River Wye Management Catchment Integrated Data Analysis Report

Data Cut-Off: 30th June 2022

Report Date: July 2022

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We help people and wildlife adapt to climate change and reduce its impacts, including flooding, drought, sea level rise and coastal erosion.

We improve the quality of our water, land and air by tackling pollution. We work with businesses to help them comply with environmental regulations. A healthy and diverse environment enhances people's lives and contributes to economic growth.

We can't do this alone. We work as part of the Defra group (Department for Environment, Food & Rural Affairs), with the rest of government, local councils, businesses, civil society groups and local communities to create a better place for people and wildlife.

Published by:

Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

www.gov.uk/environment-agency

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About this Report

The River Wye SAC (Special Area of Conservation) is failing to meet phosphate targets in some reaches and is very close to the threshold in others. There have been reports of algal blooms in the river and recognition of ecological decline over a number of years.

The scale of data being captured in the Wye Management Catchment is increasing exponentially as more continuous monitoring sondes, autosamplers, remote sensing, and citizen scientists are deployed.

All this data contributes to the overall picture of what is happening in the catchment. We will combine new evidence with existing datasets four times a year to contribute to a common understanding among all stakeholders of the issues and actions required.

The report covers:

1. What are the main variables contributing to algal blooms in the Wye?
2. What other ecological and water quality issues does the data show?
    a. When did these occur?
    b. Where did these occur?
3. Which locations, sectors and activities were responsible for the ecological and water quality issues identified in the data?
4. What recommendations can be made for regulatory, partnership and industry sector actions to prevent the reoccurrence of ecological and water quality issues identified in the data?

If the available data does not allow us to answer a question, we describe what data is needed to be able to answer it.

If you have any feedback on this report or additional information to contribute to future reports, please contact Enquiries_WestMids@environment-agency.gov.uk

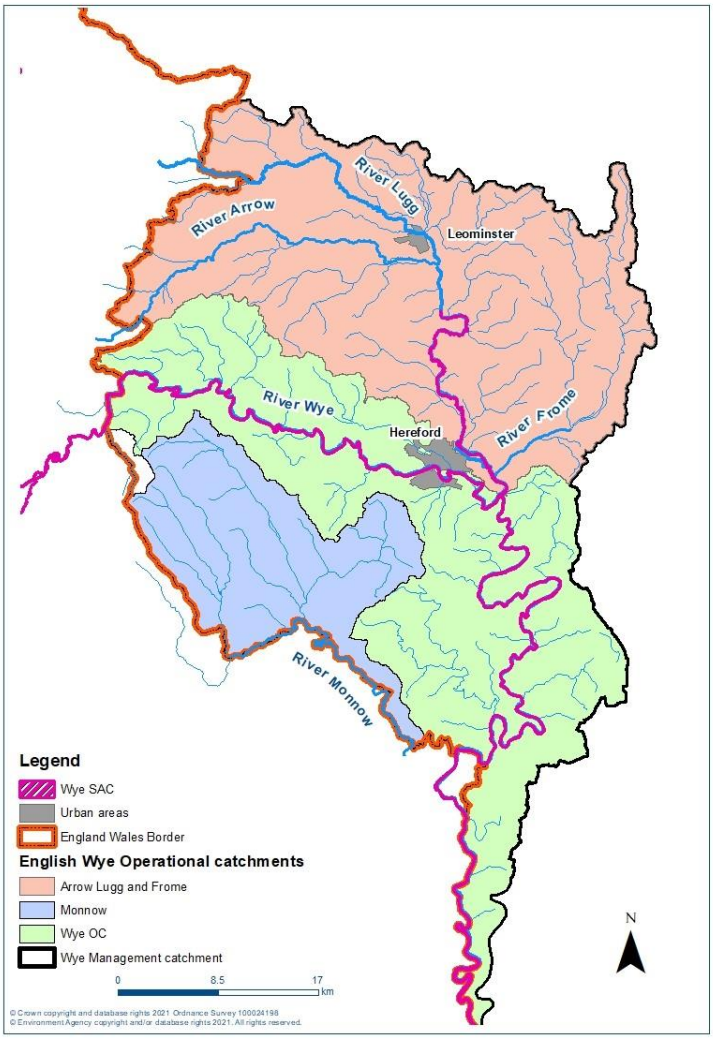

Figure 1: River Wye Management Catchment within England and associated Operational Catchments and major tributaries.

Summary of Conclusions

This summary includes conclusions drawn from previous reports and builds on them.

2021-22 Q3 Report

2021-22 Q4 Report

We can currently conclude, based on the latest available data, that:

1. What are the main variables contributing to algal blooms in the Wye?

Significant algal growth occurs on the main River Wye during the summer. A large amount is filamentous algae and diatoms covering the riverbed. The relative proportion of riverbed to free floating algal growth is currently unknown.

Excessively high summer water temperatures on the main River Wye are a major contributing factor to this algal growth.

Water column phosphate concentrations appear to increase temporarily prior to this algal growth, following summer rainfall events, while river flows are relatively low. These temporary increases are likely to contribute to the algal growth. More frequent and widespread orthophosphate, total phosphorus, and sediment nutrient data is required in partnership, to continue to build an understanding of contributing factors to these algal blooms.

Water column nitrogen concentrations are excessive throughout the catchment, but nitrogen is not the most important nutrient causing algal blooms. If phosphate availability to aquatic plants were low enough, it would limit algal growth despite high nitrogen levels.

2. What other ecological and water quality issues does the data show?

Salmonid fish populations have declined over the last 10 years, and there has been a shift to the headwaters of the Lugg for the main Atlantic Salmon population in the English sections of the Wye.

Invertebrate populations currently appear to be generally healthy, although some smaller tributaries are affected by sedimentation and water quality issues.

Macrophyte communities sampled in 2021 show evidence of eutrophication across the whole catchment.

Nutrients within the water column are a bigger problem in tributaries than the main Wye. Sediment analysis is needed to build a more complete understanding. Since 2010, there has been an increasing trend in orthophosphate on tributaries of the Wye and an increasing trend in nitrogen across most of the catchment.

There have been short-term water quality improvements in some parts of the catchment. However, these are minor compared to the long-term decline and fall short of the SAC and SSSI targets in the Lugg Catchment.

Rainfall events correlate with increases in phosphate and turbidity across the whole Wye Management Catchment, confirming that diffuse pollution is a component of water quality issues in the catchment.

Our sondes have detected ammonium peaks in Hereford that correspond with rainfall and high Citizen Science phosphate readings. We are investigating further. Ammonium is an ion that contains nitrogen and is a component of nitrogen inputs to the catchment.

3. Which locations, sectors and activities were responsible for the ecological and water quality issues identified in the data?

Analysis of Citizen Science data collected since the start of 2021, and new incidents reported since October 2021, supports and enhances the analysis of Environment Agency data.

Arable agriculture, particularly maize and autumn sown crops like winter wheat on permeable soils or those prone to surface-run-off contribute significantly to orthophosphate concentrations.

There has been a significant increase in the proportion of land managed as arable since 2016, particularly maize and potato crops, which are more susceptible to soil loss.

Sewage treatment works (STW) discharge rates are significant contributing factors to orthophosphate concentrations. STW phosphorus limits are effective in reducing the contribution to orthophosphate concentrations. However, combined sewer overflows (CSOs) and agricultural run-off are suspected to contribute towards target exceedance where phosphorus limits are in place.

The number of poultry units in a catchment shows a positive but very weak correlation (R^2=0.04) with orthophosphate levels and appears to show a stronger link with nitrogen levels and total phosphorus. Total phosphorus data is currently too sparse to demonstrate a statistically significant causal relationship and this analysis does not account for pathways of impact outside the unit such as spreading of manure or digestate on fields outside the catchment where the poultry units themselves are located. Further investigation is needed to understand the potential source, pathway, and receptor relationships.

Sewage discharge and agriculture account for the largest share of environmental incidents reported to the Environment Agency in the Wye Management Catchment between 01/04/2020 and 30/06/2022. Our regulatory activity has seen an increasing trend in substantiated water pollution incidents since 2015. Most of these incidents and our associated enforcement activities have been related to sewage and agricultural material. There are likely to be many other incidents, particularly after heavy rainfall, that may go unreported.

4. What recommendations can be made for regulatory, partnership and industry sector actions to prevent the reoccurrence of ecological and water quality issues identified in the data?

Taking a catchment-based approach all contributing partners in the Wye Management Catchment could target investigations, analysis, and remedial actions in key five focus areas:

- River Arrow near Kington
- River Arrow near Pembridge and Curl Brook
- River Lugg and tributaries near Presteigne
- Little Lugg and Withington Marsh Brook
- River Frome

These five areas have been identified as upstream parts of the catchment with high phosphate concentrations relative to the wider catchment, taking the size of watercourse into account. They also experience a high proportion of the pressures identified in this report.

Significant reduction in nutrient input from all sources is required across the whole catchment to contribute to the recovery of river quality including macrophytes. Reducing run-off and leaching of nutrients from land, during summer rainfall events, when dilution is low, and temperatures are high, is an important element of this remedial activity.

Investigations into the sources of pollution events on the River Wye in Hereford should be carried out to identify areas for investment to prevent reoccurrence of the events inputting ammonium and phosphate to the river captured by the sondes and Citizen Scientists.

Further investigations in partnership should include understanding the pathways and impacts of manures and wastes that are spread to land and a comprehensive appraisal of options to mitigate the impacts of poor water quality, including whether we could manage existing water resources differently, and seek to identify new options that support water users, including the environment, over the longer term, and potentially provide additional flow for dilution when beneficial to do so.

Where Citizen Scientists can support the efforts of land managers and discharge operators, to reduce the impact of their operations, by targeted monitoring and evaluation in response to identified high nutrient events. We would encourage them to do so and have suggested areas to undertake further monitoring, along with guidance on safe and effective monitoring practices.

Efforts to increase shade by tree planting and better management of riparian trees could help mitigate high temperatures. We have developed a high temperature and algal bloom early warning system to enable us to respond to excessive temperatures with advice and extra monitoring.

Data Sources

Citizen Science Monitoring

We are working with a variety of partners in the development and delivery of a Citizen Science monitoring programme. This additional resource is used to collect water quality data throughout the Wye Management Catchment and will help to identify and prioritise where measures can be targeted to reduce inputs of pollution.

We politely request Citizen Scientists to follow our data collection and reporting guidance to ensure the data can be used effectively.

We are extremely grateful for the commitment of Citizen Scientists in the catchment, who have contributed to a higher resolution of data, which bolsters shared efforts to understand the issues affecting the Wye Management Catchment. This data is also contributing to ongoing calibration of improved water quality models for the catchment.

Details of the Citizen Science Groups are available here: Citizen Science Groups | The Wye Catchment Partnership

We have used data from the following groups in this report and thank them for their efforts.

- Campaign for the Protection of Rural England, Herefordshire (CPRE)
- Friends of the Lugg (FOL)
- Friends of the Upper Wye (FOUW)
- Wye Salmon Association (WSA)

Open data and details of methodologies can be found here Wye Catchment Collaborative Monitoring Network | The Wye Catchment Partnership

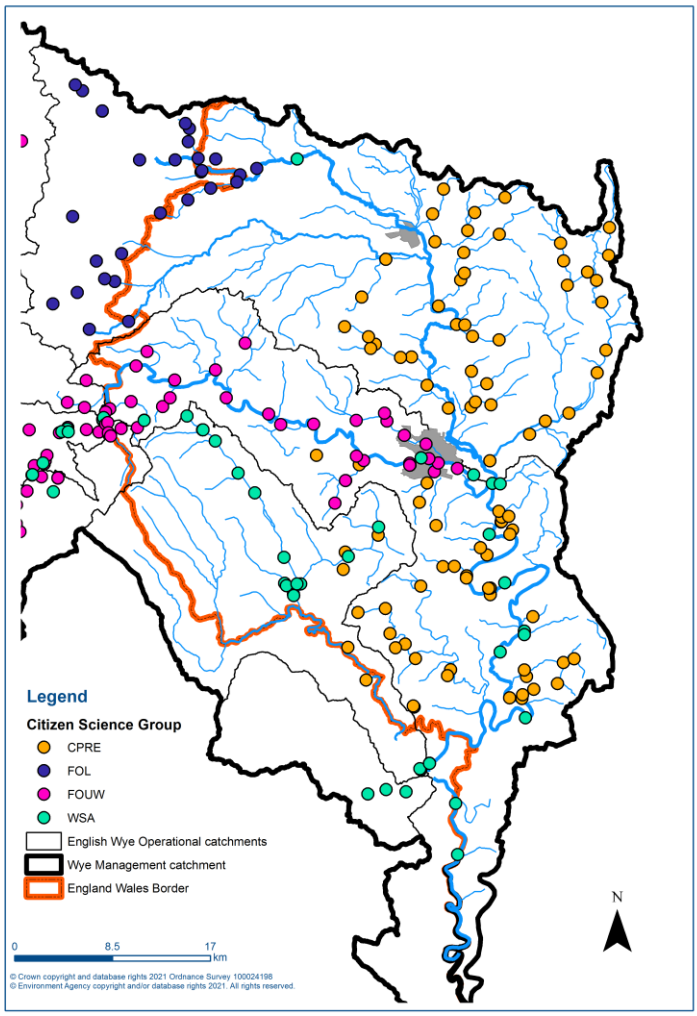

Figure 2: Citizen Science sampling points within the Wye Management Catchment in England.

Continuous Data Loggers (sondes)

Sondes are remote water quality measuring units, which are comprised of a probe placed in a waterbody and a unit that collects and transmits data in real time. Data is cleaned prior to analysis by omitting erroneous measurements caused by probe fouling or sensor malfunctions.

Eight sondes are currently deployed in the English Wye Management Catchment, with a further four awaiting deployment. We have also deployed autosamplers to collect water samples for further analysis at a higher frequency than our manual sampling. We will trigger these autosamplers remotely to capture dry weather and rainfall events. The water samples collected automatically will then be analysed for determinands that the sondes cannot record, for example, phosphate.

Most sondes currently collecting data within the Wye catchment were deployed in early June, this was later than planned due to supply chain issues limiting the availability of components required for the telemetry systems to operate.

The sondes located at Holme Lacy and Ross on Wye were deployed over summer 2021 and have also been deployed since April 2022, and the sonde located at Mortimer’s Cross has been in continuous deployment since January 2020.

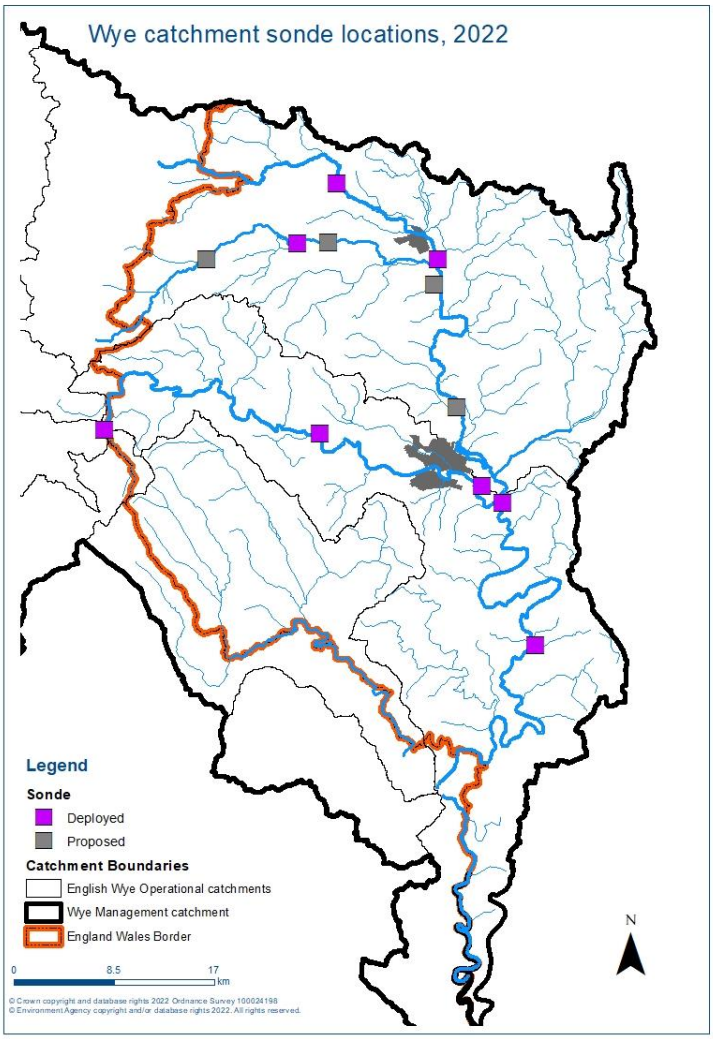

Figure 3: Map of deployed and proposed sonde locations during 2022.

Algal samples

We are undertaking monthly riverbed and water column algae sampling from spring to autumn 2022. We also undertake reactive algae monitoring when sondes and incident reports suggest conditions may trigger prolific algal growth or that algae blooms are occurring.

Our algal monitoring involves collecting water column samples to identify free floating algae and carrying out repeatable 5x10m riverbed surveys for filamentous and crust forming algae using Rapid Assessment of PeriPhyton Ecology in Rivers (RAPPER) methodology. We have monitored at Holme Lacy and Ross on Wye since April 2022 and will also include Hay on Wye and Hampton Bishop from July 2022. The survey sites are co-located with sondes, and physicochemical, invertebrate and diatom monitoring is also being conducted at most of the sites. This will improve understanding of the composition of algal communities, the environmental and chemical conditions they are indicative of, and how the ecology of the River Wye is affected.

Figure 4: EA officers conducting a channel bed algae survey at Ross on Wye, June 2022.

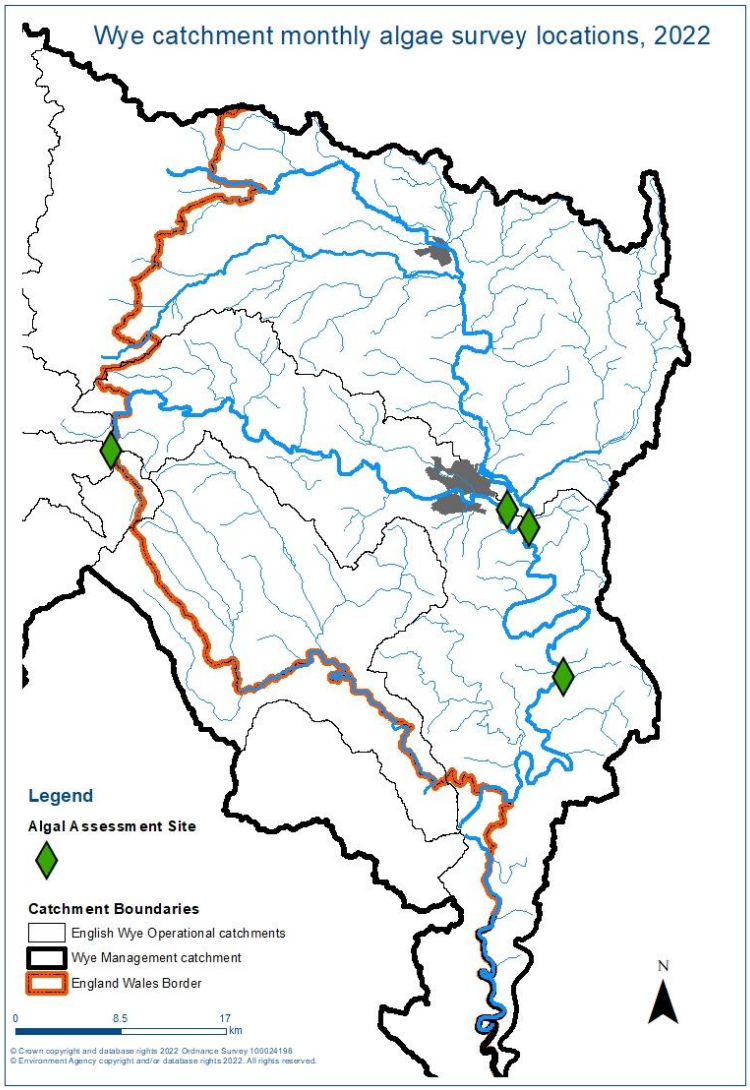

Figure 5: Map of monthly algae monitoring sites.

Routine Water Quality Sampling

The Environment Agency's water quality data is available as open data on the Water Quality Data Archive.

The water quality parameters analysed for this the report were orthophosphate (also known as soluble reactive phosphate), ammonia, dissolved oxygen and total oxidised nitrogen (TON).

Crop Map of England

Since 2016 the Rural Payments Agency has been using satellite imagery collected by the European Space Agency's Sentinel network to annually classify agricultural land use in England. The project is known as CROME (Crop Map of England) and assigns crop types using a machine learning approach called Random Forest Classification. Large validation efforts were undertaken to ensure reasonable accurate classification of crop types, with approximately 18300 field visits conducted to validate the crop assignments generated by the classification system.

To generate crop cover area England has been divided into approximately 32 million equally sized hexagonal tiles, each 4156 square meters (0.42 hectares) in area. The English portion of the Wye Management Catchment contains approximately 452,000 tiles; each individually assigned a cover type.

Although CROME classifies arable land by individual crop, with the exceptions of maize and potato, crops have been aggregated into mixed arable for this report to account for crop rotation cycles and to simplify analysing changes in land use. The cover of grassland, woody plants (trees, shrubs and hedgerows), non-agricultural/sparsely vegetated land, and open water were also classified. This had made it possible to compare changes in rural land cover between 2016 and 2021. There are some caveats around overall accuracy of the classification, with it predicted to be 84% accurate in 2016 and 70% accurate in 2020. However, due to the large number of classification tiles, this still makes it possible to observe overall changes in land use with reasonable confidence.

UKCEH (UK Centre for Ecology & Hydrology) Land Cover Map

The UKCEH Land Cover Maps show land cover across Great Britain using UKCEH Land Cover Classes. These are based on UK Biodiversity Action Plan broad habitats.

The 2018, 2019 and 2020 datasets used in this report (Morton, et al., 2020; Morton, et al., 2020; Morton, et al., 2021) were developed by the UK Centre for Ecology & Hydrology by classifying satellite images from 2018, 2019 and 2020 respectively. The 2020 data has a higher 10m resolution.

National Soil Map

The National Soil Map is produced by Cranfield University (National Soil Resources Institute, 2001) and was last updated in 2013. It details soil associations across England and Wales and includes typical characteristics of soil series in each association.

Environment Agency remote sensing analysis of poultry units

During 2021 the Environment Agency analysed current and historic LIDAR data alongside available permit data to identify possible poultry units and assess change. This analysis is exploratory and subject to change so is not currently available as open data.

Environment Agency permitted discharge outlets

These data provide details of all permit details as required under the Environmental Permit Regulation. Information is held for all permit holders and covers all substances that are controlled.

The dataset is available as open data on the Defra Data Services Platform.

Natural Resources Wales permitted discharge outlets

These data provide details of all permit details as required under the Environmental Permit Regulation. Information is held for all permit holders and covers all substances that are controlled.

The dataset is available as open data on the Lle Geo-Portal for Wales.

Welsh Water combined sewer overflows

Welsh Water/ Dwr Cymru monitor their combined sewer overflows and report spills as Event Duration Monitoring. These reports include the site, number of spill incidents per year, number of hours spilled and percentage outage in the monitoring.

Welsh Water/ Dwr Cymru have provided detailed time series data for their overflows in the Wye Management Catchment, and we will analyse this data for future reports.

The RePhoKUs Project

The RePhoKUs project (The Role of Phosphorus in the Resilience and Sustainability of the UK Food System) is a collaboration between the Universities of Lancaster and Leeds, that has used the River Wye as one of three study catchments. The project examined how P is

used, the drivers of P efficiency, surplus and loss at the catchment scale, local vulnerability to market failures in P supply and the consequences for catchment water quality.

The project's report on re-focusing phosphorus use in the Wye catchment was published in May 2022 (Withers, et al., 2022).The report presented the results of research work on elemental phosphorus (P) inputs and outputs in the Wye catchment, links to river water quality and stakeholder responses to the challenges of maintaining future food and water security in the region.

Analysis Methods

We have used the following exploratory, statistical, and spatial methods in this analysis.

Algal Survey Rapid Assessment of PeriPhyton Ecology in Rivers (RAPPER)

Using RAPPER methodology, algal taxa are assigned as Competitive (C taxa), Stress Adapted (S taxa) or unclassified. C taxa are tolerant and indicative of excessive nutrients,: whereas S taxa are intolerant of excessive nutrients. The colonial diatom, *Melosira,* is unclassified but potentially indicative of eutrophication during certain conditions. The abundances of observed C and S taxa are used to assign a survey as ‘not at risk’, ‘maybe at risk’ or ‘at risk’ of eutrophication.

We have presented the list of agal taxa but not the final risk status in the report as surveys are still ongoing throughout the growing season.

Time series analysis

Parameters associated with algal blooms and water quality problems were combined on single time series plots, where each parameter was available; particularly dissolved oxygen and ammonium.

Indicative Water Framework Directive (WFD) Classifications

Where sufficient data has been collected over the last 36 months for quality elements that are assessed under WFD, indicative WFD classifications have been produced using this recent data. These are not formal classifications but allow comparisons with the 2019 formal classification and previously reported indicative classifications. An update to the formal classifications is scheduled for 2022 and the next full classification is scheduled for 2025.

Spatial Mapping

Plotting each data source on a map of the River Wye Management Catchment allows a comparison of the results for each Operational Catchment or Waterbody. This helps locate the sources and pathways of ecological and water quality problems identified.

Results

The results section of this report is divided into three sections to answer the questions posed at the start of this analysis.

1. What are the main variables contributing to algal blooms in the Wye?
2. What other ecological and water quality issues does the data show?
3. Which locations, sectors and activities were responsible for the ecological and water quality issues identified in the data?

1. What are the main variables contributing to algal blooms in the Wye?

The algae surveys conducted, and sonde data collected up to 30/06/22 were not indicative of potentially harmful algae blooms in the river Wye and identified crust forming and filamentous algae rather than free floating algae. Planktonic algae and cyanobacteria have not been detectable in readily quantifiable abundances to date.

Between April and June 2022 six algal taxa have been recorded from the Holme Lacy and Ross on Wye channel bed algae surveys (Table 1).

The information provided by the algae surveys being collected will be used in future reports to determine the nutrient pressure and risk indicated by algae in the River Wye.

Table 1: Algal taxa recorded from the Holme Lacy and Ross on Wye algae surveys conducted between April and June.

Type	Taxon	Trophic rank
Chlorophyta – green algae	*Cladophora*	Competitive
	Ulva intestinalis	Competitive
	Klebsormidium	Stress adapted
Bacillariophyta – diatoms (colonial taxa only)	*Melosira*	Unclassified
Phaeophyta – brown algae	*Heribauldiella fluviatilis*	Stress adapted
Rhodophyta – red algae	*Hildenbrandia rivularis*	Unclassified

Figure 6: Selection of filamentous and crust forming algae present at Ross on Wye, June 2022.

There is anecdotal evidence suggesting that water crowfoot is re-establishing or increasing in abundance compared to recent years. We have observed water crowfoot during drone surveys near Hoarwithy Bridge (Figure 7) and during algae surveys. There have also been recent observations of water crowfoot in the Wye reported on social media.

We are not currently able to confidently state the reasons for variation in the coverage of water crowfoot over the last few years.

It is possible that extremely high river levels and associated increases in current velocity that occurred during the winters of 2019/20 and 2020/21 or associated inputs of sediment to the system could have affected the species' distribution, and that the beds are now starting to re-establish. There is also a complex relationship between water crowfoot abundance and the proliferation of filamentous algae in the River Wye. Reduced competition for nutrients from water crowfoot may have enabled fast-growing and opportunistic algae to establish. Alternatively other confounding factors such as siltation may be at play. We are working in partnership to explore methods to assess water crowfoot coverage.

Figure 7: Drone captured photographs of water crowfoot near Hoarwithy Bridge, July 2022.

2. What other ecological and water quality issues does the data show?

Water quality

Most of the deployed sondes did not detect any issues such as high temperatures or pollution between April and June 2022 and will not be discussed further until future reports, when a full season's data has been collected.

However, increased ammonium concentrations were detected at two sites in June, and we present that data in this report. We examined available citizen science and incident report data in the river sections where increased ammonium concentrations were detected.

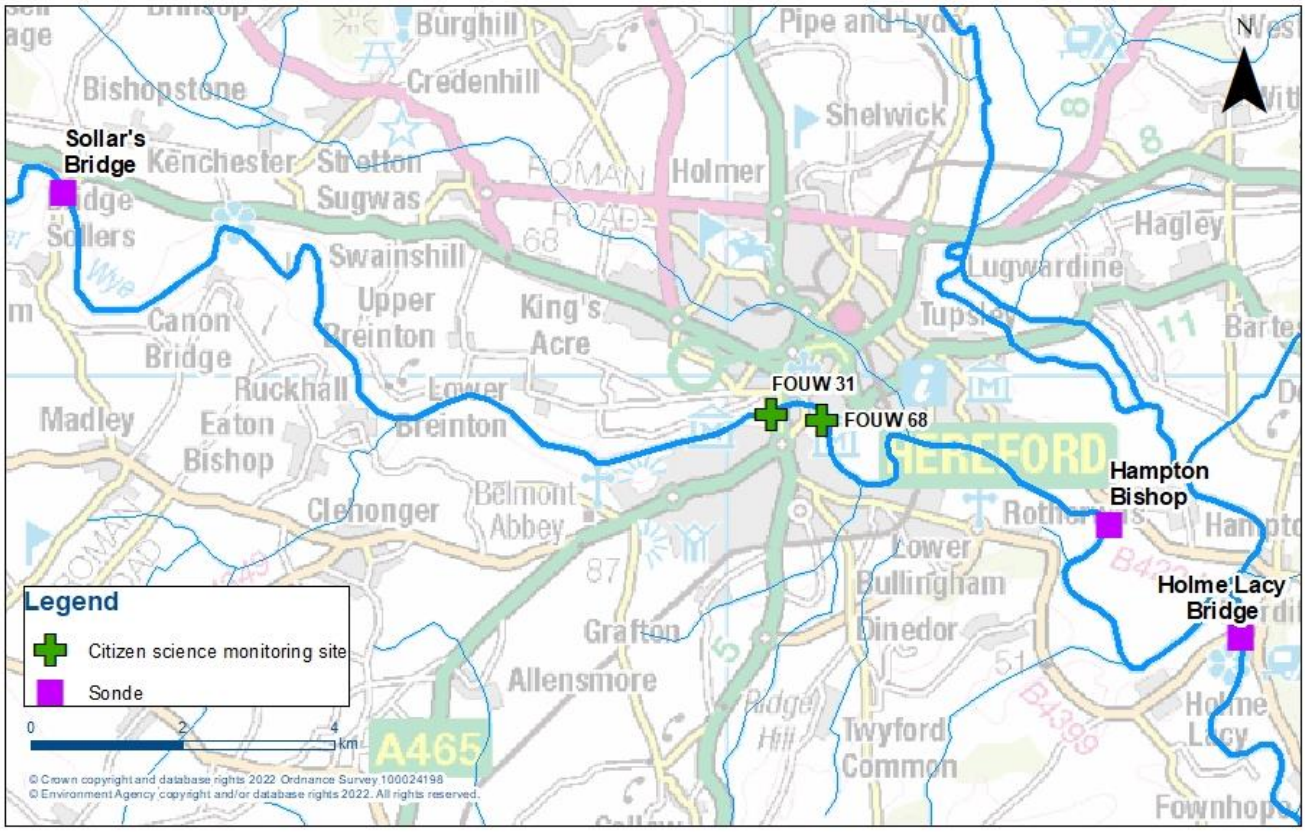

Figure 8: Map of sondes and citizen science monitoring sites examined.

The sondes at Hampton Bishop and Holme Lacy detected three separate periods of increased ammonium concentrations during June 2022. Elevated ammonium levels were not detected by the upstream sonde at Sollar's Bridge, Figure 10. The pattern of ammonium peaks is similar, albeit reduced at Holme Lacy when compared to Hampton Bishop. However, Holme Lacy is located downstream of the Lugg confluence with the Wye and is approximately 5.5km downstream of Hampton Bishop. This suggests that large volumes of ammonium containing pollutant entered the river in June 2022 in the vicinity of Hereford. The greatest concentrations of ammonium occurred between the 16th and 19th of June, during a period of rainfall .

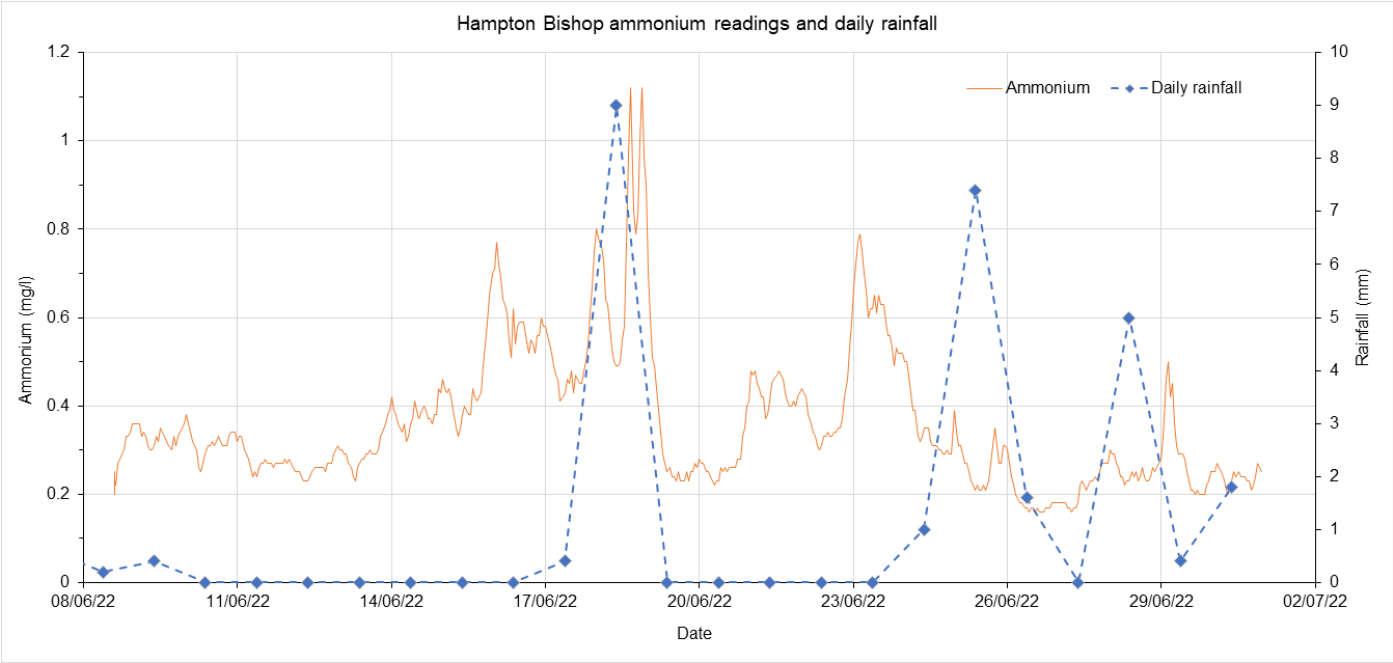

Figure 9: Ammonium readings from the sonde deployed at Hampton Bishop plotted with daily rainfall totals from the Broomy Hill rain gauge

Dissolved Oxygen concentrations were slightly reduced at all the river Wye sonde sites during this period, which is likely to be due to reductions in photosynthetic activity caused by overcast conditions. However, these reductions were not sufficiently extreme or prolonged to be ecologically harmful at any of the sites. The reduction in dissolved oxygen levels was greatest at Hampton Bishop and likely to have been exacerbated by the increased ammonium concentrations that occurred.

Two citizen science monitoring sites with several phosphate test readings taken in June 2022 are present in the vicinity of Hereford. Phosphate concentrations were below the detection limit of the equipment used at the upstream citizen science monitoring site (FOUW 31) during the periods of elevated ammonium concentrations. However, the downstream site (FOUW 68) had several phosphate readings of 0.1ppm (roughly equivalent to milligrams per litre), which coincided with ammonium peaks at Hampton Bishop (Figure 13). Phosphate and ammonium are both typical components of various organic pollutants such as sewage and slurry, and the relatively localised extent of the detectable ammonium peaks suggests that an acute point source discharge of organic pollutant as opposed diffuse inputs occurred in the vicinity of Hereford.

The two citizen science sites are situated close together, with approximately 0.8km of river length between them. This potentially limits the source of the ammonium input to within this 0.8km section of channel. The information provided by citizen science monitoring can be used to refine Environment Agency monitoring and investigations, helping to identify and target sources of pollution into rivers.

We analysed additional citizen science sites on tributaries that showed no clear association with the increase in ammonium concentrations detected by the sondes. This

helped us narrow down the source of this input to the stretch between the two sites presented.

Several sites did not have regular enough samples in June to compare with the sonde data during the period of interest.

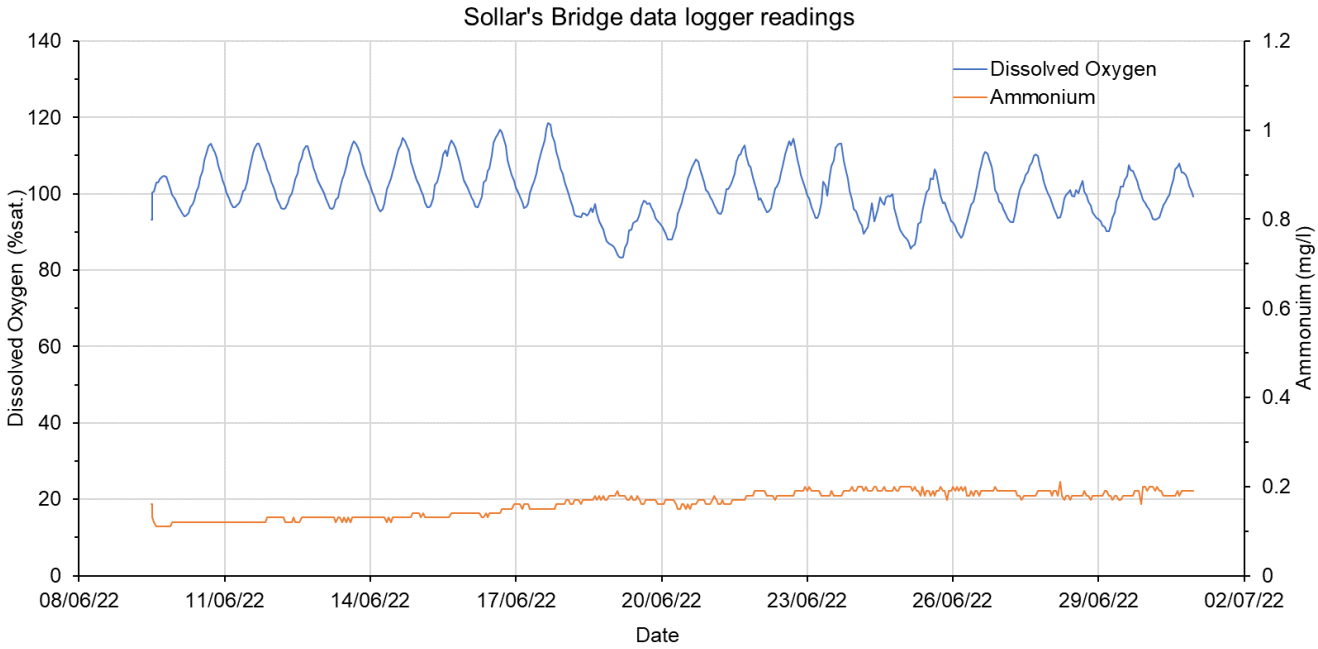

Figure 10: Time series plot of Ammonium and dissolved oxygen readings collected from the Sollar's Bridge sonde, 08/06/22-31/06/22.

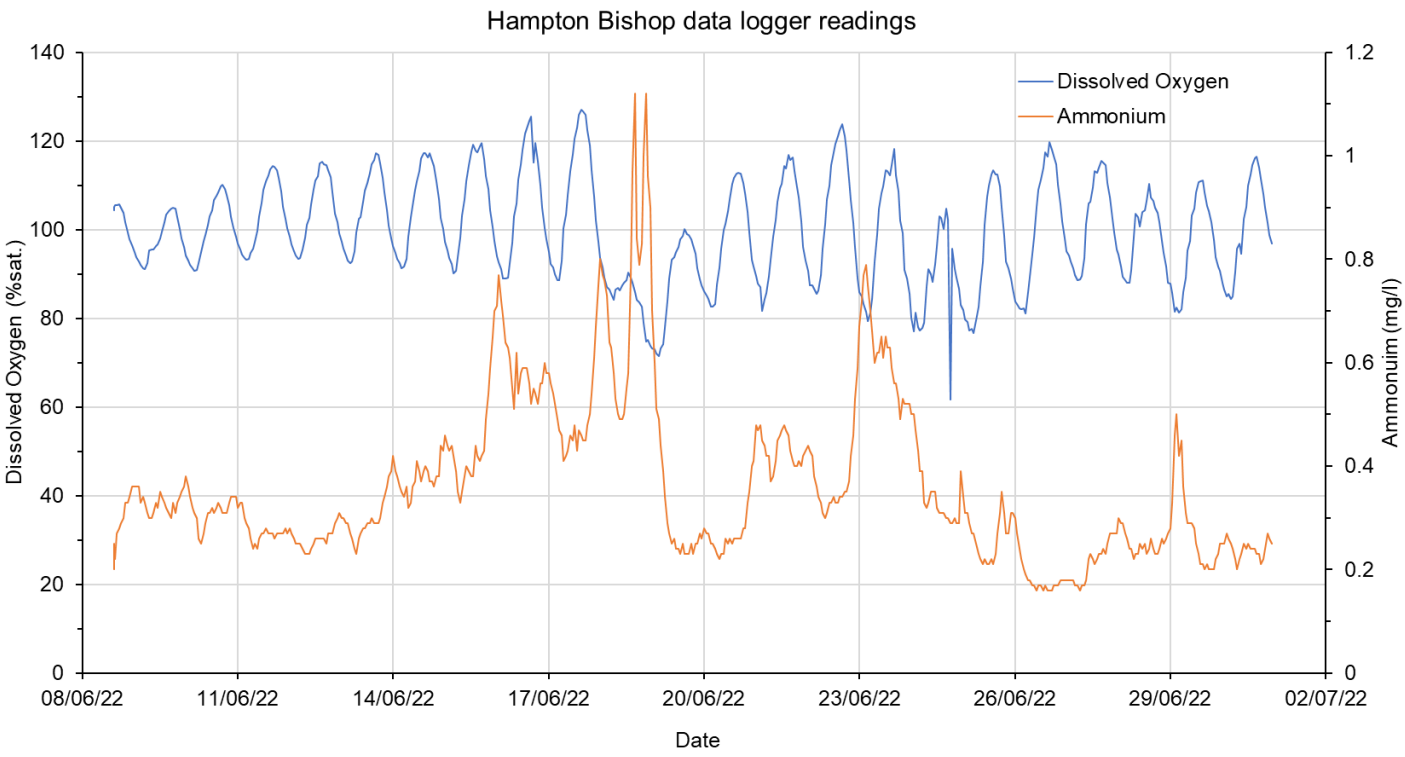

Figure 11: Time series plot of Ammonium and dissolved oxygen readings collected from the Hampton Bishop sonde, 08/06/22-31/06/22.

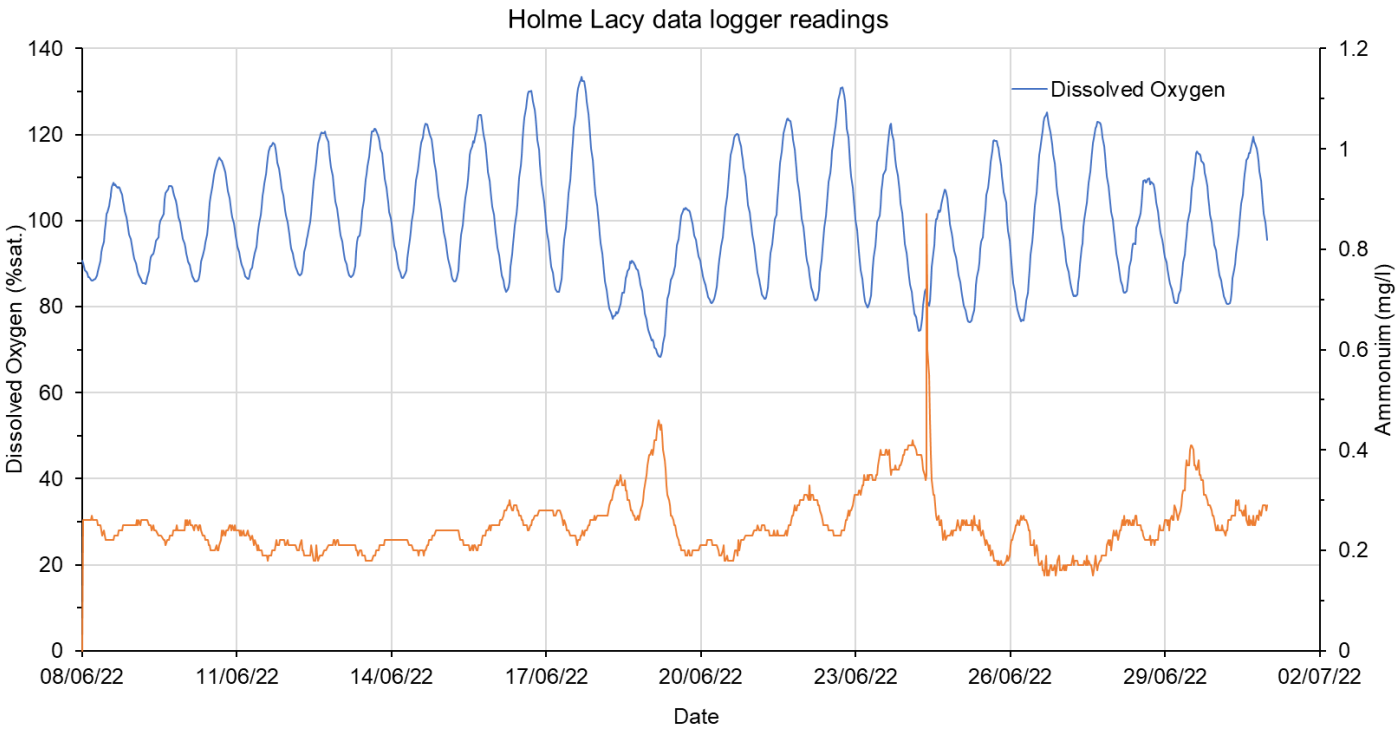

Figure 12: Time series plot of Ammonium and dissolved oxygen readings collected from the Holme Lacy sonde, 08/06/22-31/06/22.

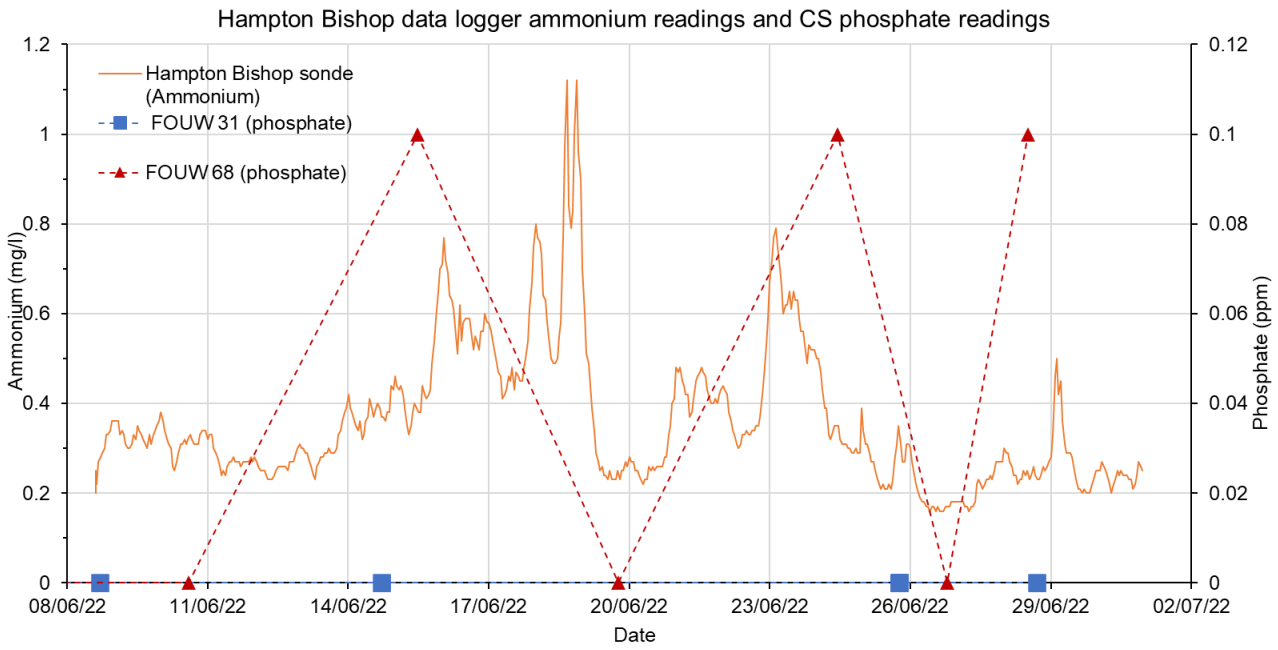

Figure 13: Time series plot of Ammonium and citizen science phosphate readings collected from the Hampton Bishop sonde and FOUW 31 and FOUW 68, 08/06/22-31/06/22.

Short term trends in water quality

Figure 14, Figure 15 and Figure 16 show the individual sampling point locations and status for orthophosphate, dissolved oxygen, and ammonia. These figures show the previous reports indicative classifications (01/04/2019-31/03/2022) alongside the most up-to-date indicative classifications available (01/07/2019-30/06/2022).

We will continue to produce new 'rolling' indicative WFD classifications for each site in the quarterly reports where new data is available.

Due to alterations to monitoring programmes many routine WQ monitoring sites within the Wye Management Catchment had limited new data within the latest rolling analysis period.

For sites where no new data was available, results from the most recent classification runs were not compared against previous classifications to avoid the risk of drawing inaccurate conclusions due to these new classifications being based on a reduced number of existing sample results. Additionally, as in the previous quarter, monitoring data for a small number of sites within the Lugg catchment was limited, as access for EA staff was restricted.

Data analysis

This showed at all sites compared, no deterioration in 3-yearly rolling phosphate or Ammonia classifications was recorded.

For Dissolved Oxygen this also showed one improvement in classification status and one deterioration in classification status. These were as follows:

- Yazor Brook as discharge to R Wye (50175) improved from Moderate to Good status between the Q1 and Q2 indicative report classifications. This improvement was very marginal (the mean DO 10%ile improved from 74.81 to 75.84, with the Good/Moderate threshold being 75).
- River Lugg at Eaton Bridge, Leominster (50042) deteriorated from High to Good status between the Q1 and Q2 indicative report classifications. This deterioration was very marginal (the mean DO 10%ile reduced from 80.32 to 79.79, with the High/Good threshold being 80).

In both cases, continued monitoring will be required to determine whether these changes offer a true reflection of long-term trends.

Finally, Figure 17 shows the mean total oxidised nitrogen (TON) values recorded within the River Wye catchment between 01/04/2019-31/03/2022 and between 01/07/19-30/06/22. There is no WFD classification for TON, however analysis of trends in mean TON values suggest that, of the site where new data is available:

- Escley Brook c/w River Monnow (50752) has seen the largest increase in mean TON between the two sampling periods, rising from a mean TON of 0.093 mg/l to 1.184 mg/l.
- Cage Brook Downstream C/W Coldstone Brook (50120) has the highest mean TON (10.406 mg/l)
- River Dore at C/W River Monnow (50063) has seen the greatest reduction in mean TON between the two sampling periods, reducing from a mean TON of 4.562 mg/l to 3.76 mg/l.

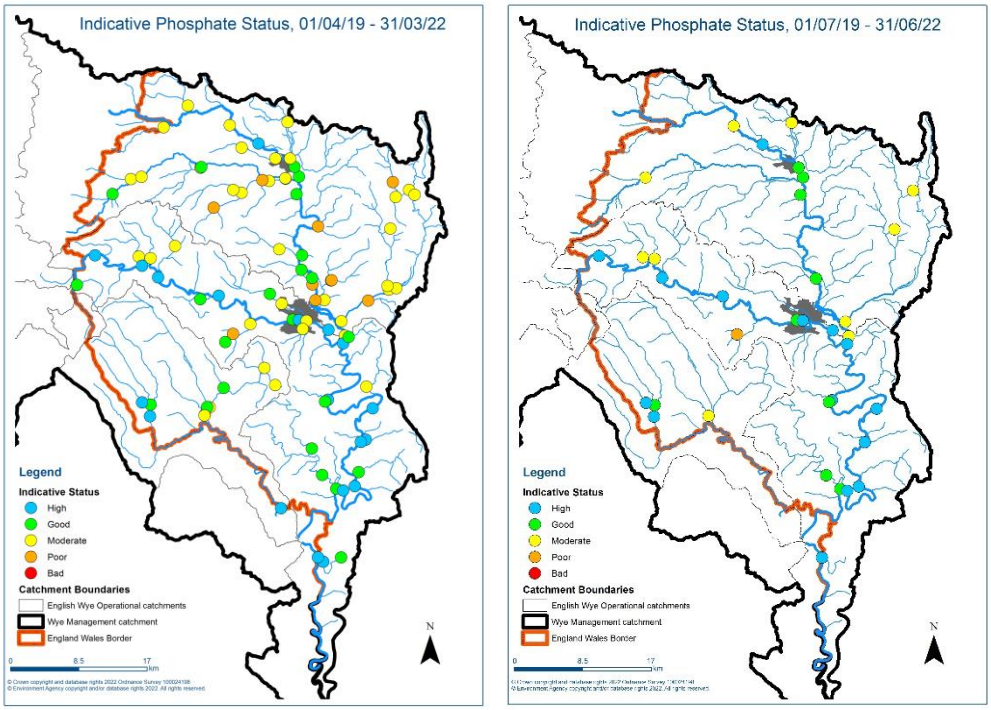

Figure 14: Change in indicative status for phosphate calculated for sites within the Wye Management Catchment between 01/04/2019-31/03/2022 and 01/07/19-30/06/22. Showing no

change at sites where new data is available. Note the exclusion of sites in the right-hand side map where new data is absent.

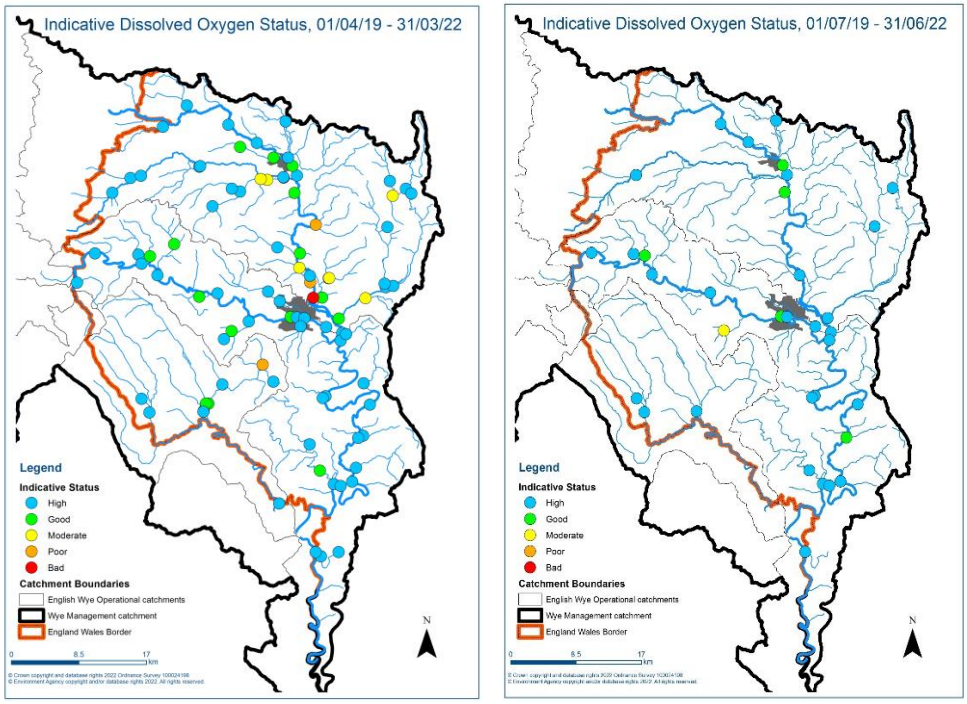

Figure 15: Change in indicative status for Dissolved Oxygen calculated for sites within the Wye Management Catchment between 01/04/2019-31/03/2022 and 01/07/19-30/06/22. Showing classification status changes at Yazor Brook as discharge to R Wye (50175), and River Lugg at Eaton Bridge, Leominster (50042). Note the exclusion of sites in the right-hand side map where new data is absent.

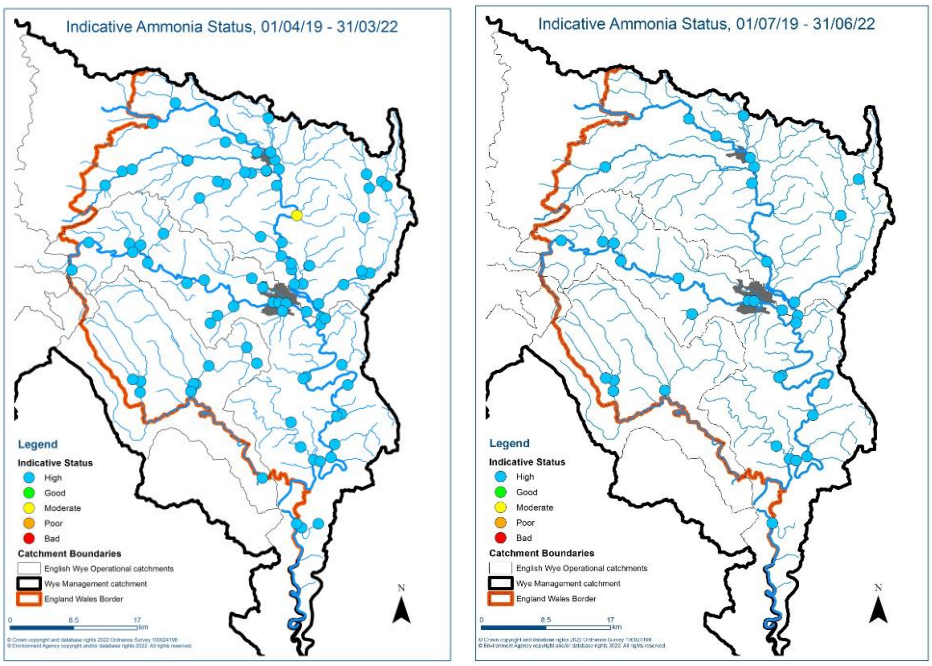

Figure 16: Change in indicative status for ammonia calculated for sites within the Wye Management Catchment between 01/04/2019-31/03/2022 and 01/07/19-30/06/22. Showing no

change at sites where new data is available. Note the exclusion of sites in the right-hand side map where new data is absent.

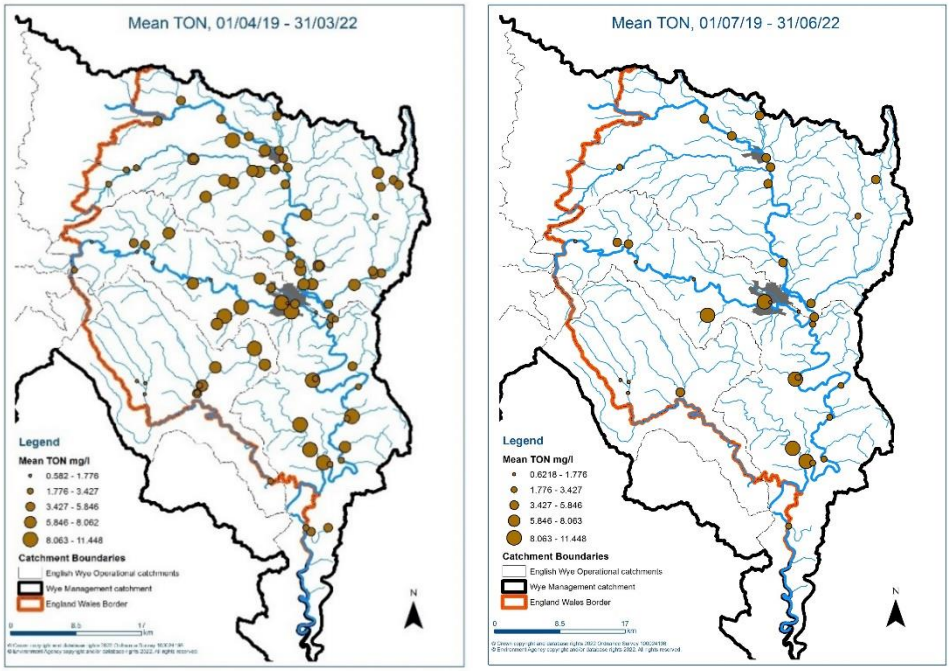

Figure 17: Change in mean Total Oxidised Nitrogen in the Wye Management Catchment between 01/04/2019-31/03/2022 and 01/07/19-30/06/22. Showing TON values remain highest at locations on the Cage Brook, Wriggle Brook, Garren Brook, and Yazor Brook (all consistently above TON mean values of 9mg/l at certain sites). Note the exclusion of sites in the right-hand side map where new data is absent.

3. Which locations, sectors and activities were responsible for the ecological and water quality issues identified in the data?

Temperature

Data presented in the previous reports suggests that elevated water temperature is a key factor triggering algal blooms in the River Wye. Climate change, lower flows and lack of shade are likely to contribute to increased temperatures.

Nutrients

Previous watershed analysis of sampling points supported the results of modelling work, suggesting that arable agriculture and sewage treatment works without phosphorus limits are both significant contributors to the nutrient loading of the wider catchment.

The RePhoKUs report (Withers, et al., 2022) suggests that the Wye Management Catchment is particularly susceptible to water quality impacts from agricultural phosphate because of the high phosphate inputs, frequency of rainfall events and soil types.

An important finding of the report was that annual inputs of phosphorus to the soil in the catchment comprise about 82% manure, 15% fertiliser and 3% biosolids. There is also a lower phosphorus uptake efficiency (57%) compared to the UK national average of 65%.

The study also concluded that agriculture generates a surplus of roughly 2000 tonnes of phosphorus per year in the Wye Management Catchment, which is accumulating in the soils. This surplus is nearly 60% more than the national average and is predominantly driven by manure application.

Crop cover

The previous reports highlighted that there has been a decline in coverage of pasture and hedgerows in the Wye Management Catchment in England, with grassland being replaced by arable crops, in particular increases in the production of maize and potatoes. We cannot confidently describe the driving markets for these changes, and they may include anaerobic digestion, livestock feed and human consumption.

During previous quarterly Wye reports, we incorrectly described the grassland classification assigned by CROME as ‘permanent’ grassland. To be classed as permanent, grassland needs to have been continuously present for a minimum of 15 years. Using CROME we are not able to distinguish between rotational and permanent grassland. However, land-use has been classified annually since 2016, and the information provided by CROME still makes it possible to identify longer term change in agricultural land-use.

Although CROME classifies arable land by individual crop, with the exceptions of maize and potato, we have aggregated crops into mixed arable to account for crop rotation cycles and to simplify analysing changes in land use. Figure 19 shows land use in the English Wye Management Catchment classified annually between 2016 and 2021 respectively.

Upon analysis of the 2021 dataset, we identified that there are low probabilities of correct classification of grassland and some crop types for the 2020 dataset within the Wye catchment. Further work is required to understand the impact upon the accuracy of agricultural land use classification and implications for conclusions drawn from this dataset.

Probability of classification for each tile by CROME is available for the 2020 and 2021 datasets. The median and mean probabilities for grassland, maize and the aggregated mixed arable land use are much less than 2021 (Figure 18). We are not currently fully certain of the reasons for the reduction in certainty in 2020. However, far less validation of land use assignments via site visits in 2020 occurred compared other years due to COVID-19 related restrictions. The reduction in data validation will have reduced the certainty of CROME land use assignments. For future analysis, we intend to develop a data quality threshold derived from the probability of land use value assigned to individual tiles. Once a quality threshold has been established, we will re-analyse the CROME datasets within the Wye catchment.

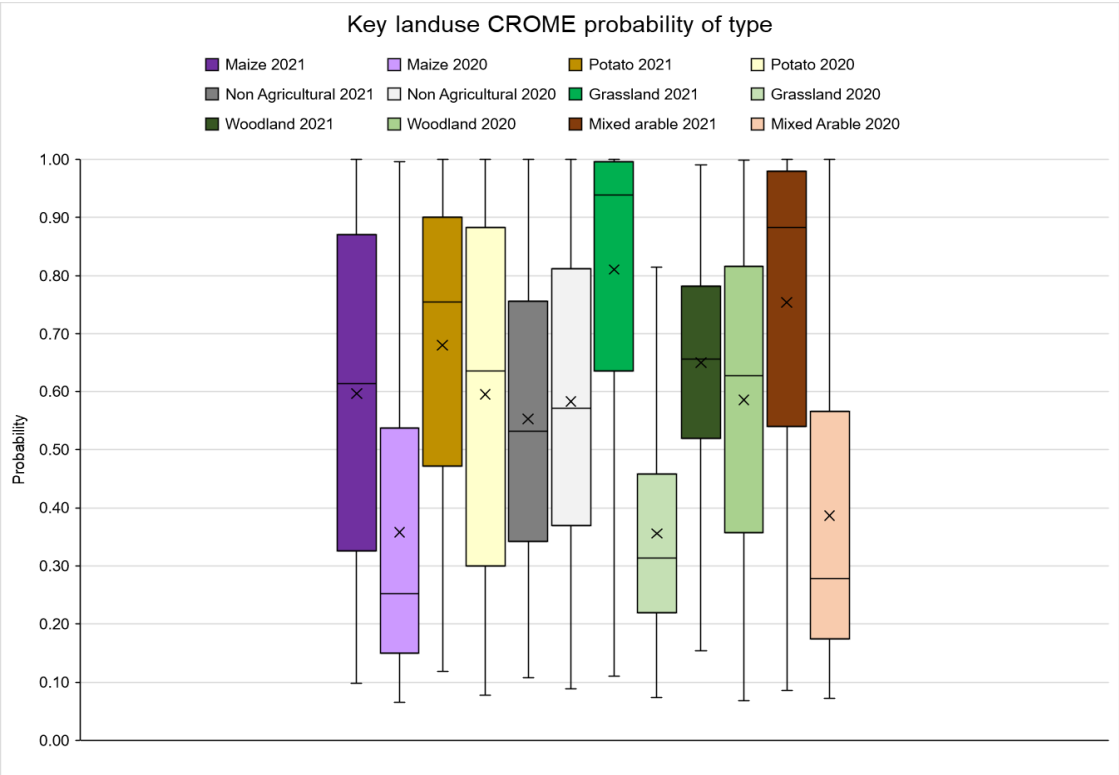

Figure 18: Box and whisker plot comparison of distribution of probability socres for land use types between 2021 and 2020. Probability scores are a representation of the confidence that the classification is correct.

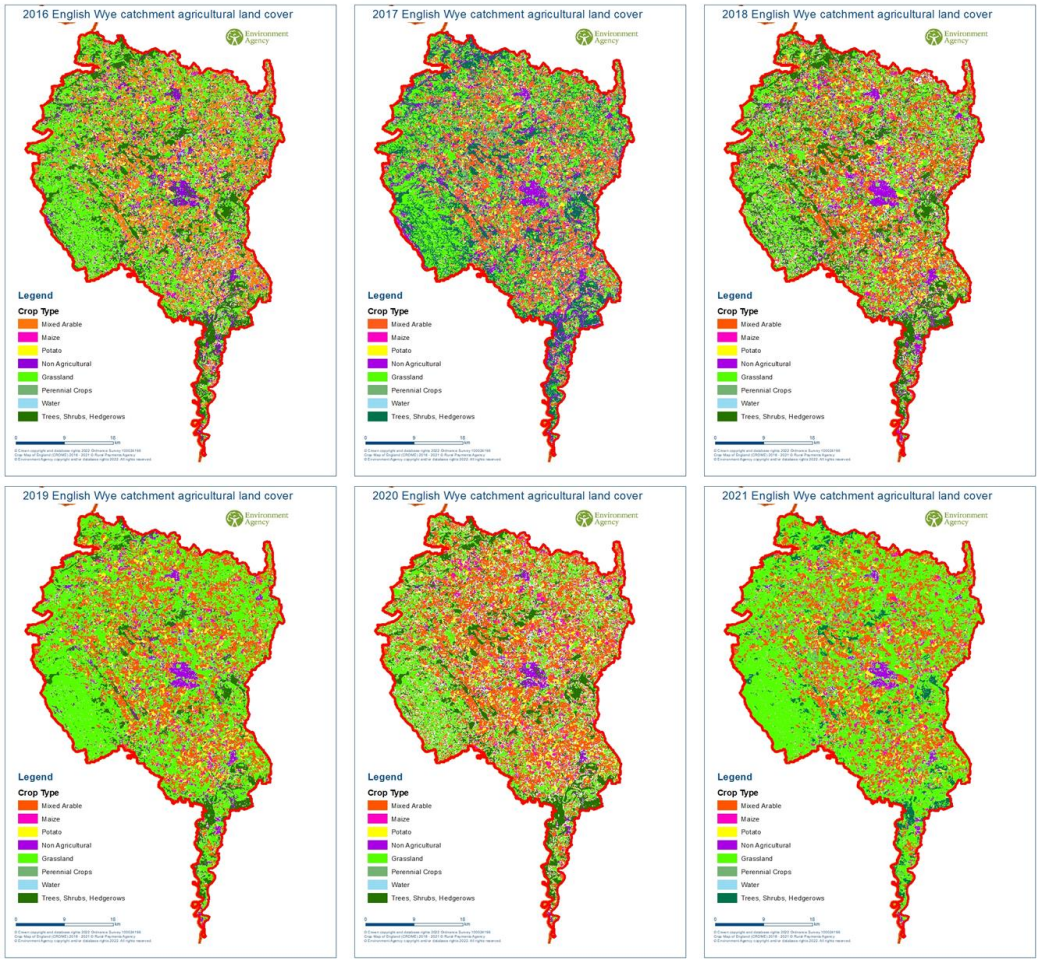

Figure 19: Land Use change 2016-2021 from RPA CROME

Table 2: Comparison of selected rural land use between 2016 and 2021 using CROME land cover assignment. Other non-agricultural land uses are not presented in the table. Further work is needed to verify these figures following our identification that confidence scores in 2020 are much lower in the Wye compared to the overall model.

Year	Mixed Arable (hectares)	Maize (hectares)	Potato (hectares)	Total Arable (hectares)	Grassland (Hectares)	Trees, Shrubs, Hedgerows (hectares)
2016	53251	3224	2735	59210	66784	35236
2017	47158	3570	3392	54120	55607	50676
2018	58763	7680	6019	72461	49696	41451
2019	44121	6941	6043	57105	98244	17180
2020	87737	12540	6556	106833	45507	31808
2021	43854	6355	4632	54841	104996	12167

Change 2016 - 2021	**-18%**	**+97%**	**+69%**	**-7%**	**+57%**	**-65%**

Table 3: Comparison of the percentage covers of total land arable and grassland and the percentage cover of farmland (arable + grassland) arable and grassland between 2016 and 2021 using CROME land cover assignment.

Year	Percentage of total land arable	Percentage of farmland arable	Percentage of total land grassland	Percentage of farmland grassland
2016	28	47	35	53
2017	25	49	29	51
2018	31	59	26	41
2019	23	37	52	63
2020	46	70	24	30
2021	23	34	55	66

The CROME data for the English Wye shows considerable change in rural land use between 2016 and 2021, with considerable variation in the cover of arable crops and grassland occurring annually. There has been a step change in the amount of land used for maize and potato production, with maize apparently increasing by 97% between 2016 and 2021. The increases in maize and potato cover will in part be due to crop rotation. However, fluctuations in grassland coverage are likely to affect sediment loading into the Wye catchment, and potentially increase runoff of fertilisers and other agrochemicals during years with reduced grassland coverage. Furthermore, the growth of maize and to a lesser extent potatoes can increase sediment runoff due to the late harvest times (mid-late autumn), which can coincide with wet weather. This can increase the risk of runoff of exposed soil and compaction by machinery reducing the soil's ability to absorb water compared to non-arable land or overwintering crops.

Whilst the trend is most visible for these crops, it must be recognised that any form of land use that receives high phosphate inputs and generates run-off and leaching of soil or nutrients is likely to contribute to the water quality problems in the Wye.

Incident Reports

Reports of environmental incidents from members of the public to the Environment Agency give an indication of the sectors and activities that are contributing to ecological and water quality problems in the English parts of the Wye Management Catchment.

The location and number of incident reports is heavily biased towards areas of higher population, recreational activity, and Citizen Science monitoring points, where there are greater numbers of observers. However this data does generally support the findings from spatial, water quality and ecological monitoring - that both agricultural land management and sewage discharges are significant contributing factors to problems within the River Wye and its tributaries.

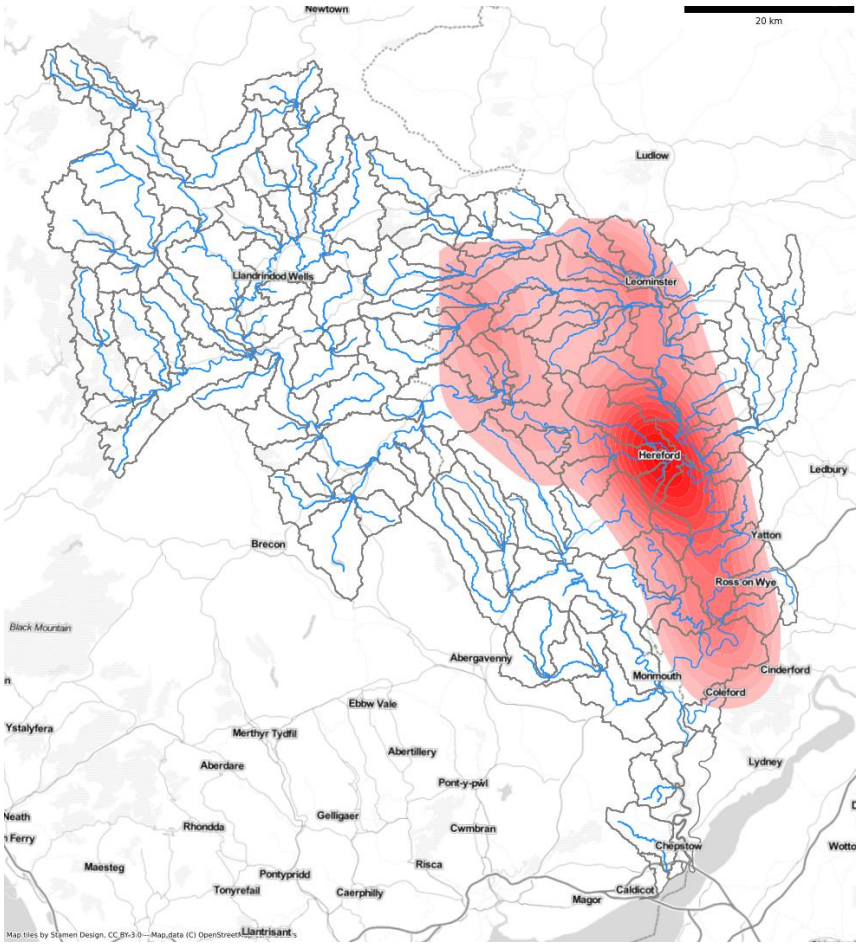

Figure 20: Heatmap of incident reports received by the Environment Agency in the English Wye Management Catchment between 01/04/2022 and 30/06/2022. Multiple reports can be received for the same incident.

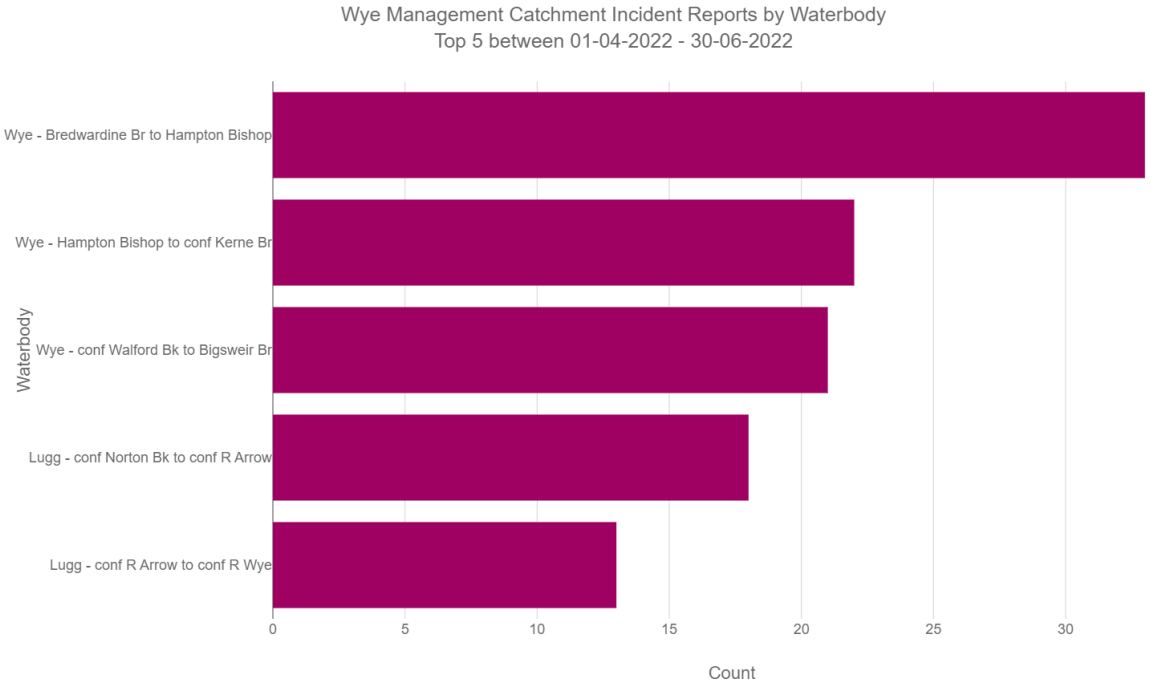

Figure 21: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five waterbodies between 01/04/2022 and 30/06/2022. Multiple reports can be received for the same incident.

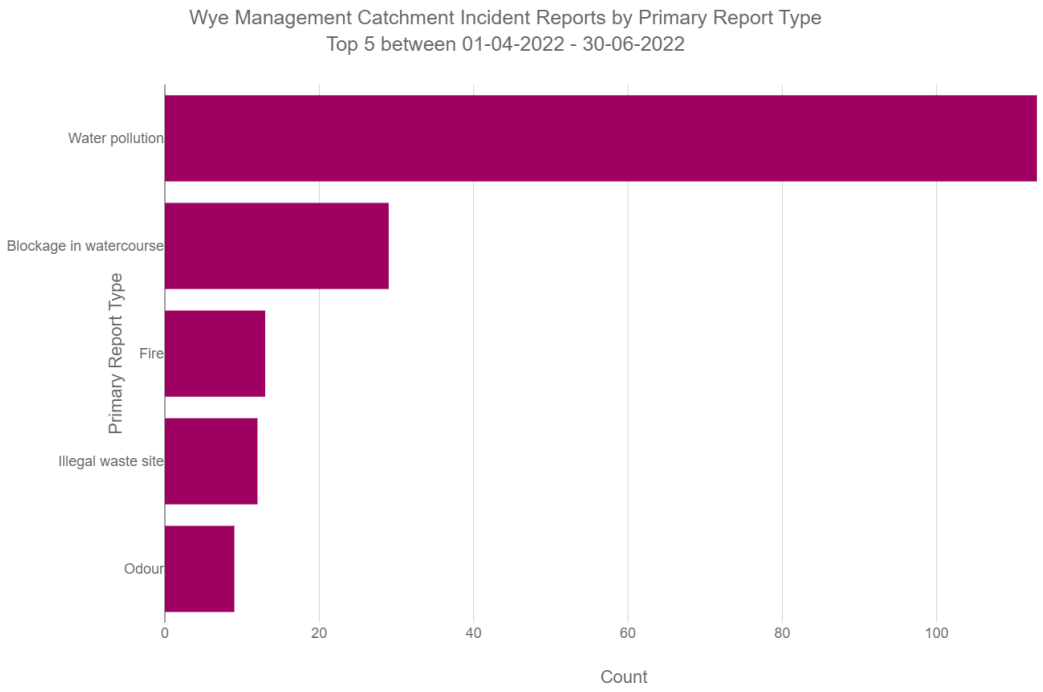

Figure 22: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five report types between 01/04/2022 and 30/06/2022. Multiple reports can be received for the same incident.

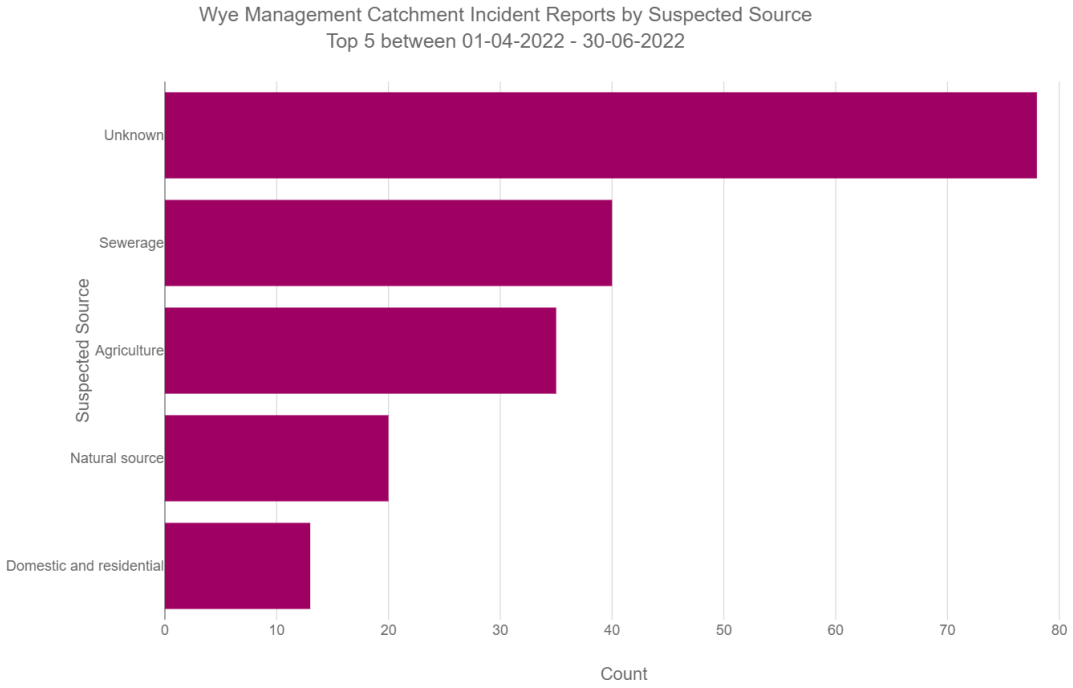

Figure 23: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five suspected sources between 01/04/2022 and 30/06/2022. Multiple reports can be received for the same incident.

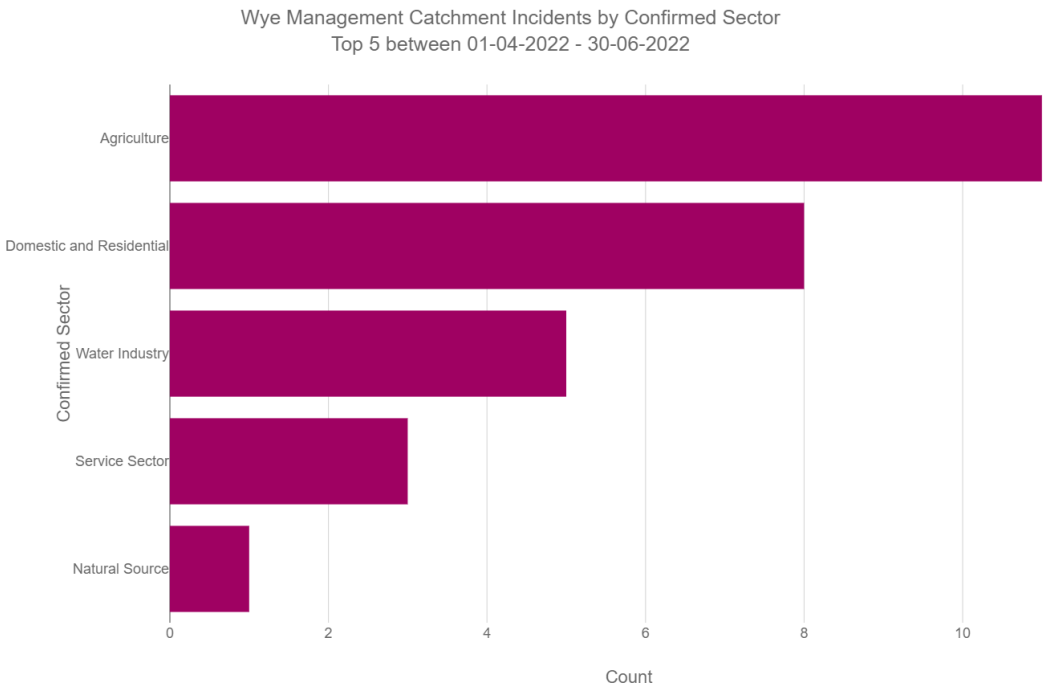

Figure 24: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five confirmed sectors between 01/04/2022 and 30/06/2022. This chart displays the number of incidents, not reports.

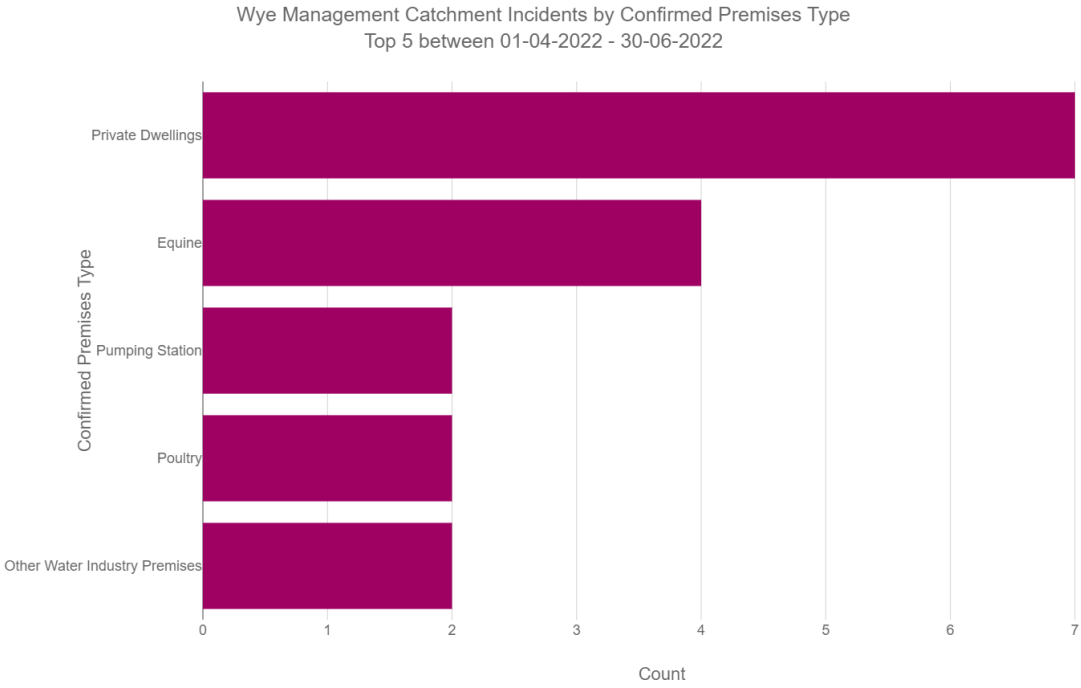

Figure 25: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five confirmed premises between 01/04/2022 and 30/06/2022. This chart displays the number of incidents, not reports.

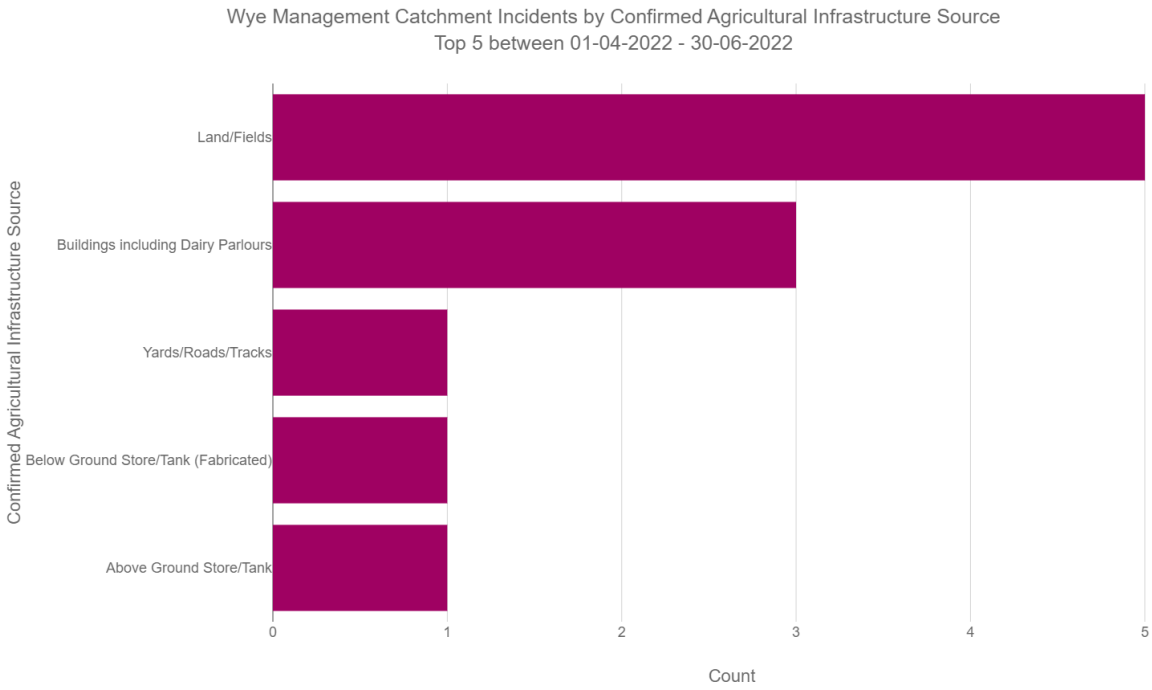

Figure 26: Number of incident reports received by the Environment Agency in the English Wye Management Catchment for top five confirmed agricultural infrastructure sources between 01/04/2022 and 30/06/2022. This chart displays the number of incidents, not reports.

The level of our enforcement activity in response to incident reports, reflects the findings of our watershed analysis presented in previous reports that agricultural diffuse pollution and sewage account for the largest share of the water quality problems in the River Wye. Accounting for the impacts of COVID-19 there is also a trend of increasing numbers of substantiated water pollution incidents. The data for 2022 underrepresents the numbers of incidents as enforcement actions take time to complete. This data does not include all our enforcement activity. Only that which we undertake in response to incidents.

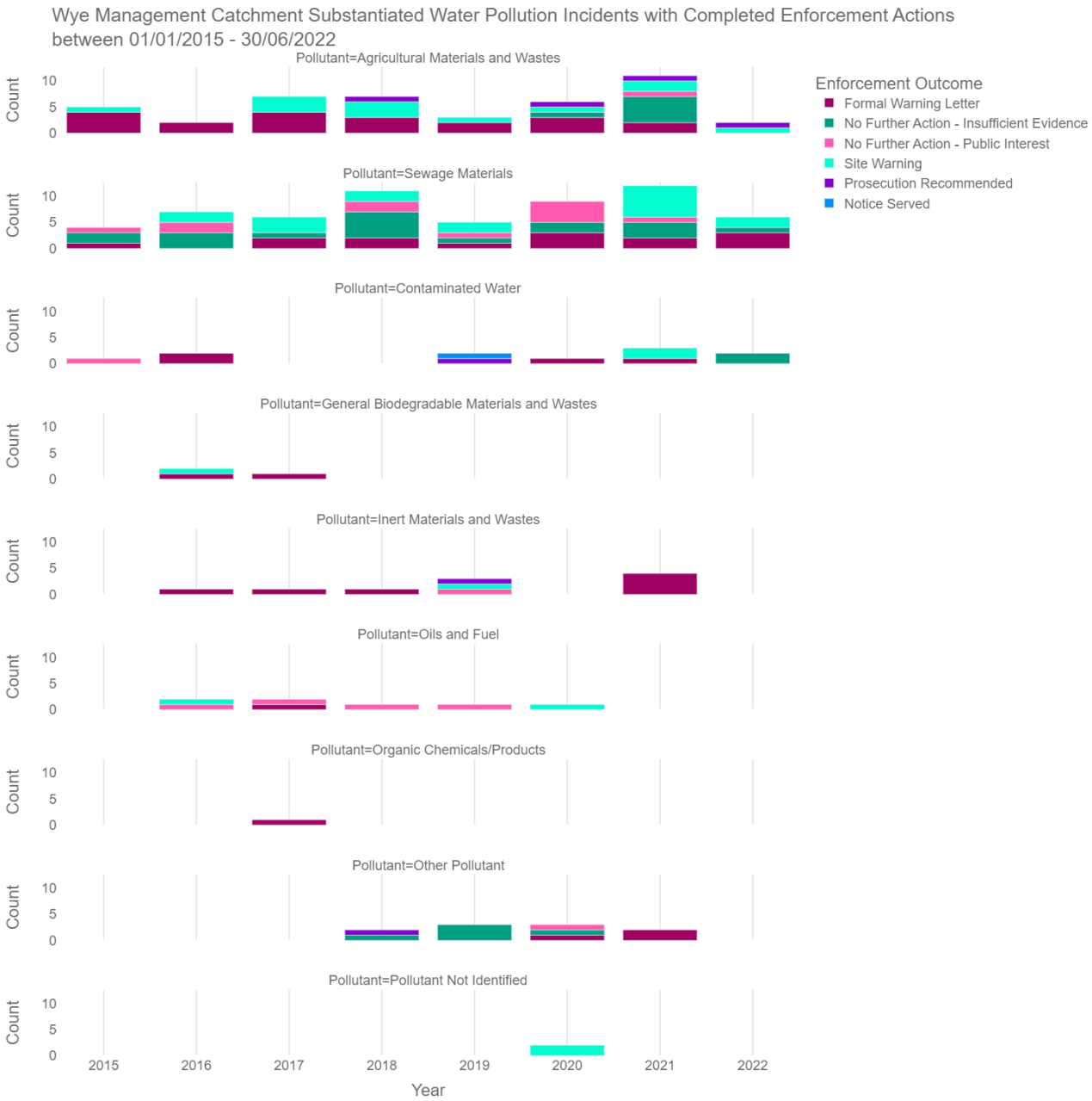

Figure 27: Breakdown of completed enforcement actions by pollutant in response to substantiated water pollution incidents in the River Wye Management Catchment.

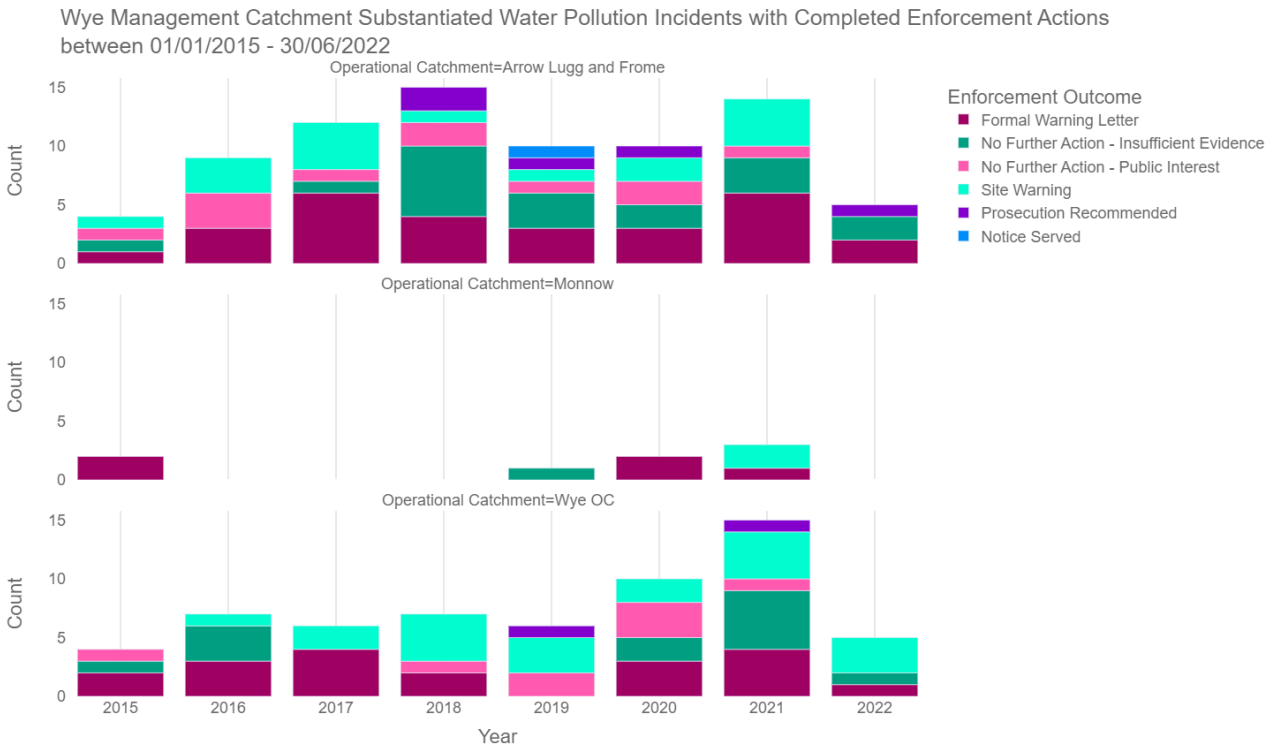

Figure 28: Breakdown of completed enforcement actions by Operational Catchment in response to substantiated water pollution incidents in the River Wye Management Catchment.

Recommendations

Additional data and analysis required

There is a large amount of Citizen Science monitoring that has taken place within the Wye Management Catchment by third parties in the past year. We will continue to analyse Citizen Science data in future reports and expect that the usefulness of this data will grow even more when all sites have at least a full year's worth of data by autumn 2022. We aim to integrate this data more with incident report intelligence in future reports.

We are looking at how we can incorporate the findings from RePhoKUs into our modelling work with partners to identify the areas of the catchment presenting the highest risk of nutrient input to watercourses. We are also funding Catchment Partnership projects to investigate land drains and understand whether the lab findings regarding soil type vulnerabilities to leaching phosphate are confirmed in the field.

Further work is also required to assess the sources of nutrient uptake to macrophytes and algae which are not detectable by water column monitoring. Sediment sampling especially, should be explored to fill this gap in understanding. We will pursue all available funding and delivery routes for this, including asking for support from partners where our resources do not allow us to undertake the desired sampling.

Describing the habitat through Habscore and River Habitat Surveys would help in understanding the interplay between the physical conditions and biological communities and contribute to understanding the impacts of climate change on habitat availability. We will pursue all available funding and delivery routes for this, including asking for support from partners where our resources do not allow us to undertake the desired sampling.

More detailed time series data on volumes spilled by CSOs is required to rigorously assess the relative contribution that such sources play. Dwr Cymru Welsh Water have shared this information with us and we aim to analyse it for future reports.

Detailed information on the movements of manure and wastes spread to land is needed to be able to understand the impacts of activities that generate these materials. We are investigating the options available to obtain this information.

Targeting Regulatory and Partnership Action

While more information is still required to provide more detailed recommendations to support targeted action, we can recommend the following:

Significant reduction in nutrient input from all sources is required across the whole catchment to contribute to the recovery of river macrophytes. Reducing run-off and leaching of nutrients from land during summer rainfall events when dilution is low and temperatures are high is an important element of this remedial activity.

The RePhoKUs project (Withers, et al., 2022) concluded that eliminating the agricultural phosphorus surplus and drawing down the existing phosphate from soils to at least the agronomic optimum, and possibly further, is required to achieve water quality targets in the catchment, which may take about a decade.

Investigations into the sources of pollution events on the River Wye in Hereford should be carried out to identify areas for investment to prevent reoccurrence of the events inputting ammonium and phosphate to the river captured by the sondes and Citizen Scientists.

Efforts to increase shade by tree planting and better management of riparian trees could help mitigate high temperatures. We have developed a high temperature and algal bloom early warning system to enable us to respond to excessive temperatures with advice for anglers and river users and extra monitoring.

Taking a catchment-based approach, all contributing partners in the Wye Management Catchment could target investigations, analysis and remedial actions in key focus catchments that meet the following criteria:

- As far upstream as possible
- High phosphate concentrations relative to the wider catchment, taking the size of watercourse into account.
- A high proportion of the following factors and drivers are present:
    - Arable land use
    - Maize
    - Poultry sheds
    - Anaerobic digesters
    - Sewage treatment works
    - Combined sewer overflows
    - Macrophytes status less than good and indicative of eutrophication
    - Declining Atlantic salmon populations
    - Land allocated for development to which Nutrient Neutrality guidance applies
    - Active Citizen Science groups
    - Active partnership projects

Based on these criteria the following functional groups of waterbodies seem most suitable initially:

1. River Arrow near Kington
2. River Arrow near Pembridge and Curl Brook
3. River Lugg and tributaries near Presteigne
4. Little Lugg and Withington Marsh Brook
5. River Frome

Further investigations in partnership should include understanding the pathways and impacts of manures and wastes that are spread to land and a comprehensive appraisal of options to mitigate the impacts of poor water quality, including whether we could manage water resources differently to create more dilution.

Where Citizen Scientists can support the efforts of land managers and discharge operators to reduce the impact of their operations by undertaking targeted monitoring and evaluation in response to identified high nutrient events, we would encourage them to do so, following the guidance we have previously shared on safe and effective monitoring.

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