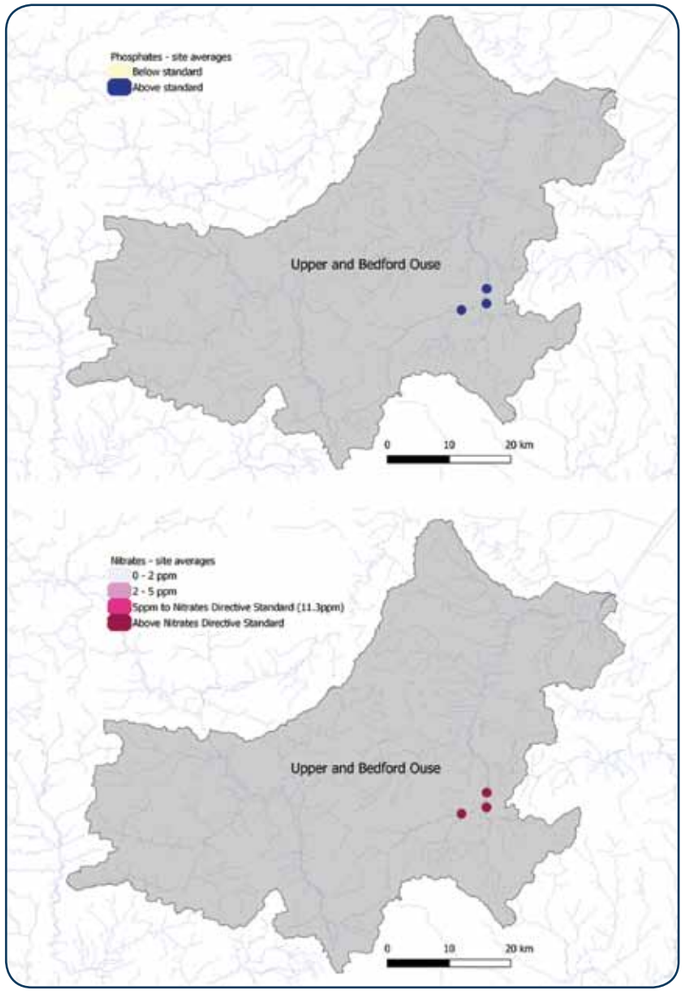


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia is not plotted as there were no ammonia measurements taken.

Upper and Bedford Ouse

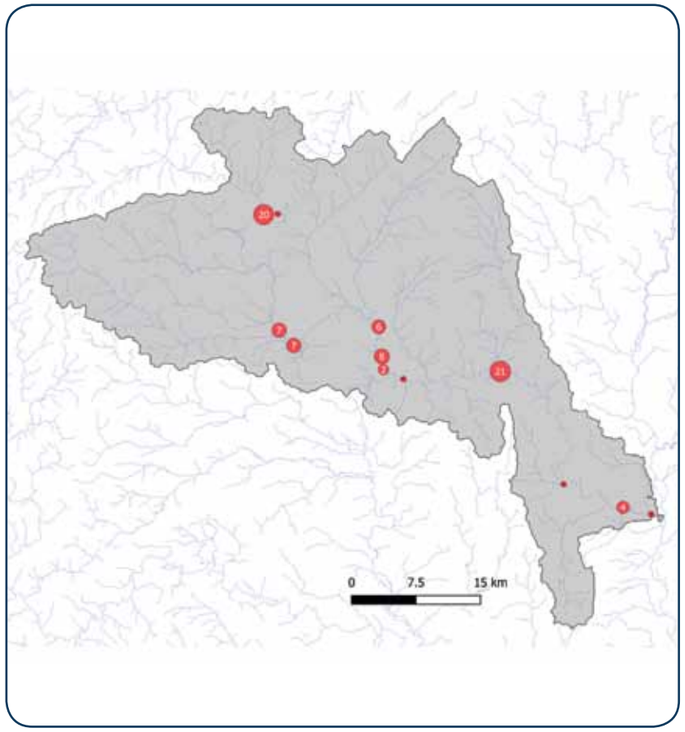


Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details). Ammonia not plotted due to low sample size.

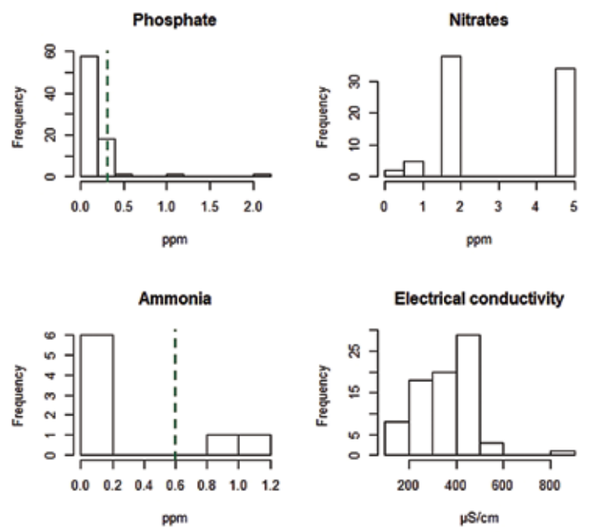
Teme

Number of samples	
Phosphate	**79**
Nitrate	**79**
Ammonia	**8**
EC	**79**
Temp	**79**

- 0 visual records of algal blooms
- 1 records of visual pollution
- Temp ranges 3.3-23°C

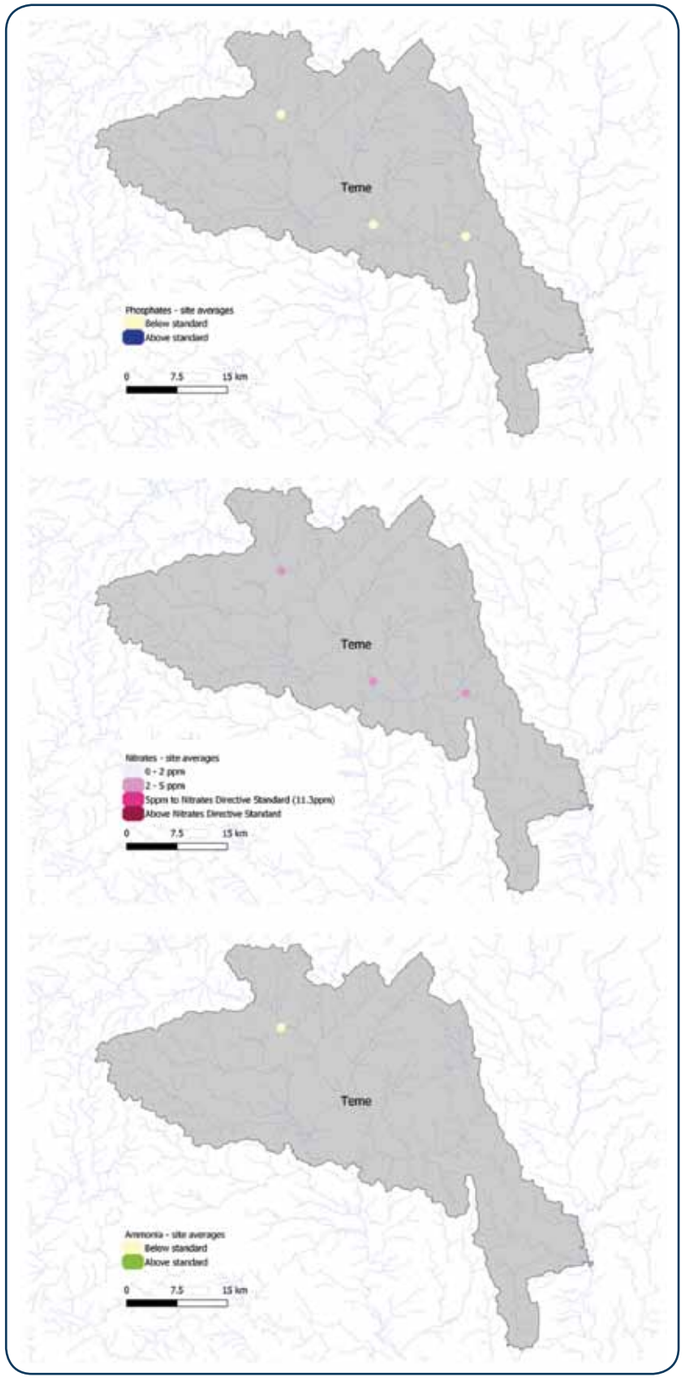


Distribution of records. Numbers within red circles indicate the number of records made within close proximity. Each record consists of multiple measurements and observations taken at the same site and at the same time.



Frequency distribution of physio-chemical measurements. Green dashed lines indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).taken

Teme



Site averages (minimum 8 replicates) of physio-chemical measurements. Above or below standard indicate environmental quality standards (based on WFD and Nitrates Directive), above which, may indicate some level of pollution (see methods for details).

How can I interpret my data?

Not all data requires complex statistical analysis. For water quality monitoring, most citizen scientists want to know "does the level I am recording indicate pollution?". To answer that question, as well as comparison to standards, simple time series plots of data from the same site (such as the example in Figure 13 below), help to form the "baseline" of what is normal for that site. It is then possible to examine if the level being monitored is unusual, i.e. much higher or lower than usual. Additionally, by adding rainfall, or river temperature onto the time series, you can examine if weather conditions might contribute to explaining the change, for example in the case of rainfall driven sources of nutrients such as runoff from agriculture.

In the example from Ham Farm Bridge (Figure 13), there is apparent seasonality in the phosphate concentrations, with the highest concentrations recorded in summer months. At a constant input of nutrient, lower nutrient concentrations would be expected in winter months due to the higher dilution linked to higher precipitation and river flow. However, the interpretation of concentrations of nutrients in streams is complex, as concentrations are influenced by a range of physical and biological parameters. Much more could be done to provide detailed guidance with a range of examples that could empower citizen scientists to interpret their own data.

Site time series graphs can also be used to explore spatial patterns. Graphs of citizen science data collected upstream and downstream of suspected pollution sources have been used by others to help identify pollution sources (e.g. Loiselle et al, 2022).

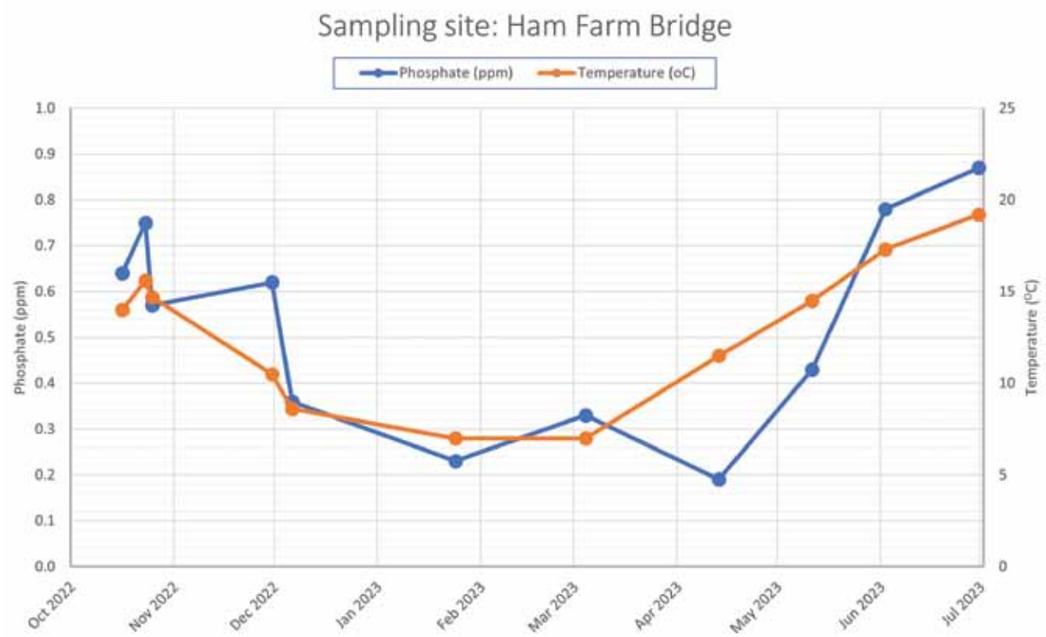


Figure 13 Example time series from a Medway catchment site

Discussion

At the end of its first year of, the WQMN has established citizen science water quality monitoring across many catchments in England and Wales. The volume of data is testament to the widespread concern for rivers and the dedicated efforts of many volunteer anglers. There are many more opportunities to expand the network, and the Angling Trust is keen to recruit more monitors in the next phase. Some gaps in the WGMN coverage of England and Wales can be explained by already established citizen science water quality monitoring groups, for example the Wye Catchment Collaborative Monitoring Network, or West Country Rivers Trust Citizen Science Investigators.

This low-cost citizen science water quality monitoring is not intended as a replacement or rival for statutory monitoring which is the responsibility of the Environment Agency and Natural Resources Wales. Instead it is a powerful complementary measure. Indeed, the WQMN results indicate that phosphates were more likely than nitrate and ammonia to exceed the standards associated with ecological health, aligning with the current focus on phosphates in rivers. Phosphorus is the main cause of eutrophication in freshwaters, and is recognised by EA and NRW as a significant cause of water quality failures (EA, 2022, Hatton-Ellis and Jones, 2021). The WQMN data provides further supporting evidence of this.

With its potential for greater temporal and spatial coverage than statutory monitoring data, citizen science water quality data could be utilised as an early warning system, highlighting areas of concern for further investigation and action by statutory bodies and water utility companies. Citizen scientists are in the fortunate position of knowing what is 'normal' for their monitoring area: for example, knowing mean concentrations, and the usual responses of the catchment after rainfall. They can then rapidly identify when behaviour is abnormal and report to the relevant agencies.

Alternatively, agencies could periodically review data to identify these events. This process requires the statutory bodies, water companies and governments to invest in the development of processes for rapid identification of readings that indicate pollution, and rapid pathways to escalate concerns. This would allow citizen scientists to share their findings with catchment managers so that they can initiate further investigations, actions, or if necessary enforce regulations on the ground.

Further analysis and future use of WQMN data

- We recommend continued data collection to enable deeper interpretation of the data – presently we have excluded many of the samples from the catchment maps because sites have not been repeat-sampled.

- Once a sufficient number of samples per site (>8) are recorded, it is possible to make a more informed temporal assessment, and identify how individual sites respond to environmental events (either natural or anthropogenically induced).

- As yet, the WQMN are not recording the volume of data needed in order to produce heat maps of phosphate, nitrate or ammonia readings for catchments. There are many more sites where site averages might be possible to calculate in the future if monitoring continues (i.e. those sites sampled fewer than 8 times thus far). In the future with expanded citizen science monitoring it should be possible to integrate citizen science data with statutory monitoring (as in the Environment Agency River Wye Management Catchment Integrated Data Analysis Report, 2023). This will enable the identification of hotspots of poor water quality.

- Integration with biological measures of water quality e.g. habitat, plant or invertebrate surveys.

- Training materials could be produced to empower citizen scientists to interpret their own data more.

- One concern some have about citizen science data is that they could be biased towards visual pollution, or extremes of weather, either warmer drier weather (i.e. fair weather recording), or conversely high flows following rain to seek out associated pollution events from storm overflows. The low incident rate of visual pollution and algal blooms in this data set indicates this is unlikely to be the case for WQMN data. Further exploration of the weather, river level and flow data associated with these samples, along with the date ranges for each catchment could illuminate if recorders are biased to extremes of weather.
- WQMN monitors also collected basic river flow, river levels, and weather data. These could be used to explore associations, for example algal growth is associated with very high summer water temperatures. Further analysis to assess what is driving water quality is possible by testing for associations with location data (proximity to upstream WWTW or CSO, rural/urban-ness, land-use/ALC, waterbody width, distance to source/sea), weather (temp, rainfall) and river flow and river levels.

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Map references

IN CONCLUSION

In recent years whilst our rivers decline, government has sought to relax nutrient neutrality rules, it's delayed the next Water Framework Directive assessment, cut funding to the environmental regulators, instructed Ofwat and water companies to not invest in necessary infrastructure improvements, guided the EA not to prosecute farmers who break the Farming Rules for Water and pollute our rivers, put forward storm overflow reduction plans that excluded coastal waters and set targets and deadlines in the dim and distant future, and on the 1st January 2024 removed the need for farmers to be "cross complaint" before they get taxpayer money, meaning a number of safeguards to protect water courses have been removed.

This report highlights that phosphate pollution is widespread with *"44% of site averages for phosphates exceeded the England-wide upper standard for good ecological status"* and that *"As we use the conservative overall upper standard, it is likely that more samples would exceed site-specific limits if they were available".* Whilst *"the majority (of nitrate results) were below the Nitrates Directive standard, historical nitrate levels indicate that natural river conditions are often much lower"*, and that therefore nitrate levels on a number of catchments are also of concern.

Government policy lacks focus, imagination and any sense of urgency and is failing our precious rivers. To address the issues blighting rivers across England and Wales the Angling Trust asks for the following.

We need ...

- The English and Welsh Governments to establish fully funded policies to address pollution in our waterways that deliver improvements now, not in the dim and distant future.
- Government to fund the enforcement of regulatory standards and implementation of the polluter pays principle across all sectors.
- Government to fast track the mapping and replacement of septic tanks discharging into surface waters, with a focus on high-risk areas such as protected sites.
- Government to ensure that the Department for Environment, Food and Rural Affairs (Defra); the Water Services Regulation Authority (Ofwat); the Environment Agency (EA); and Natural Resources Wales (NRW) prioritise addressing the pollution of our rivers and that they are funded in order to do so.
- Government to provide significant investment in local and catchment wide nature-based improvements, working with nature and using natural processes to protect and improve water quality.
- Government to include gateway requirements and specific options in all three Environmental Land Management schemes that go beyond regulatory baselines and basic good business practice and encourage farmers to achieve clean water in watercourses and waterbodies across their holdings. Options should range from basic soil health measures to large-scale habitat creation through arable reversion.
- Government to drive compliance with agricultural diffuse water pollution regulations by establishing a comprehensive advice and training regime to support land managers, complementing enforcement work.
- Farmers to stop polluting rivers and to comply with the most basic regulations such as Nitrate Vulnerable Zone (NVZ); Silage, Slurry and Agricultural Fuel Oil (SSAFO); Environmental Permitting Regulations (EPR); and the Farming Rules for Water.
- The EA to further increase the number of Agriculture Regulatory Inspection Officers, undertake more farm inspections, support compliance, enforce regulations and boldly prosecute non-compliance.
- Water companies to do more, and more quickly. No bonuses for directors and senior managers until raw sewage is no longer illegally discharged into our rivers.
- A change of culture at the EA and NRW. They need to become detectives looking for pollution and enforcers of the law.
- Government to follow through on its commitment to reinvest fines handed out to polluters into environmental improvements.

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WHAT NEXT FOR THE WATER QUALITY MONITORING NETWORK?

The Angling Trust will continue to expand the WQMN, through engagement with further angling clubs and recruiting additional volunteers. This extensive citizen science initiative continues to gain momentum and is poised to evolve as we extend its reach to encompass stillwaters and estuaries. This expansion will provide a comprehensive understanding of pollution dynamics, tracing its path from source to sea, and expanding beyond our rivers.

We are also focused on empowering angling clubs with the necessary tools to instigate local change. The case studies presented in this report vividly illustrate the transformative impact achievable by angling clubs determined to challenge polluters and ensure regulatory compliance.

Acknowledging the indispensable role played by angling clubs across England and Wales, we express our heartfelt gratitude for their support. Our gratitude extends to the numerous volunteers who have actively participated in this cause. Additionally, we extend appreciation to our funders and supportive partners whose generosity has enabled WQMN progress including the organisations providing essential monitoring equipment.

Lastly, The Angling Trust extends its thanks to Dr Eleanor Keen and Dr Liz Bagshaw for their invaluable contribution to producing this initial report. We eagerly anticipate presenting more comprehensive trend analysis of the pollution challenges affecting our rivers in 2024, with the collective aim of fostering positive change in our waterways.

Stuart Singleton-White
Angling Trust, Head of Campaigns

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