Citizen Science on the River Chess

A report on our findings from 2021 to 2025

Thames Water

Chilterns National Landscape

CHILTERNS CHALK STREAMS PROJECT

River Chess Smarter Water Catchment

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River Chess

Wigginton

Northchurch

Berkhamsted

Bovingdon

Chesham

Great Missenden

Hyde Heath

Chesham Bois

Amersham

Chenies

Little Chalfont

M25

M25

Chorleywood

Rickmansworth

River Colne

Sewage Treatment Works

Chesham

Chenies

Latimer

Water vole training

Riverfly training

Citizen science training

N

Scale

0 1 2km

Introduction

The purpose of this report is (i) to provide an overview of our citizen science activities on the River Chess over the past four years; (ii) to highlight critical findings and impact from our surveys and investigations; (iii) and to celebrate all the amazing work and dedication of our volunteers.

We hope that this report will help inform other local rivers groups around the country about the methods and toolkits we've used and the approach we have taken to create a sense of community and purpose around citizen science activities in the catchment of the River Chess.

The work started with a baseline assessment to identify our knowledge gaps about the river and its catchment. We identified the questions that we wanted the citizen science activities to answer and then weaved citizen science methods together with the work of consultants, universities and other research organisations to help answer our questions about river health. This report details the findings from this joint endeavour. The work would not have been possible without the pre-existing network of volunteers who had been collecting riverfly, flow and water vole data about the Chess for many years prior to this work.

Their enthusiasm and knowledge about the catchment formed the firm foundation for us to build on.

Citizen science at this scale can only be achieved with continuous and long-term funding to employ staff, recruit and engage volunteers, and purchase equipment and consumables. In our case we have been supported by a full-time dedicated citizen science coordinator who helps train and co-ordinate volunteers and fieldwork, provides regular feedback to the citizen scientists, and helps them turn data into knowledge about the river and its catchment.

The whole programme of work has been funded by Thames Water's 'Smarter Water Catchments' initiative.

Kate Heppell and Hannah Parry-Wilson
March 2025

Kate Heppell in the field installing sensors

Hannah Parry-Wilson in the field conducting MoRPh

Riverfly training on the River Chess

River Chess Smarter Water Catchment

Chilterns Chalk Streams Project staff

Smarter Water Catchments Initiative

The Smarter Water Catchments initiative takes a systems-based view of the environment, collectively addressing multiple challenges and co-delivering solutions that make the most of opportunities on an even bigger scale.

The River Chess is one of three catchments being piloted under Thames Water's Smarter Water Catchments approach. The premise of our Smarter Water Catchments initiative is the core belief that working in partnership can address multiple challenges and deliver multiple benefits at scale. Thames Water wanted to pilot three catchments which were representative of the different challenges faced within their operational area to understand and explore how partnership working can present opportunities to deliver against environmental outcomes.

The Chess Steering Group is led by a partnership of sector-based local stakeholders who have guided the development and delivery of a catchment plan, whilst ensuring it reflects local needs and considers local area knowledge. The first step on this journey was to co-create a catchment plan with the technical working groups and bring in additional stakeholders who are responsible for ensuring the best plan is in place to achieve our objectives. Our 10-year catchment plan was published in March 2021, detailing actions under our six key themes. Citizen science initiatives have been a key part in the process, supporting data and evidence collection covering all six key themes.

Thames Water · The River Chess Association · Chilterns Chalk Streams Project · Chilterns National Landscape · Chiltern Society · Buckinghamshire Council · Environment Agency · Queen Mary University of London · Affinity Water · Herts & Middlesex Wildlife Trust

Community excavation

Water sampling

Thames Water seed-funded £3million from 2020 to 2025 to support the Chess partnership with resources, project funding, community engagement and education, landowner and community grants, nature recovery including the creation of a farm cluster and river restoration, with monitoring and evaluation embedded into all aspects of the programme.

Chiltern Society hedge planting volunteers at Restore Hope Latimer

INNS stem injection

Sarratt restoration in progress

River Chess strategy 6 themes

1 Improving water quality

2 Managing flow

3 Control of invasive non-native species (INNS)

4 Improving wildlife corridors

5 Involving people

6 Working together

Looking to the future, Thames Water is committed to working with catchment partnerships to amplify the success of Smarter Water Catchments and achieve the River Chess' objectives.

You can find further information about the initiative at **chesssmarterwatercatchment.org/**

The River Chess is currently classified as 'poor' status for phosphorus under the Water Framework Directive

1

Surveying on the Chess

2

Filamentous algae

Baseline assessment

We identified gaps in our knowledge of water quality issues with a baseline assessment. In 2014, following a period of prolonged storm tank discharge from Chesham sewage treatment works to the river, the River Chess Association identified a need to understand the reasons for frequency and impact of storm tank discharges to the River Chess.

In 2019, funded by a Queen Mary University of London public engagement grant and with Thames Water as co-applicants, the River Chess Association and Chilterns Chalk Streams Project began working with Queen Mary University of London to record changes in critical measures of water quality at 15-minute intervals in the river at four locations. Early results from this work indicated a need for the group to better understand water quality issues in the River Chess, and a baseline assessment was commissioned when the Smarter Water Catchment initiative commenced in 2021.

The baseline assessment was published in 2022 and identified three critical gaps in our knowledge of water quality issues in the River Chess, and actions to be taken to address these as follows:

1 Sources and impacts of nutrients in the River Chess

The River Chess is currently classified as 'poor' status for phosphorus under the Water Framework Directive. The Environment Agency estimates that 96% of phosphorus in the river is from Chesham sewage treatment works.

Phosphorus stripping at the works was planned in 2024, with the intention of moving the classification from poor to moderate status. Nitrate concentrations are also high (c. 14 mg/L Nitrate-N below the sewage treatment works). The influence of Chesham sewage treatment works (STW) on this nutrient has not been assessed but the spatial pattern of concentrations suggests it is a major source of nitrate. Nitrate concentrations rose substantially in the river following a permit change at the sewage treatment works in 1985.

The baseline report recommended sampling at high spatial resolution between the seven Environment Agency monthly monitoring sites to provide a detailed picture of spatial patterns in phosphate and nitrate in the river, and to better understand concentrations in the headwaters above the sewage treatment works (where Environment Agency monitoring ceased in 2012) and in groundwater (a critical component of flow in this chalk stream).

This analysis would also provide a snapshot of conditions before Phosphorus stripping at Chesham STW was introduced in 2024 (a requirement under Water Industry National Environment Programme (WINEP)). In addition to measuring phosphate concentrations the report also recommended investigating citizen science methods to understand the impact of high phosphate concentrations on the river ecosystem.

2 Sources and impacts of fine sediment in the River Chess

Fine sediment is a natural component of any river but can become problematic when supply from the catchment due to human activity exceeds the ability for the river to transport the sediment. Fine sediment can smother the riverbed, change oxygen conditions in sediment and harm valuable spawning sites for trout and grayling. Chalk streams are especially sensitive to the effects of excessive fine sediment inputs.

The baseline report recommended;

(i) a systematic survey of fine sediment inputs into the river augmented by local knowledge;

(ii) an analysis of areas in the landscape where there is risk of soil erosion and sediment transport to the river to prioritise action to prevent sediment runoff; and continued measurement of water clarity and

(iii) estimate of suspended sediment concentrations using turbidity sensors on the water quality sondes to assess the importance of rainfall events for suspended sediment inputs to the river.

The Mud Spotter methodology (by Cartographer) was recommended to engage citizen scientists in recording and evaluating locations of fine sediment input into the river. A sediment-sensitive riverfly metric, such as that used in Wildfish SmartRivers toolkit was also recommended to assess the impact of fine sediment on aquatic invertebrates, alongside use of a habitat assessment tool such as Modular River Survey (by Cartographer) to assess the extent of fine sediment coverage along and across the riverbed.

3 Risk to river health from contaminants of emerging concern

Contaminants of emerging concern (CECs) are a range of synthetic or naturally occurring chemicals that have been recently discovered in the environment and for which concerns about potential adverse impacts exist. CECs are often under-researched and lack regulation or management solutions. In many cases sewage treatment works were not designed to remove these chemicals, which increases the challenges to mitigate their potential effects. Based on some pilot work carried out with Imperial College London in March, 2020 which found 35 unique CECs in the river, the baseline assessment report recommended a further 12-month study to understand more about the spatio-temporal distribution of these chemicals in the river and the potential risks they pose to aquatic life.

Collecting passive samplers

Cleaning the sensors on a sonde.

A crayfish takes up residence in a sonde.

Water quality sensors

What are sondes?

A sonde is a piece of equipment used to monitor water quality directly in the river. Sondes can have multiple sensors that measure various aspects of water quality. Each aspect is known as a 'parameter'. Example parameters are water temperature, dissolved oxygen content of the water, turbidity or cloudiness of the water caused by suspended sediment, and the concentration of chemicals such as ammonium.

Where are the sondes on the River Chess located and why?

Initially we placed four sondes into the River Chess in 2019 as part of the ChessWatch collaborative project between the Chilterns Chalk Streams Project, Queen Mary University of London and River Chess Association. When the Chess Smarter Water Catchment initiative started in 2022, we purchased four new sondes from two companies. We deployed two sondes in key locations upstream and downstream of Chesham sewage treatment works to capture changes in water quality arising from runoff in and around Chesham, and from the operation of Chesham sewage treatment works. A further two sondes were placed in the lower Chess, one to record water quality changes downstream of the M25 and the other to provide a water quality dataset at the confluence with the River Colne. Our sondes are set to record data every 15 minutes so that we can capture event-based water quality dynamics (e.g. in response to intense rainfall events).

Our approach to data management and quality assurance

Our sonde data has been integrated into an online water quality data dashboard, set up and managed by a citizen scientist, Hefin Rhys. Citizen scientists also help to maintain the sensors on the sondes by cleaning them at regular (fortnightly) intervals and help out with data interpretation by maintaining a log of interesting events. Staff from Queen Mary University of London calibrate the sensors monthly to ensure precision and accuracy of the data.

Figure 1 - Specific conductivity, 12 – 20 December 2023

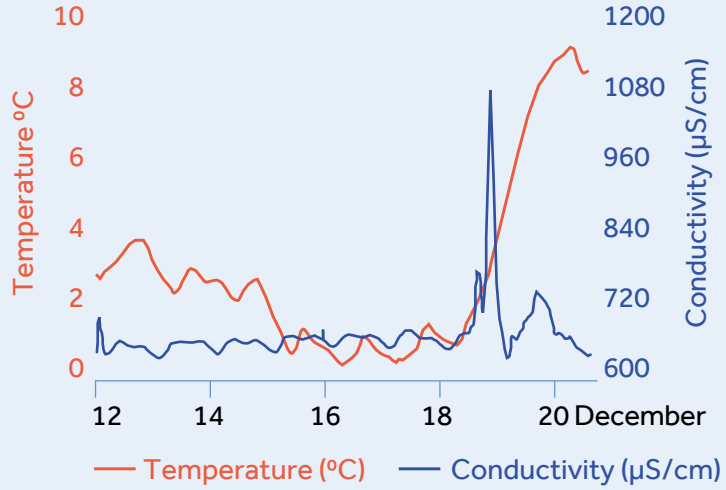
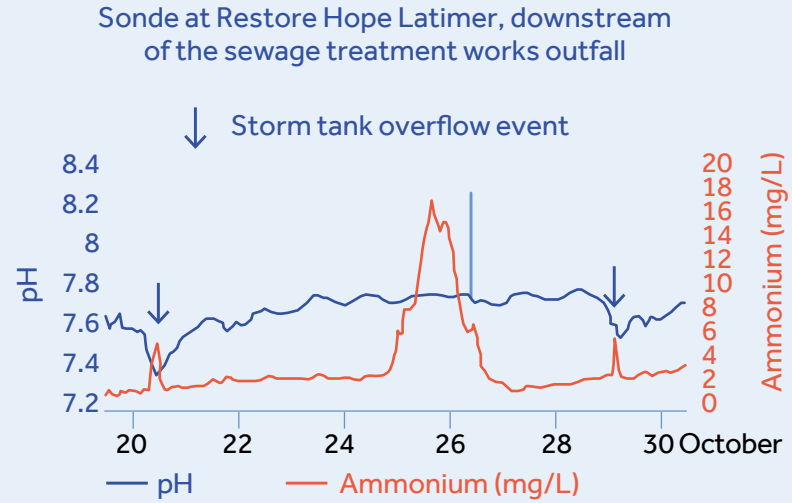


Figure 2 – Ammonia treatment issue at sewage treatment works, 20 – 30 October 2023



Key findings

Figure 1

In December 2022, a rapid warming spell after very cold wintry conditions caused a spike in specific conductivity on all our sondes, indicating that road salts were being washed into the river. Although not at very high levels, this highlights that the chemicals used on our roads end up in our rivers.

Figure 2

In October 2023, our sondes recorded increased ammonium concentrations as a result of two storm tank overflow events from Chesham sewage treatment works. On 24 October our sondes also detected a substantial increase in ammonium levels as a result of tertiary treatment issues at the sewage treatment works. The data enabled us to keep track of the situation and Thames Water deployed aerators in the river during the event to try to keep dissolved oxygen concentrations at safe levels for fish.

The data from our sensors has contributed to several scientific studies and impactful reports on chalk streams

Sensor mounted horizontally on riverbed due to shallow water

1 Can machine learning help us interpret patterns in water quality?

We have worked with scientists at Queen Mary University of London to apply machine learning approaches to our sensor data to explore repeating patterns in water quality in the River Chess. **A research article** [1] published in Scientific Reports journal showcased our high-frequency water quality measurements and showed that:

- The treated effluent from Chesham sewage treatment works creates patterns in electrical conductivity in the River Chess that are detectable along the entire river length and throughout the year.
- Water temperatures are an average of 1°C higher downstream of Chesham sewage treatment works during low river flows due to the release of treated effluent.

2 Will river water temperatures be affected by climate change?

Our water temperature data have contributed to a large dataset that the Environment Agency has compiled to develop the first national river water temperature projections in the context of climate change. The projections suggest that average water temperature of the warmest summer month is projected to rise by about 0.6 °C each decade. Because they are buffered by groundwater, chalk streams are predicted to have the slowest water temperature rise of all river types.

We found that river water temperatures in the River Chess already exceed safe levels for salmonids during hot summers and published **these findings** [2] at the European General Assembly 2020 – a leading international academic conference. Any additional rises in river water temperature will put further stress on fish such as trout and grayling.

1. www.nature.com/articles/s41598-022-16342-9 2. www.meetingorganizer.copernicus.org/EGU2020/EGU2020-17950.html

Figure 3 – Temperature (ºC) 21 – 28 June 2023 ● 12 noon

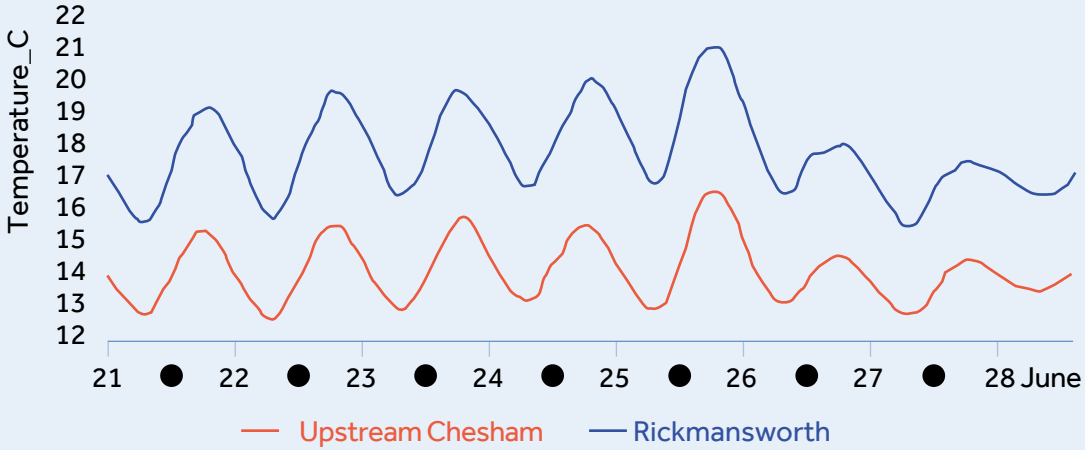


Figure 3
In June 2023, the Chilterns experienced a summer heatwave and our sondes recorded large differences in water temperatures between upstream river reaches near Chesham and the downstream sections of the river in and around Rickmansworth.

Protective copper mesh around a sonde to prevent fouling by sediment and algae

Figure 4 – Turbidity (NTU) 17 – 23 May 2023 ● 12 noon

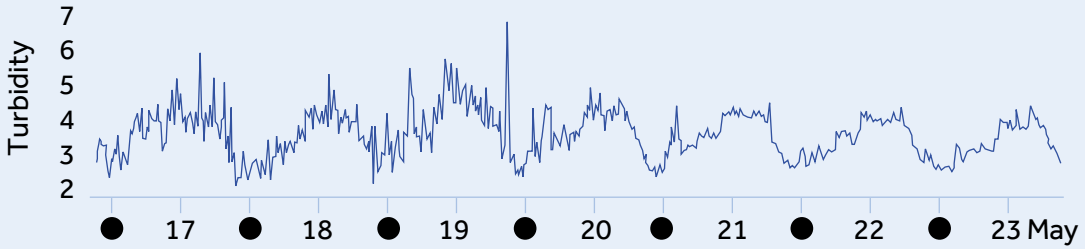
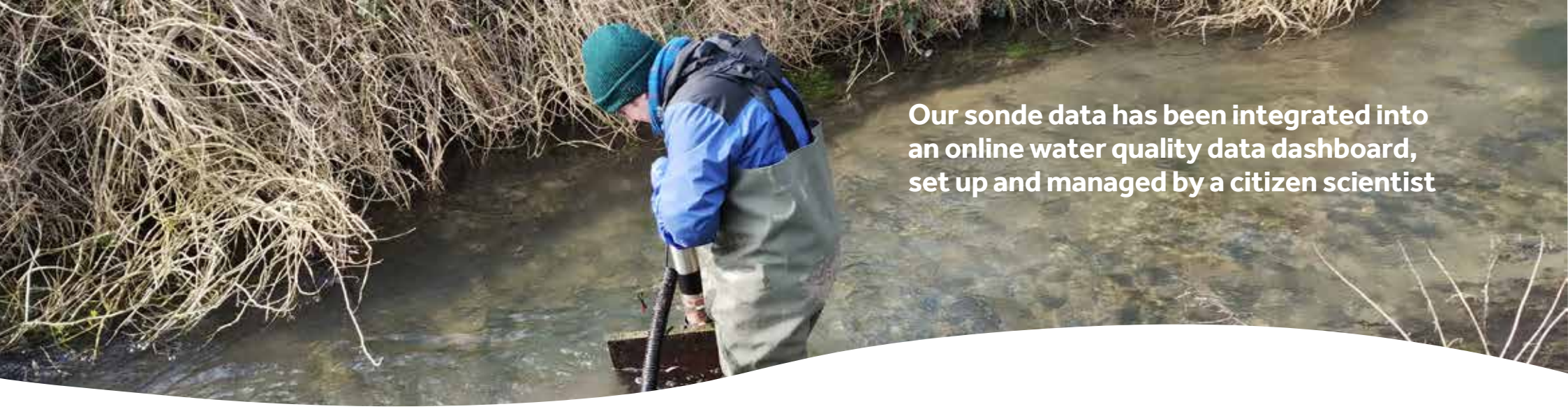


Figure 4
In May 2023, we noticed that turbidity levels on a lower Chess sonde were elevated at night and discovered this was due to nocturnal activity and burrowing behaviour associated with the non-native signal crayfish in the river.



Our sonde data has been integrated into an online water quality data dashboard, set up and managed by a citizen scientist

Downloading data on a sonde

3 Can storm tank discharges due to groundwater ingress impact dissolved oxygen levels in chalk streams?

Data from our sensors were published on page 71 of the Catchment Based Approach (CaBA) **Chalk Stream Restoration Strategy 2021**[3] to illustrate the impact of longer duration (days to months) storm tank discharges on dissolved oxygen concentrations in a chalk stream. From September 2019 to March 2020 five high-intensity rainfall events caused intermittent storm tank discharge to the river from Chesham sewage treatment works. Our sensors showed that not every storm tank discharge has the same effect on oxygen status. Some were characterised by a marked transient drop in dissolved oxygen of three to five hours duration. When groundwater levels were high, and the sewage treatment works were discharging excess flow from storm tanks due to groundwater ingress, a gradual decline in dissolved oxygen concentrations at night were noted. The patterns suggest that organic material settling on the riverbed alter river metabolism during these periods.

4 How can fluorescence technology help us study patterns in organic matter pollution and bacteria in rivers?

We have worked with scientists from the University of Birmingham to help them investigate how the fluorescence technology on two of our sensors can be used to study changes in bacteria and organic matter pollution in real-time in the River Chess. **The results of this study** [4] were presented at the European General Assembly in 2024. The potential to use fluorescence as a proxy for traditionally lab-based parameters within freshwaters has been highlighted within scientific literature. It comes with significant challenges including the ability to validate and calibrate data, signal interferences and the complications associated with continuous monitoring. As a groundwater-fed, sewage-impacted stream, the Chess provided a unique opportunity to test the use of fluorescence-based algorithms to monitor organic carbon, nutrients, and bacteria in real-time. The study highlighted both the applicability of fluorescence for continuous, in-situ monitoring but also how the impacts of pollutants and their pathways differ along the Chess.

3. www.catchmentbasedapproach.org/learn/chalk-stream-strategy/ *4. www.meetingorganizer.copernicus.org/EGU24/EGU24-9065.html*

Water quality sensors

Location of the water quality sondes in the River Chess

1. Chesham Main
2. Little Chess
3. Latimer Main
4. Watercress beds
5. Loudwater Estate
6. Rickmansworth

Chesham sewage treatment works (STW)

Bovingdon

Chesham

Chesham Bois

Amersham

Little Chalfont

Chenies

M25

M25

Chorleywood

Rickmansworth

River Colne

Multipe sensors on a sonde

Cleaning the sensors on a sonde

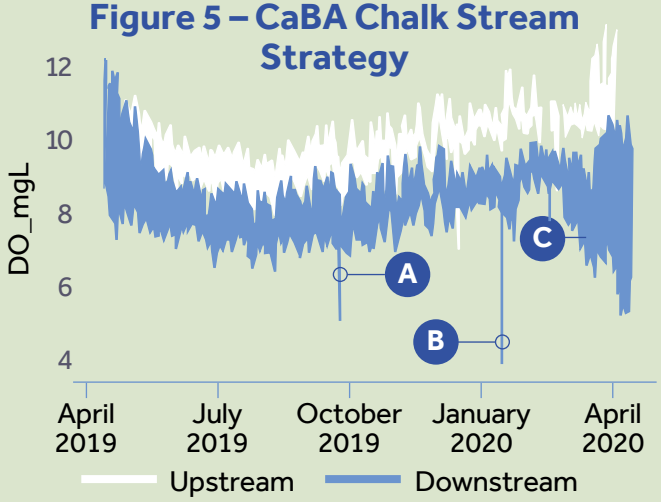
Sondes are powered by solar panels

N

Scale

0 1 2km

Figure 5 – CaBA Chalk Stream Strategy



Mud Spotter provides a record of significant locations where fine sediment is entering the River Chess

Surface runoff flowing to Neptunes Roundabout

Collecting Mud Spotter data in the rain

Mud Spotter

Why did we start using Mud Spotter?

We wanted a method by which our volunteers could record the significant locations where fine sediment is entering the River Chess and the timings of these events. We wanted this information to be stored on a database with a map and the ability to upload photographic evidence. The ability to distinguish between the different ways that the fine sediment was reaching the river (e.g. overland flow, ditch, pipe, culvert, bank erosion) was also important to us.

How do we run Mud Spotter?

In 2022 we trained five people to test Mud Spotter in the river around the town of Chesham. This is a location where we were already aware of an issue with sediment-laden runoff entering the river from a culverted section of the river bed and from road runoff. We wanted to test whether the method could be used to identify and assess locations and timings of fine sediment inputs to the river.

Training comprised a two-hour session to discuss the method, health and safety and use of the database followed by a two-hour walk along the river with the survey to identify potential locations of fine sediment input and get accustomed to identifying pipes and culverts, and allocate river reaches to the different surveyors.

Even though the method needs volunteers to be keen enough to record fine sediment inputs in the rain, the initial surveys were a great success and yielded useful results, so we then offered the training to other volunteers. We think it's important to walk the river with new recruits to offer on-site training in using the app and identifying the different pathways by which sediment-rich runoff can enter the river.

We have updated volunteers about our results on several occasions (and everyone can access the information on the website) and have identified repeat 'offender' locations using the database. The website enables us to store geo-located photographic evidence alongside the observations made via the survey.

Percentage of events at each risk assessment

Vale Brook Culvert

Bovingdon
Chesham
Chesham Bois
Amersham
Little Chalfont
Chenies
M25
M25
Chorleywood
Rickmansworth
River Colne

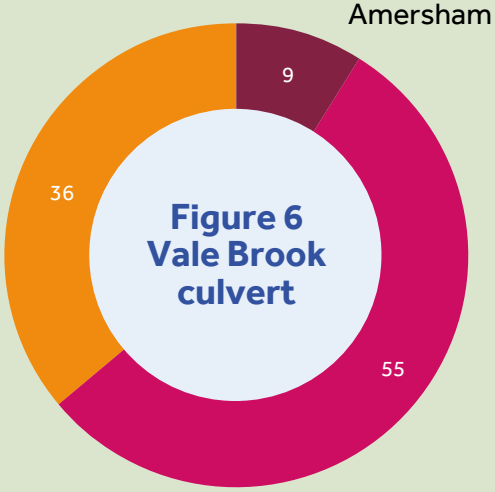


Figure 6 Vale Brook culvert

Risk

- Very high
- Moderately high
- High
- Moderate

Types of flow

- Detailed Bank Face
- Overland Flow
- Ditch
- Pipe
- Culvert

Sewage Treatment Works

- Chesham
- Chenies

N

Scale

0 1 2km

Enjoying river restoration activities

Germain Street Bridge

Our key findings

Mud Spotter data were collected by citizen scientists following the methodology outlined in the survey manual provided by Cartographer. We now have over 170 observations of fine sediment entering the river around Chesham. These data have enabled us to identify locations where fine sediment is repeatedly entering the river during rainfall. The entire dataset has been assessed using a scoring system to assign a risk score for each record.

Records include observations of the size of the source of fine sediment (small/medium/large), the flow of water (small/medium/ large) and the clarity of the water (coloured/translucent/opaque) as an indicator of the amount of fine sediment being carried by the flow. Numerical scores were assigned to each category and then multiplied together to give a risk score. The higher the score, the greater the risk. The frequency of observations at each site was also recorded.

Two sites were associated with the highest risk and the most frequent inputs of fine sediment: Vale Brook culvert (19 observations) and a river side-channel adjacent to the Moor Gym and Swim (16 observations). The charts on pages 15 and 17 indicate the percentage of events observed at each risk category.

Two other locations of note were

- Fine sediment entering the river at Neptunes Roundabout from a combination of road runoff from Amersham Hill and the unmetalled parking area near Chesham Cricket Club.
- Fine sediment entering the river from under the bridge at Germain Street, from overland flow travelling down Fullers Hill.

'*This is the first fully integrated application of Mud Spotter in a single catchment and it is impressive to see it being used with such good effect in identifying problem mud sources.*'
Professor Angela Gurnell, Queen Mary University of London

cartographer

Mud Spotter and sediment work

Bovingdon

Chesham

B

Chesham Bois

Amersham

Chenies

Little Chalfont

M25

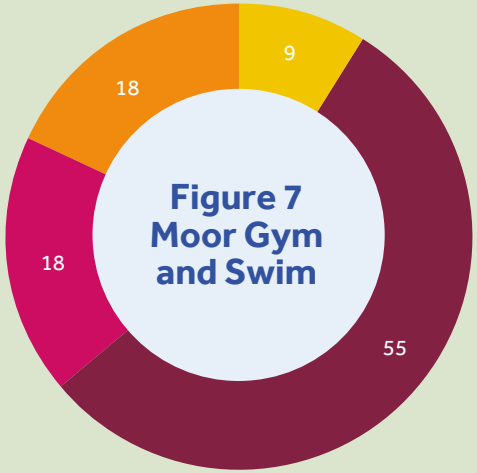
M25

Chorleywood

Rickmansworth

River Colne

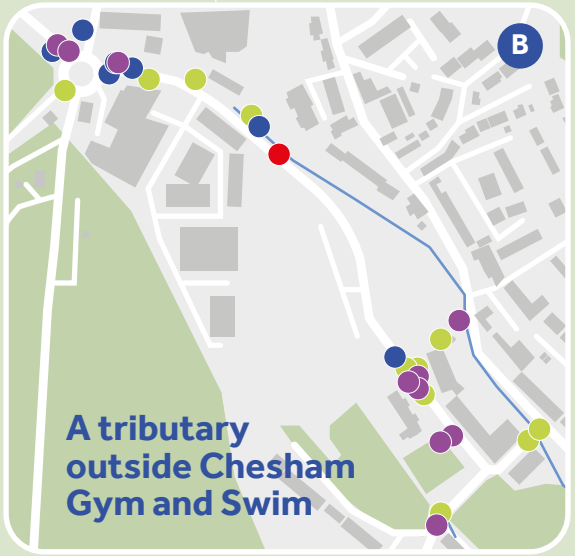
Percentage of events at each risk category



Risk

- Very high
- Moderately high
- High
- Moderate

Germain St Bridge



Types of flow

- Detailed Bank Face
- Overland Flow
- Ditch
- Pipe
- Culvert

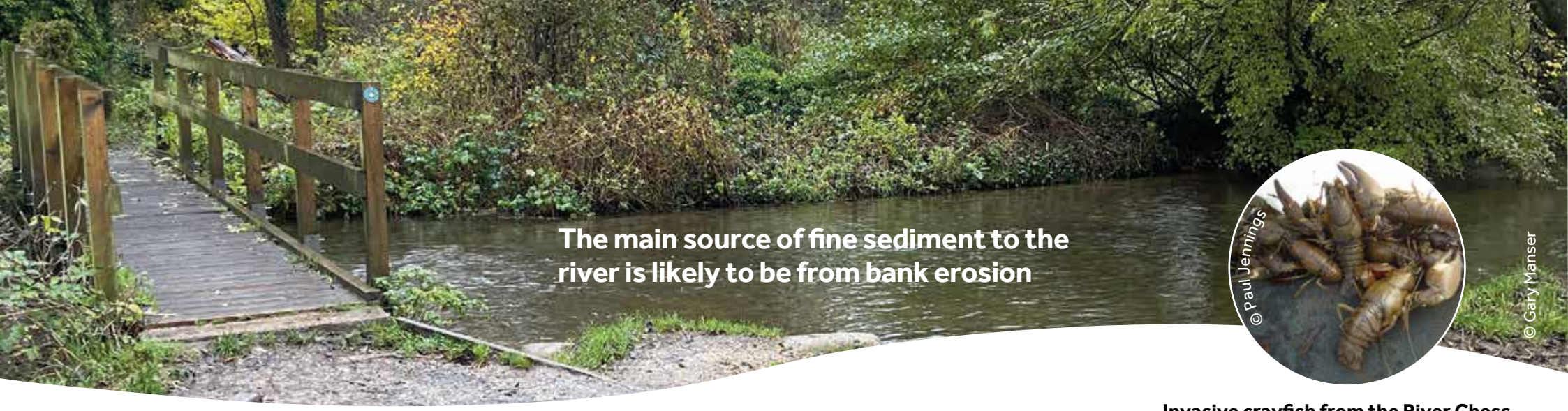
Sewage treatment works

- Chesham
- Chenies

N

Scale

0 1 2km



© Gary Manser

Invasive crayfish from the River Chess

Fine sediment

Where appropriate we have complemented our citizen science monitoring with professional surveys. Because there were few data on fine sediment in the River Chess, we identified a need to carry out some further work to assess the different sources of fine sediment entering the river and determine the best actions to address any effects of fine sediment accumulation in the river channel.

What are the major sources of fine sediment in the River Chess?

The findings from our sediment source apportionment study carried out by Rothamsted Research suggests that the main source of fine sediment to the river is likely to be from bank erosion. Many stretches of the river that were previously 'poached' by cattle are now fenced off, and much of the River Chess is well buffered from the effects of soil erosion by grazing animals. So, it is thought that most of the bank erosion is occurring due to burrowing by invasive crayfish, as is suggested by an increase in night-time turbidity at our downstream water quality sensors (data on page 11).

Surface runoff is not believed to represent a significant sediment source in much of the catchment due to the limited pathways connecting these sources to the river. Despite this, Mud Spotter survey evidence reveals instances of highly turbid water during heavy rainfall along tributaries such as the Vale Brook and where roads flow directly down steep valleys to the River Chess. Furthermore, water quality and sediment quality sampling reveals high organic levels which cannot be explained by sewer misconnections. These data suggest that surface runoff to river connections do exist during heavy rainfall.

In the north of the catchment there are many observations of overland flow from sloping arable fields and concrete pads to roads during heavy rain or when the ground is saturated. Action to prevent soil erosion and to hold back the flow of water from fields should help reduce the amount of fine sediment reaching the river.

One road where runoff is particularly problematic is the Vale Road in Chesham, which transports water to the Vale Brook culvert which flows under the High Street. The Vale Brook flows with a different colour of sediment depending on rainfall conditions, which dictate whether sediment is sourced mainly from urban road surfaces or from areas outside of Chesham.

Buckinghamshire Council commissioned a study on the Vale Brook culvert in Chesham to better understand sediment-associated contamination. The study showed that fine sediment flowing from the Vale Brook culvert contains elevated levels of copper, lead, zinc and polyaromatic hydrocarbons above safe standards for aquatic life from vehicle wear and tear and combustion products.

The graph shows the samples 1 to 9 are representitive of channel banks sources, whereas samples 10 to 11 showed characteristics of urban

ROTHAMSTED RESEARCH

First flush event May 2022

Road runoff June 2023

Lighter sediment indicating arable runoff February 2024

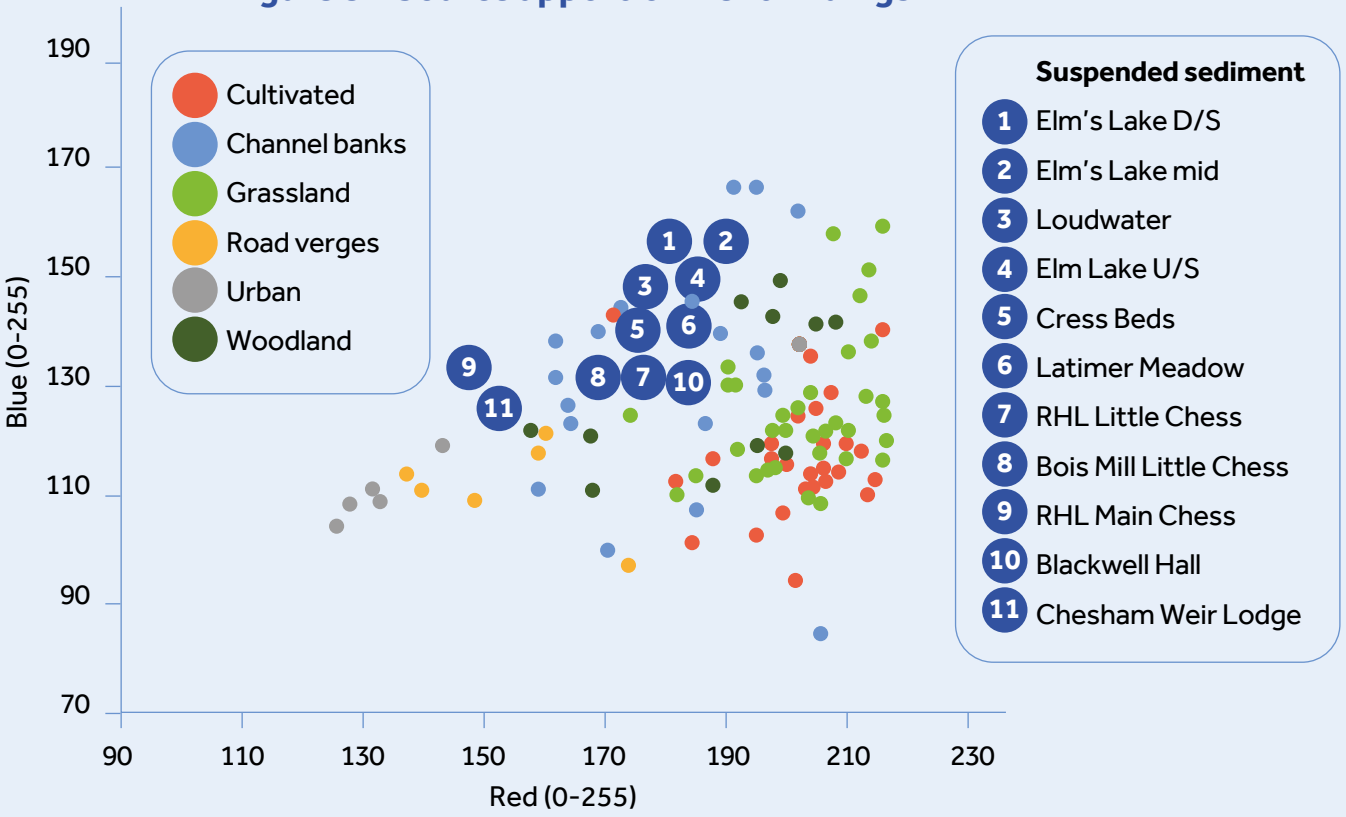
dust and road verges, indicating different sources of sediment around Chesham compared to downstream.

Is the fine sediment an issue for river health?

Our results reveal that fine sediment concentrations in the riverbed are similar to neighbouring chalk stream catchments. Whilst it is not possible to determine how this relates to natural characteristics of the river due to a lack of reference data, the catchment has been extensively modified (reach homogenisation, installation of weirs, widening for watercress beds and land-use changes in the wider catchment).

It is therefore likely that fine sediment storage within the River Chess is higher than it would be naturally and would benefit from measures to help reduce concentration within the gravel bed. River restoration schemes that narrow over-widened stretches of the river channel and encourage a diversity of flows should be prioritised for this purpose.

Figure 8 – Source apportionment findings



Volunteers collecting water samples for analysis at Caravan Lane

Emerging contaminants of concern

Why did we consider emerging contaminants of concern?

Emerging contaminants of concern are synthetic or naturally occurring compounds that have recently been discovered but are not commonly monitored in the environment. They have the potential to negatively influence ecological or public health. There are more than 200 million chemicals reported in the literature since the 1800s and of these more than 350,000 chemicals used in commerce globally. Our analysis considered only the risk to aquatic ecology arising from the presence and concentrations of the chemicals.

How did we monitor these chemicals in the river?

We recruited the help of citizen scientists to collect monthly water samples from eight locations throughout the River Chess for 12 months (including a groundwater spring).

Imperial College London trained up the volunteers to take the samples, ensuring that everyone was aware of the risk of sample contamination given the low concentrations of chemicals that were being monitored, and rigorous quality assurance procedures were followed. All the necessary equipment (such as sampling dippers, nitrile gloves, hand sanitiser, cool bags, clean bottles) was provided. All samples were frozen within a few hours of collection and sent to Imperial College London for analysis.

The analytical method used by Imperial College London enabled the identification of up to 200 chemicals and their concentrations in the river water. We also measured the presence and absence of a further group of chemicals using passive samplers deployed in summer and winter months.

IMPERIAL

Main findings

Grab samples taken by citizen scientists from nine sites on the River Chess identified 28 different contaminants of emerging concern (CECs) including pharmaceuticals, pesticides, and traces of illicit drugs. The figure overleaf shows the quantities detected as a % of the total.

Of the contaminants, nine were considered low risk and two were moderate risk to the aquatic ecology of the River Chess at the levels detected (with the remainder not considered problematic).
The adjacent Table lists the compounds, their class (pharmaceuticals or pesticides) and their perceived rick to the aquatic ecology of the river.

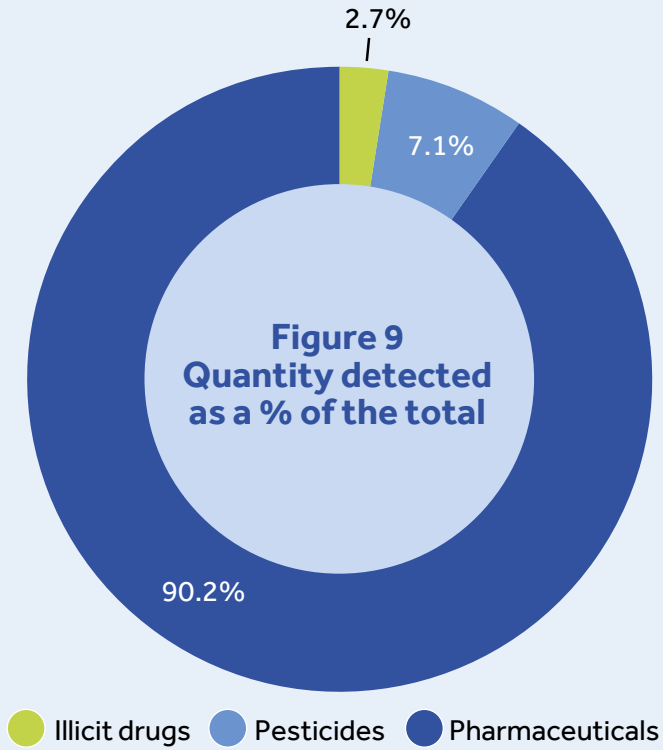


Figure 9
Quantity detected as a % of the total

Treated wastewater from sewage works was found to be the most likely main source of the pharmaceuticals, with higher numbers of compounds, and higher concentrations, found immediately downstream from wastewater outlets. With our passive samplers we also recorded the presence of the chemical, fipronil, in the River Chess. This chemical is used in some flea treatments for pets and makes its way to rivers from our homes through the wastewater treatment network.

We detected the presence of a herbicide, atrazine, in the groundwater and surface water which was formerly used for control of weeds in crops such as maize, and has been banned and unavailable for use since 2004. This indicates that a compound applied to the land over 20 years ago can still be detected in the river today due to the length of time (decades) it can take water to move through the ground, into the chalk aquifer and back out into the river. Atrazine has been linked to endocrine disruption and harm to amphibians. So the river water contains an unwelcome signature of land use activities decades ago.

Perhaps most importantly, we identified the presence of the neonicotinoid insecticide, acetamiprid, in all the river water samples across the River Chess. This chemical is used in various domestic and professional aphid sprays, but we don't yet know the source of this contaminant in the River Chess. Our analysis suggests it poses a medium risk to the ecology of chalk stream invertebrates in the river.

CEC class – Pesticides	
Low risk	**Moderate risk**
Atrazine*	Acetamiprid*
CEC class – Pharmaceuticals	
Low risk	**Moderate risk**
Carbamazepine*	Diclofenac*
Clarithromycin*	
Diphenhydramine	
Fluoxetine	
Nortriptyline	
Propranolol	
Tamsulosin	
Venlafaxine*	

* Compounds that have been or are on the current EU WFD Watchlist and Priority Substances List.

Next steps

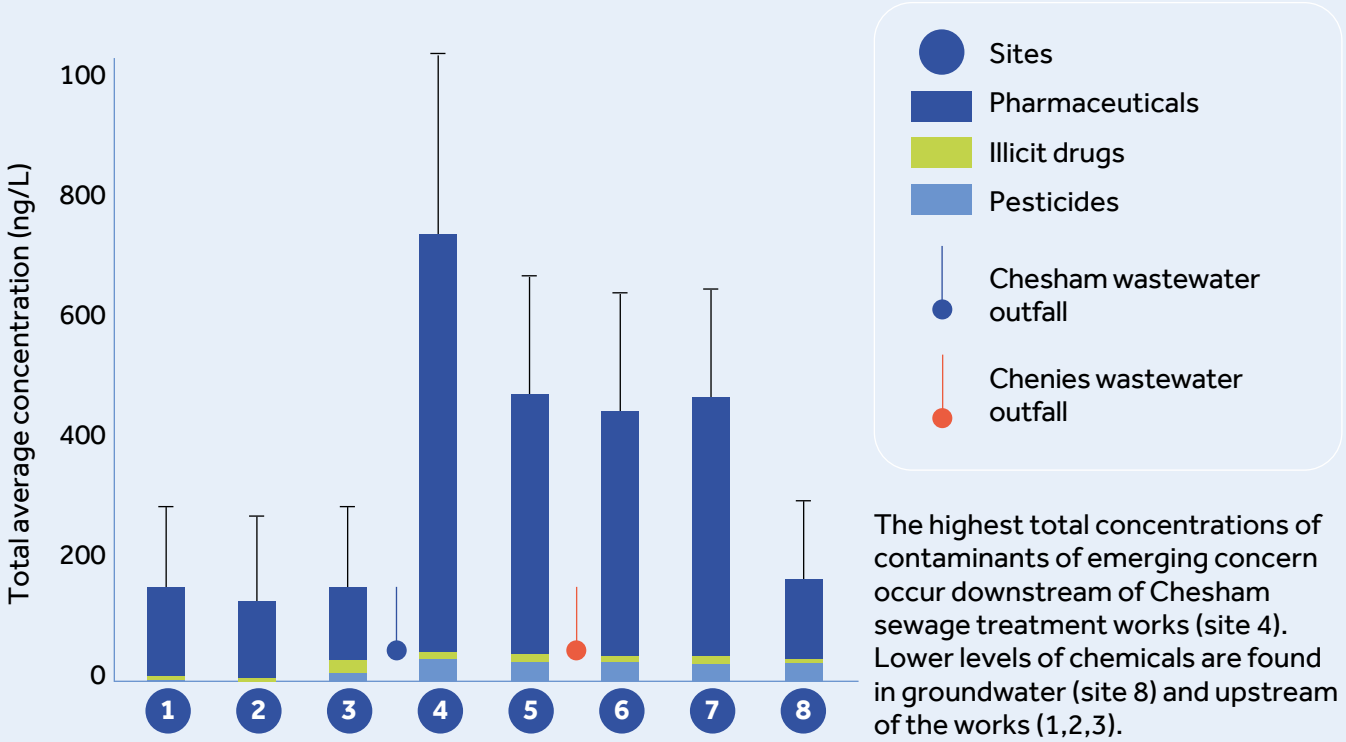
The work showed us that many water-soluble chemical products we use around our homes, such as pharmaceuticals and flea treatments, can make their way into our rivers via sewage treatment works. Working with our citizen scientists, we have designed and distributed informative leaflets for the public about the domestic use of chemicals in the home and alternative products that might be better for the environment.

Many of the water-soluble chemical products we use around our homes can make their way into our rivers

Writing labels on sample bottles

Sample preparation at Imperial College London

Figure 10 – Change in total average concentrations of chemical groups by site



The highest total concentrations of contaminants of emerging concern occur downstream of Chesham sewage treatment works (site 4). Lower levels of chemicals are found in groundwater (site 8) and upstream of the works (1,2,3).

Sampling for emerging contaminants of concern

Collecting a groundwater spring sample

1. Queens Head
2. Meades Water Garden
3. Holloway Lane
4. Restore Hope Latimer
5. Watercress Beds
6. Loudwater Estate
7. Caravan Lane
8. Groundwater Spring, Latimer

Sewage treatment works

Chesham
Chenies

Bovingdon
Chesham
Chesham Bois
Amersham
Little Chalfont
Chenies
M25
M25
Chorleywood
Rickmansworth
River Colne

Water sampling in Chesham

Water sampling at Latimer

The sampling site at Holloway Lane

N

Scale

0 1 2km

Measuring phosphate levels

Phosphate sampling site

NOSES

Why did we create the 'NOSES' methodology?

Our NOSES survey (Nutrient Ongoing Scrutiny Evaluation Survey) was named by one of our citizen scientists. It is a survey method designed to monitor phosphate concentrations at multiple locations in the River Chess at higher spatial resolution than Environment Agency sampling. The method also enables us to teach volunteers about nutrients in rivers. The focus of the first campaign was to investigate a potential increase in phosphate levels occurring in the lower catchment between Sarratt Bottom and Solesbridge Lane, as captured by Environment Agency monitoring data.

Phosphorus is a critical nutrient for plants in the river, but too much of it can lead to a condition known as cultural eutrophication. This happens when nutrient enrichment changes the biodiversity of the river system, reducing the variety of plant species and encouraging the growth of algae.

How did we measure phosphate concentrations?

To cover as much of the river as possible, we co-ordinated seven separate public and privately organised citizen science survey days. For each of the survey days, we were based either at a host venue (Loudwater Farm, Rickmansworth Waterways Education Trust Centre, Elms Fishing Lake, Croxley Hall Fisheries), or under a gazebo in a more rural location. Before the day we carried out risk assessments of each reach, and produced maps of sampling locations.

On the day we divided volunteers into pairs, gave out equipment and demonstrated use of the water sampling methods before volunteers collected samples. They then brought back samples to staff at the river bank and we analysed the water with them using Hanna HI-97713C colorimeters. We used certified reference materials and field blanks to ensure good quality results.

Intensity of blue colour indicates higher phosphate level

River Chess NOSES data collections in 2023

Collecting a water sample for analysis

NOSES and riverfly training

Main findings

Our results confirmed that groundwater springs along the River Chess are characterised by low phosphate concentrations of c. 0.02 to 0.04 mg/L, whereas phosphate concentrations in the river water in 2023 were ten times higher, ranging from 0.4 to 0.65 mg/L depending on location. We are looking forward to repeating these surveys now that Phosphorus stripping has been introduced at Chesham sewage treatment works.

Flow gauging in the River Chess

Flow monitoring

Why?

The River Chess is one of the largest of the Chilterns' chalk streams. Like other chalk streams, it derives its flow largely from the rainfall that has percolated into the chalk aquifer underlying the catchment. This groundwater feeds into the river through numerous natural springs and some boreholes. The flow in the river is a major factor in determining the ecology and amenity of the river and the surrounding valley.

There have been concerns that periods of low flow might be increased due to the water supply abstractions made from boreholes within the catchment. These concerns prompted a study to gain a better understanding of the flows, and how the river responds to variations in rainfall and groundwater abstraction. In 2016 a programme of monitoring was agreed with the Environment Agency and undertaken by volunteers from the River Chess Association. Regular flow measurements have been carried out at these sites since the end of 2016. Flow monitoring was brought within the scope of citizen science activities and included in the 10-year catchment plan produced in 2021. In 2023, the Chess citizen scientists agreed to take over the sites formerly monitored by the Environment Agency (EA) so that the full length of the river is now covered by the citizen science team.

How?

Flows in the river are measured monthly by recording the depth and velocity of flow at different locations along the river using wade gauging, which is suitable in a relatively small and shallow river like the Chess.

Two types of meter have been used to survey flows on the Chess. Before 2023, impeller flow meters were provided by the EA and Thames Water. More recently, hand-held Acoustic Doppler flow meters have been used and volunteers were trained in their use by the Environment Agency. Survey work has had to be suspended temporarily at times due to concerns over health and safety during periods when discharges from Chesham sewage treatment works were assessed as being of poor quality.

Citizen Science flow monitoring sites on the River Chess

Bovingdon
Chesham
Chesham Bois
Amersham
Little Chalfont
Chenies
M25
M25
Chorleywood
Rickmansworth
River Colne

- 9 Blackwell Hall
- 10 Willow Cottage
- 11 Restore Hope Latimer
- 12 Latimer Bridge
- 13 Valley Farm Ford
- 14 Watercress Beds
- 15 Solesbridge Lane
- 16 Loudwater Estate
- 17 Scotsbridge
- 18 ELMS Lake

Sewage treatment works

Chesham Chenies

- 1 Tennis Club
- 2 Tennis Club
- 3 Queens Head pub
- 4A Duck Alley Vale Brook
- 4B Duck Alley Vale Brook
- 5 Bois Moor Road Bridge
- 6A Below Lords Mill
- 6B Bois Moor Recreation ground
- 7 Canons Mill Back Channel
- 8 Holloway Lane

N

Scale

0 1 2km

Losing and gaining sections of the river are revealed

Flow gauging at Latimer

The sites were selected to obtain an understanding of flows in the numerous channels and tributaries that make up the river. Locations were chosen where the flows were relatively uniform, free of deep silt and with a depth suitable for wading. Heavy weed growth during the summer has been a problem at some sites and small adjustments have been made to the survey locations to try and avoid the worst area of growth.

What do the results show?

The data collected by the surveys in **Figure 11** have shown the variation in flow over the year typical of a chalk stream. The longest series of observations are for sites RC5A and RCA8 in Chesham. These show that although there is a consistent annual pattern, levels of flow vary considerably from one year to another.

The three years from 2017 to 2019 were comparatively dry. A wet autumn and winter in 2019/2020 produced an increase in flow, although the peak in spring 2020 was not recorded because survey work was suspended due to the Covid-19 pandemic. High flows were again recorded in the early part of 2021. After a slightly dryer period through 2022 and much of 2023, there was heavy rain during the autumn and winter of 2023/24. This produced high flows into the summer of 2024 before a typical decline through the summer.

Figure 12 shows that there is a noticeable increase in flow downstream of Chesham sewage treatment works outfall, demonstrating how important the sewage treatment works is as a source of water in the River Chess.

The data also show that the upstream sections of the river are gaining reaches (fed by groundwater springs) whilst the river loses water, from the riverbed to the aquifer, between the watercress beds at Sarratt and Loudwater Estate. A natural loss of water due to a change in subsurface geology in this area is the most likely cause of this 'losing' section.

Main findings

Figure 11 – River Chess flow monitoring over time

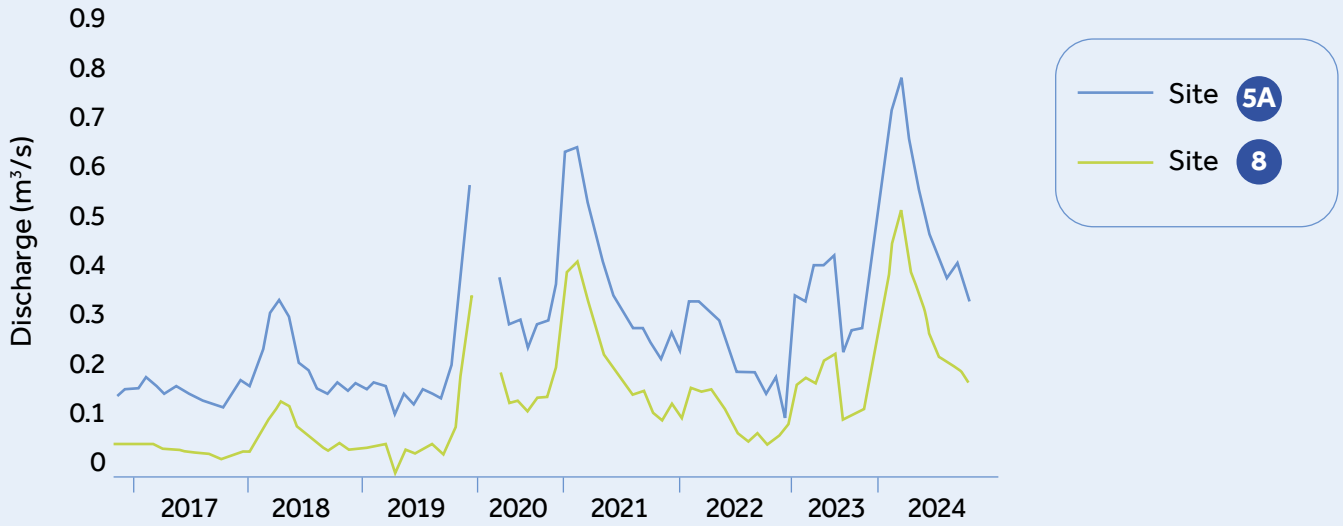
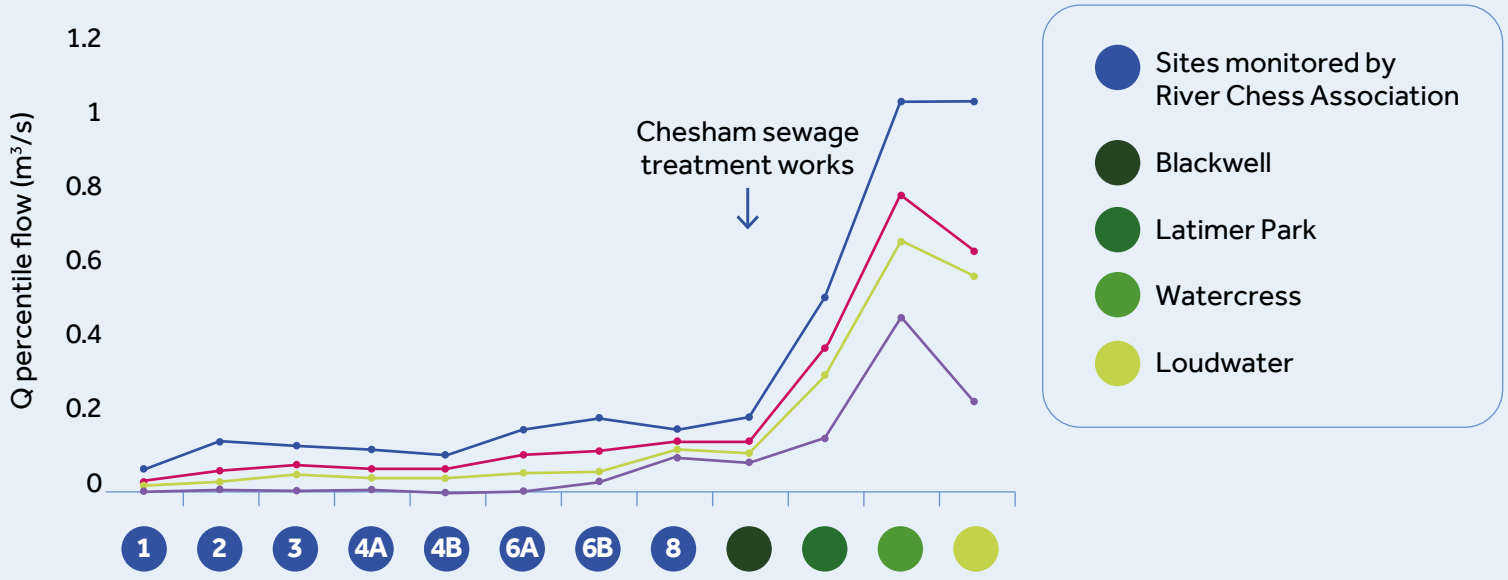


Figure 12 – River Chess flow monitoring



We carry out Modular River Survey before and after restoration projects to assess whether restoration objectives have been achieved

Surveying at Chesham Moor

Modular River Survey

Why?

Modular River Survey (MoRPh) is a national citizen science method developed by scientists at Queen Mary University of London to assess physical habitat quality of both the river channel and riverbank. On the River Chess we have been using MoRPh as a way to monitor the success of our river restoration projects. Our trained citizen scientists have carried out surveys before and after our restoration projects start, typically once a year, to monitor changes in habitat. We currently have active long-term monitoring projects along the whole length of the river.

How?

Our citizen scientists attend a one-day training course run by Cartographer to learn the methodology. We then support them with their first few surveys to help familiarise new surveyors with terminology and the technique, and to help them with any initial questions they might have. The Rivers Officer, who is in charge of the restoration, takes the volunteers on a tour around the project introducing them to the aims and objectives of the work and key characteristics of the restoration scheme. For example, one of our first Smarter Water Catchment restoration projects on the Chess aimed to improve marginal habitat for water vole, and introduced woody debris into the river to enhance sinuousity in an over-widened and straightened channel.

Once restoration plans have been finalised the reach is divided into sections for MoRPh surveys and we create a plan for each monitoring location with photographs, What3Words identifier and key information for our surveyors.

Method development

We now have over 30 volunteers trained up as MoRPh surveyors and this means that the group are now self-led and organising their own surveys to the original timetable that was set.

Our volunteers have developed the skillset necessary to check consistency of surveys and approve them within Cartographer.

River restoration sites

1. Chesham Moor
2. Blackwell Farm Fencing
3. Latimer Little Chess
4. Restore Hope Latimer (Main)
5. Sarratt Watercress Beds
6. Scotsbridge Mill

Sewage treatment works

Chesham
Chenies

Bovingdon
Chesham
Chesham Bois
Amersham
Little Chalfont
Chenies
M25
M25
Chorleywood
Rickmansworth
River Colne

MoRPhing at Sarratt

Straight channel at Holloway Lane

Restore Hope Latimer (Little Chess)

N

Scale

0 1 2km

River restoration at Restore Hope Latimer aims to improve habitat for water vole and improve flow diversity

MoRPhing at Scotsbridge

Blackwell Farm Fencing – Figure 13

Fencing was installed in 2023 to prevent trampling of the river banks by cattle and to enhance riparian biodiversity. Siltation of the riverbed dramatically decreased in 2024, so the preliminary data suggests that the fencing is preventing fine sediment from reaching the river in this section. The complexity of the bankside vegetation has also improved since the fencing was installed, so riparian biodiversity may be increasing, offering suitable habitat to a wider range of bankside plant and animal communities.

Chesham Moor – Figure 14

This site has been earmarked for restoration for several years and we carried out pre-restoration surveys in 2022, 2023 and 2024. The results show that this stretch of the River Chess is heavily modified with extensive channel reinforcement and human pressure, with scores that indicate a poorer condition than many of England's chalk streams. This site was restored in late 2024, and we are looking forward to seeing what improvements the 2025 data reveals.

Restore Hope Latimer (Main) – Figure 15

The interventions in this reach aimed to improve habitat for water vole and improve flow diversity in the channel to encourage remobilisation of fine sediment from the riverbed and expose underlying gravels. A pre-restoration survey was carried out in 2022 with post-restoration surveys in 2023 and 2024.

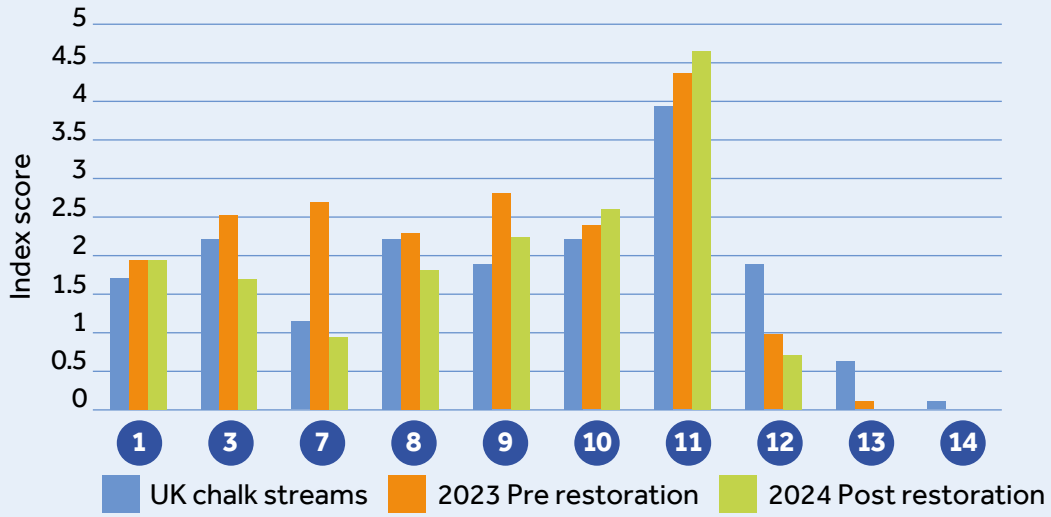
In-channel indicators have shown the greatest improvement in scores (number of flow types, channel physical habitat complexity and number of aquatic vegetation morphotypes) and for riparian vegetation complexity. Overall, the restoration has improved habitat and foraging opportunities for water vole and increased flow diversity.

'*These results illustrate not only that the restorations have had significant positive effects but also, by using the various indicator scores, how different positive responses have been achieved at the different restoration sites.*'

Professor Angela Gurnell, Queen Mary University of London

cartographer

Figure 13 – Average of MoRPh index score for Blackwell Hall Farm and UK chalk streams



1. Number of flow types
3. Number of bed material types
7. Extent of bed siltation
8. Channel physical habitat complexity
9. Number of aquatic vegetation morphotypes
10. Riparian physical habitat complexity
11. Riparian vegetation complexity
12. Degree of human pressure imposed by land cover on the bank tops
13. Channel reinforcement
14. Extent of non-native invasive plants

Figure 14 – Average of MoRPh index score for Chesham Moor and UK chalk streams

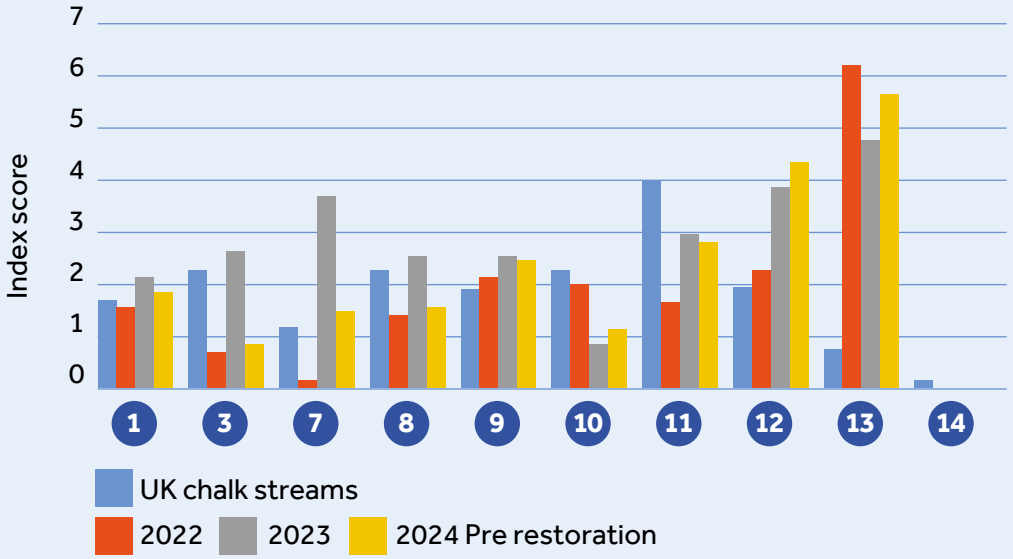
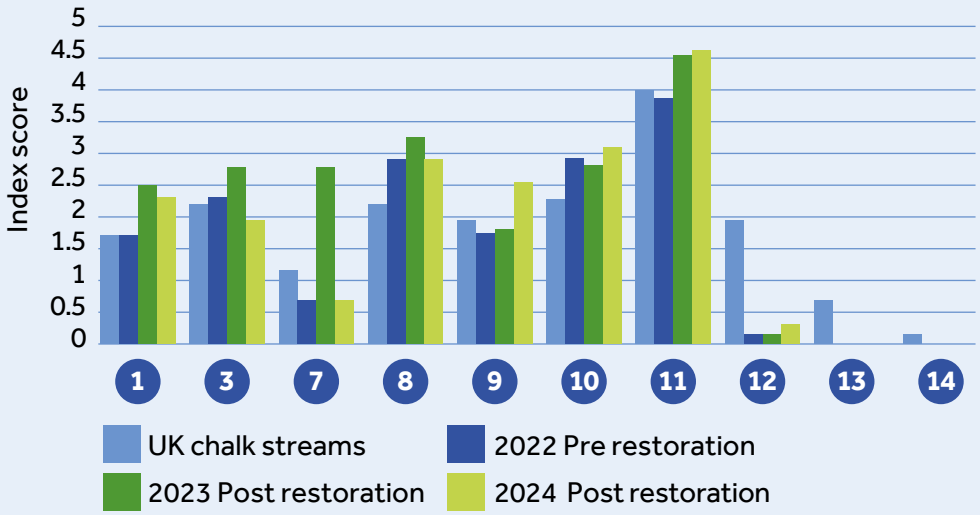


Figure 15 – Average of MoRPh index score for Restore Hope Latimer (Main) and UK chalk streams



This technique monitors river health using target groups of riverflies

Two swans on the Little Chess

Riverfly

Why do we sample for aquatic invertebrates in the River Chess?

Riverfly is an Environment Agency (EA)-approved national citizen science method that was launched by the **Riverfly Partnership** [5] in 2007, aiming to monitor the presence and abundance of target groups of freshwater riverflies to determine river health. Riverflies are great indicators of water quality due to their sensitivities to various environmental issues such as flow, siltation, habitat quality and pollution.

How do we use the Riverfly results?

Riverfly monitors have been surveying the River Chess since 2009 when four initial volunteers were trained. Three of these original volunteers are still monitoring, along with many more volunteers who have been trained since that date. During this time we have developed an understanding of the invertebrate distribution in the Chess catchment and identified abundance trends.

5. www.riverflies.org

These long-term data have provided us with a useful view of water quality trends, as well as responses and recoveries of the eight Riverfly target groups to drying and pollution events. Monitors are trained during a one-day course, then as pairs are given a long-term loan Riverfly monitoring kit and usually adopt 1-2 sites to monitor on a monthly basis.

Main findings

Whilst we are seeing an overall trend in Mayfly and Olives declining in the catchment, in recent years, whilst groundwater levels have been high, we have seen a greater variety of target invertebrates including Mayfly, Blue Winged Olives, Stonefly and Caseless Caddis (*Rhyacophilidae*).

Riverfly

Bovingdon

Chesham

Chesham Bois

Amersham

Little Chalfont

Chenies

M25

M25

Chorleywood

Rickmansworth

River Colne

Mayfly (Danica)

Cased caddis

Trout eat riverflies

Sewage treatment works

Chesham

Chenies

N

Scale

0 1 2km

Highlights in the target groups

Freshwater Shrimp (*Gammarus*)
These are the most numerous of the invertebrates in the Chess catchment. We see a greater abundance in the upstream section of the river especially around Chesham. They are also the first of the target groups to re-colonise sections of the river that have dried up. Their numbers at the Queen's Head pub can amount to many thousands in a single sample.

Flat Bodied Mayfly (*Heptagenidae*)
We only find Yellow May Dun (*Heptagenia sulphurea*) at locations in the lower half of the catchment, and we have no record of it appearing upstream of Blackwell Hall Farm. These Flat Bodied Mayfly require fast flowing, highly oxygenated water. The location with greatest abundance (over 100) is the site at Scotsbridge Mill where the flow is fast and turbulent; ideal for this scarce invertebrate.

Stoneflies (*Plecoptera*)
Stoneflies are one of the more elusive river flies in chalk streams, and this is the case in the Chess. They are not found at all in the main channel below the sewage effluent outlet. Early in our monitoring the most numerous stoneflies were found at Broad Water Bridge in the southern end of Chesham. In recent years, with reliable flows in Chesham over the past five years, their numbers are growing upstream.

A highlight was the discovery of the Winterbourne Stonefly (*Nemoura lacustris*) outside the Queen's Head pub in Chesham back in February 2023. This is a particularly rare stonefly and has only been recorded in five counties in the UK, and this was the first record for the county of Buckinghamshire. The species was confirmed by Craig McAdam of Bug Life. Ironically this species requires the channel to dry during its egg phase, fortunately there was a brief drying event at this section in September/October 2022. *Nemoura lacustris* has not being found since.

Olives (*Baetidae*)
In the early days of riverfly monitoring on the Chess this target group was the second most abundant, in recent years that abundance has been declining. The reason why requires more detailed research.

Caseless caddis
The two main families we find in the Chess are *Hydropsychidae* and *Rhyacophilidae*. The former being present in large numbers in areas immediately below the sewage outfall. *Rhyacophilidae* are only found in areas of good water quality, and these are beginning to appear around Chesham upstream of Chesham sewage treatment works.

Blue-winged Olive
These are seasonal invertebrates spending the winter months as eggs and therefore not being recorded in the kick sample year round. They are most numerous in the months of April, May June and July. They can be found in small numbers in winter months but are a rarity. Numbers fluctuate from year-to-year depending on the flow regime of the previous year.

Numbers of Blue-winged Olives at Blackwell Hall Farm seem to fluctuate in response to the duration and magnitude of storm tank discharges from Chesham sewage treatment works. Our records show uncharacteristically low numbers of Blue-winged Olives at the site (which is a few hundred metres downstream of the sewage discharge outfall) in 2014, 2020 and 2021 following extended periods of storm tank discharge.
Blue-winged Olives are particularly sensitive to elevated phosphate concentrations so this may be a reason for their decline at this site.

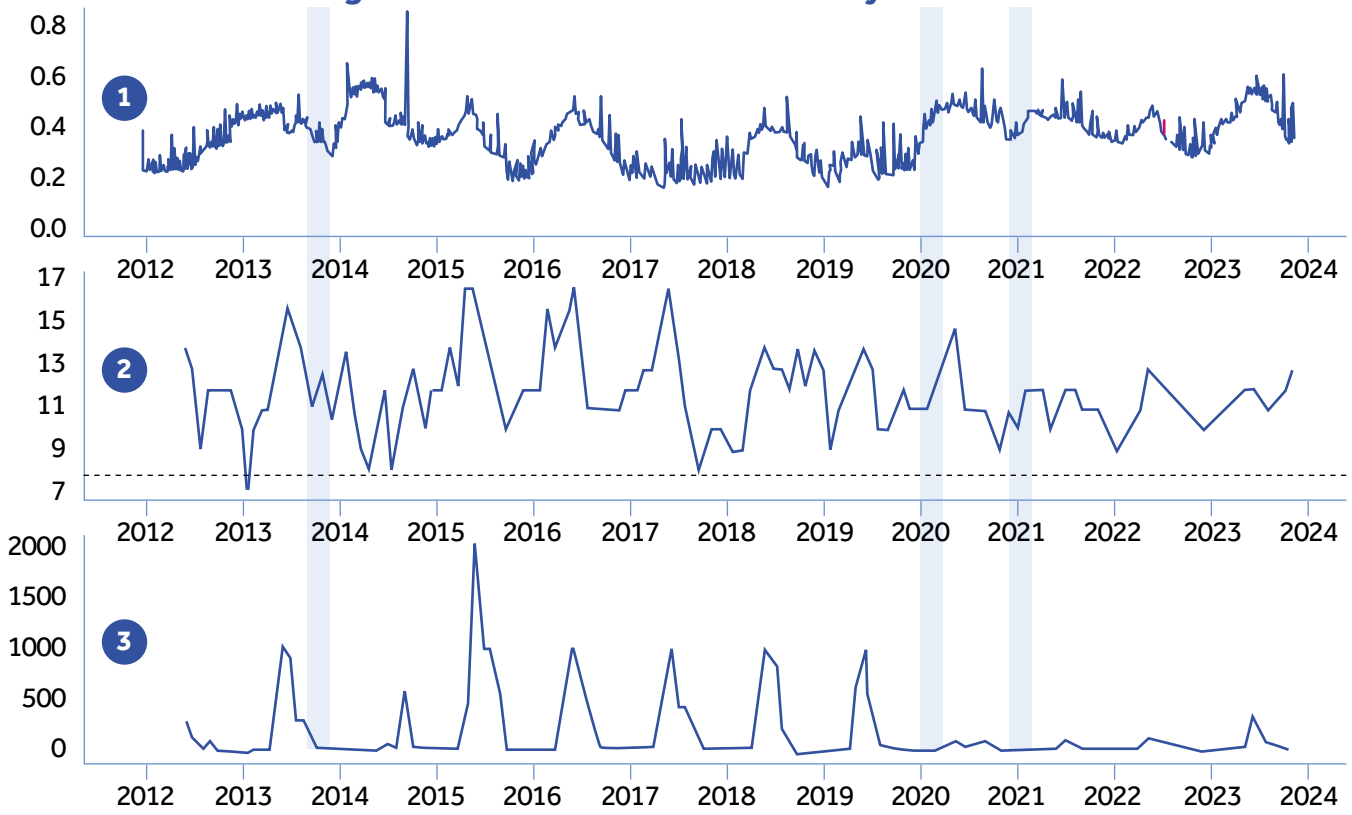
Cased caddis
These are numerous but fluctuate over the year. The most abundant in this category is *Agapetus* which can number into the high hundreds.

Mayfly (*Ephemeridae*)
This is the largest of the invertebrates we find in our sample trays. We only find *Ephemera danica* in sample trays, but do see *Ephemera vulgata* as adults. Often we see nymphs from two separate year groups in the trays. We are seeing *Ephemera danica* expanding their range upstream into Chesham, which is encouraging. Numbers fluctuate yearly but the figures downstream currently indicate a declining trend. This also requires more detailed research.

Next steps

Riverfly monitoring will continue along the River Chess, with recent monitors being trained in the new Extended Riverfly monitoring method to record 33 target groups instead of eight.
This extensive method is only required once or twice a year and is especially useful for monitoring restoration projects, such as our recent Chesham Moor project.

Figure 16 – Water level and riverfly data



1 Chesham stage board water depth (m)
2 Riverfly monthly score
3 Blue-winged Olives (*Serratella ignita*) monthly abundance below STW
Storm tank overflow
----- Trigger score

SmartRivers training at Latimer

SmartRivers

Why?

We looked for a citizen science method that could link water quality data to indicators of ecological health in the River Chess. Understanding pressures on invertebrate communities from organic pollution, nutrient enrichment, sediment, chemicals and flow was particularly important to us, and the SmartRivers scheme generates scores for all of these.

How?

SmartRivers is a national citizen science monitoring scheme run by Wildfish whereby invertebrates are collected from rivers in spring and autumn using kick-sampling and then identified to species level under a microscope. The method assesses the key pressures on each sampling site using various indices calculated using the invertebrate species data.

SmartRivers benchmarked our chosen sites to provide the baseline for the River Chess.

They also provided on-site training in kick-sampling and species identification. Then our trained citizen scientists took the reins and have been sampling twice a year since spring 2022. We have chosen to send the samples off to SmartRivers for analysis, so we receive results back twice a year.

"SmartRivers is empowering communities like the Chess group with robust science. Funding restrictions are causing insufficient river monitoring by regulatory bodies. We're providing near-professional invertebrate monitoring to help fill these gaps and drive improvements."

Lauren Harley, SmartRivers Project Manager

WildFish SmartRivers

WildFish.

SmartRivers sites on the River Chess

1. Broadwater Bridge
2. Main River, Marsh Field
3. Little Chess, Marsh Field
4. Loudwater Estate
5. Scotsbridge Mill
6. Caravan Lane

Sewage treatment works

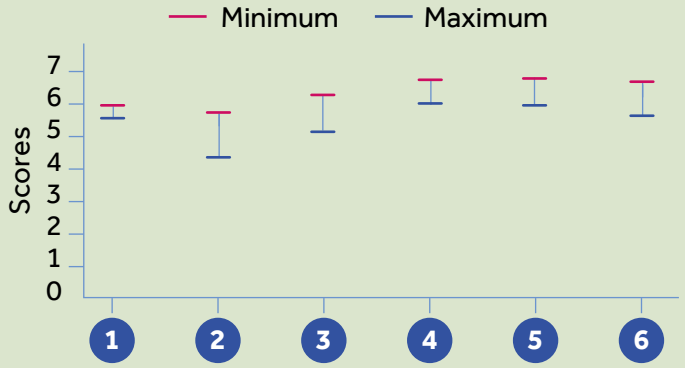
Chesham Chenies

SmartRivers sampling on the Little Chess

The SmartRivers dream team

Mayfly Danica

Figure 17 – WHPT-ASPT scores from 2022 – 2024 by site



Main findings

Overall status of the River Chess

The Walley Hawkes Paisley Trigg (WHPT) Average Score Per Taxon (ASPT) index has been developed to identify the pressures on river health by considering both the number of invertebrate families and the abundance within those families. (see graph on page 39 – **Figure 17**).

Values range from: 0 (grossly polluted) to > 6 (excellent quality). Over three years the values for the River Chess have ranged from 4.2 to 6.6 indicating good ecological health overall, but Site 2 downstream of Chesham sewage treatment works consistently has the lowest scores.

Carrying a precious sample to the bank

1 Ecological pressure from fine sediment

The Proportion of Sediment-Sensitive Invertebrates (PSI) Index highlights the pressures on invertebrates for example, from bank erosion due to fine sediment which can enter the river from roads and agricultural runoff. Our data show a slight pressure from silt in the gravel bed, with upstream sites more affected than those downstream. This means we might target efforts to reduce fine sediment inputs in upstream sections of the river.

2 Ecological pressure from phosphorus

The Total Reactive Phosphorus Index (TRPI) is used to identify the effect that phosphorus is having on river health. Our results show that the greatest impact is found at the site immediately downstream of Chesham sewage treatment works. Dilution by cleaner water from the Little Chess means that there is less stress on invertebrates due to phosphorus downstream of Latimer Lakes where the Little Chess and main river meet. The pressure at Site 2 seems worse in autumn months when the proportion of flow from treated effluent is highest.

3 Ecological pressure from chemicals

The results from the Species at Risk (SPEAR) index suggests that chemical pressures on invertebrates are relatively high, even upstream of Chesham sewage treatment works. When scores for all sites are averaged there is a seasonal pattern, with increased chemical pressure in late summer/early autumn.

Next steps

From spring 2025 phosphate stripping will be active at Chesham sewage treatment works to lower phosphate concentrations in the final effluent being released to the river.

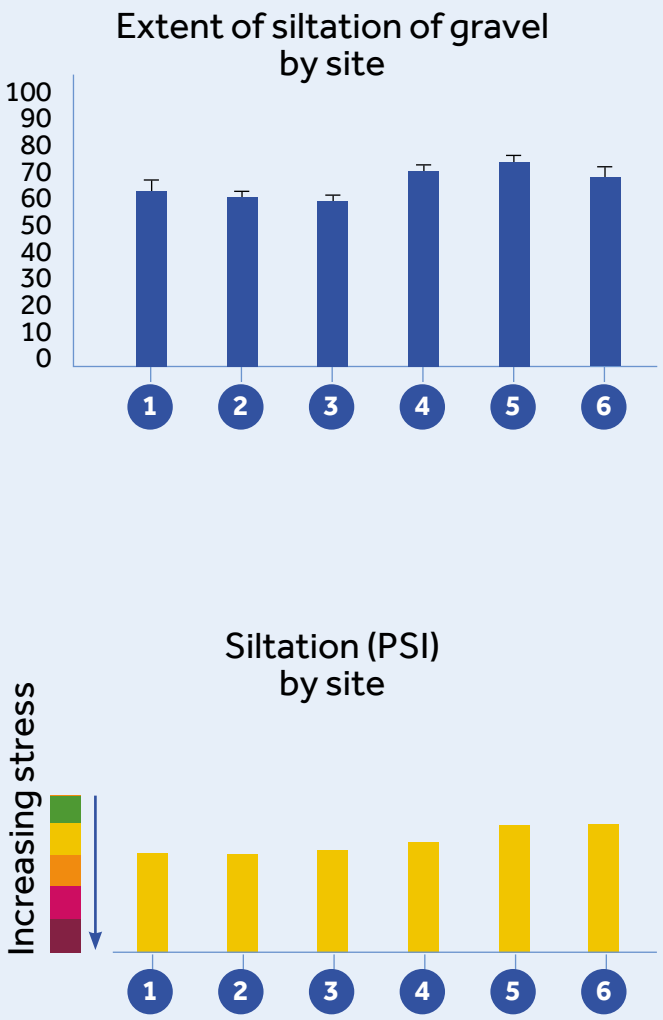
We hope to continue to monitor using the SmartRivers approach in 2025 to assess whether the reduction in phosphorus concentration manifests in increased TRPI scores, indicating lower pressures on invertebrate health. It will also be interesting to see whether the SPEAR index improves from this date. By using the SmartRivers method we have been able to show that fine sediment inputs in the River Chess are having a harmful effect on ecological health. When combined with results from Mud Spotter we now have a baseline dataset collected by citizen scientists which shows where fine sediment is entering the River Chess and the consequences for the ecology.

We hope this is compelling evidence to drive future targeted interventions to reduce fine sediment input to the river using nature-based solutions.

1. Broadwater Bridge
2. Main River, Marsh Field
3. Little Chess, Marsh Field
4. Loudwater Estate
5. Scotsbridge Mill
6. Caravan Lane

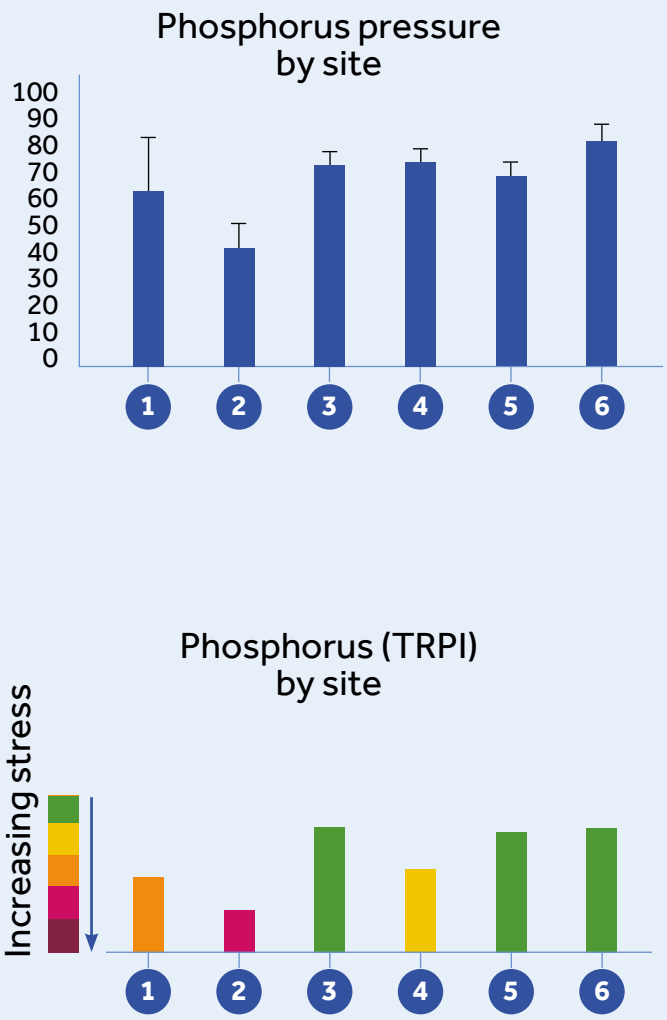
1

Figure 18 – Ecological pressure from fine sediment



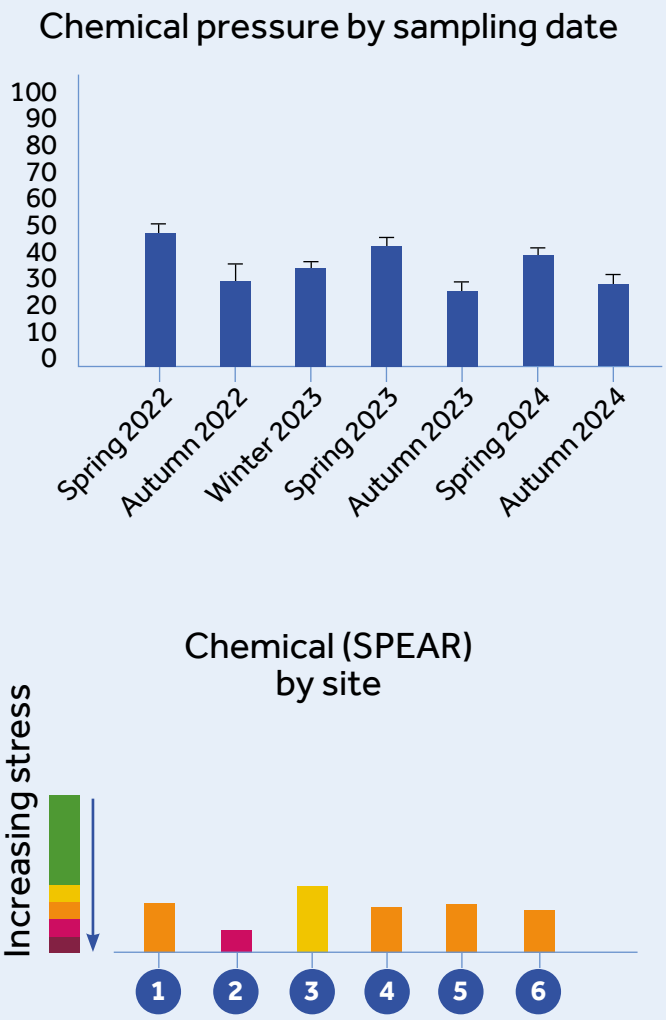
2

Figure 19 – Ecological pressure from phosphorus



3

Figure 20 – Ecological pressure from chemicals



These sites are situated from upstream to downstream with increasing number

Citizen scientists use a large stick to move the vegetation gently aside to search for water vole droppings, feeding signs or burrows

Water vole feeding signs and latrine

Water vole monitoring

Why?

Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust (BBOWT), the Chilterns Chalk Streams Project and the River Chess Association have worked in partnership for many years on a water vole recovery scheme for the River Chess which includes the control of North American mink – a non-native species that is a key predator of the water voles – and restore water vole habitat. Regular monitoring of the population is a key part of the scheme's success. Every two years a survey is completed along the river between May and September by volunteers who look for signs of the rare water vole.

How?

Citizen scientists are generally trained at a half-day event on what to look for on the banks, then are allocated a 500m stretch of river to carry out their water vole monitoring surveys. In pairs, citizen scientists wade up the river (or along the banks if the river is deep)and use a large stick to move the vegetation gently aside searching for water vole droppings, feeding signs or burrows. They then record these onto a printed map of the site.

Next steps

The water vole monitoring surveys will continue biannually into 2025 and beyond, but more monitors are always needed to ensure all survey reaches can be completed within the spring and summer months.

Between 2001 and 2003, water vole populations on the River Chess declined by 97% from an estimated 342 individuals, down to only 11, as a result of predation by mink. Since 2003, numbers have substantially increased again due to efforts to control mink and restore habitat. By 2011 the water vole population had completely recovered to 2001 levels. Subsequently however, the population has declined again with the 2023 survey results suggesting a possible 66% decline since 2021.

That being said, the first water voles in Chesham were recorded in 2023, highlighting that the range of the species has expanded back up into urbanised Chesham for the first time in more than 20 years. Whilst conducting their surveys, citizen scientists also chanced upon Himalayan balsam (an invasive non-native species) in Chesham, as well as a harvest mouse nest.

Presence and absence of water voles

Water vole

Hannah enjoying water vole monoriting

Figure 21 – Water vole population estimate by year

Training in pond surveying

Common Backswimmer

Ponds in the Chess Catchment

Why?

Ponds are hubs and stepping stones for a wide variety of species, both in terms of wetland specialists, but also as critical locations for terrestrial species to congregate at for water.

The protection and enhancement of ponds should be core to any catchment restoration project. Ponds support two-thirds of freshwater species and, at a landscape scale, deliver greater biodiversity than larger waterbodies like rivers and lakes. This is due to their collective heterogeneity (the variation in habitats between individual ponds) which underpins their extraordinary ecological value.

The Wildlife Corridor Theme in the Chess Smarter Water Catchment initiative has aimed to:

- Increase the extent of priority pond habitat (e.g. by creating new ponds in close proximity to the River Chess, and creating areas where water quality is improved)
- Restore areas of existing priority pond habitat (e.g. by restoring ponds which are no longer functioning/require de-silting)

To ensure these goals can be met a baseline of the existing pond network is required.

Ponds are often overlooked and undervalued with little scientific investigation. The project 'Ponds in the Chess Catchment' aims to develop our understanding of these unique honeypots of biodiversity.

How?

22 citizen scientists were trained in a survey method developed by the Freshwater Habitats Trust which is designed to assess the water quality of the ponds (nitrate and phosphate concentrations) and assess the ability of the surrounding habitat to support pond life (using a metric-based approach).

Freshwater Habitats Trust

Pond surveying

Pond Olive

Mosquito larva

Water Violet

Pond in Chorleywood

Dragonfly exuviae

Method development

The Priority Pond Assessment (PASS) method being trialed in the Chess hopes to bridge the gap between expert and informed citizen scientist knowledge. The citizen scientists create a provisional priority pond list which is then examined and checked by expert level botanists and invertebrate professionals. Surveys must be completed between early summer and early autumn when most wetland plants are visible in ponds.

Main findings

From an initial list of 205 ponds identified via desktop surveys and local knowledge, 63 ponds were surveyed by volunteers. 13 ponds were identified as potential Priority Ponds based on PASS indicators, aligning with national trends, which estimate that only 20% of UK ponds meet Priority Pond criteria.

Water quality testing revealed that 27 of the 42 ponds tested contained clean water – an increasingly rare feature in the UK's freshwater landscape. These ponds, even if not classified as Priority Ponds, provide vital habitats that can support diverse freshwater species.

Professional surveys are still underway, but early findings confirmed the presence of Water Violet (*Hottonia palustris*), a nationally scarce plant. However, initial results indicate that only a very small number of ponds meet Priority Pond criteria. Most were found to be degraded, poorly maintained, and lacking the key freshwater species indicative of Priority Ponds.

Before the project, very little was known about the extent and condition of ponds within the Chess catchment or the freshwater species they support. This project has established an excellent new baseline, providing crucial data to guide and co-ordinate future catchment restoration efforts.

Next steps

The Chess catchment's ponds, while generally degraded and species-poor, reflect the broader decline in freshwater biodiversity across the UK. However, the project has identified critical opportunities for restoration and new habitat creation.

Through the project, Freshwater Habitats Trust is creating a series of proposals outlining large-scale pond and wetland creation across the Chess catchment to address habitat loss and fragmentation. Clean water ponds are especially vital, as research shows they can increase plant diversity by up to 25% across a catchment and significantly benefit species reliant on high water quality.

With 10 potential restoration and creation sites already identified, Freshwater Habitats Trust has prepared funding-ready proposals to enhance habitat connectivity, reduce extinction risks, and enable species dispersal. By expanding the freshwater network, these initiatives will contribute to reversing biodiversity loss and creating resilient landscapes for wildlife and people.

2/3
of UK freshwater species can be found in ponds

80%
of remaining UK ponds are in a poor state

50%
of UK ponds lost in the 20th century

Supporting volunteers to understand changes to our wildlife

Tracking the Impact bird ID training course

Tracking the Impact

Why do we want to monitor changes in biodiversity?

At the Chilterns National Landscape we are increasingly focusing our conservation work at landscape scale through a range of catchment and/or farmer cluster related projects and are exploring ways in which we can track landscape scale trends to provide an evidence base for our work.

The UK is world leading in its citizen science data, helping to chart the fortunes of our wildlife on a national scale. However, these surveys are designed to work nationally and don't offer the coverage to support landscape scale work. This is where Tracking the Impact comes in, helping us to track the impact across the Chilterns National Landscape using bird, butterfly and plant data as proxy for wider landscape scale change.

How do we run this activity?

In 2020, the Chalk, Cherries and Chairs Landscape Partnership (funded by the National Lottery Heritage Fund) worked with a group of national and local partners to design the project which replicates Breeding Bird Survey (BBS), Wider Countryside Butterfly Survey (WCBS) and the National Plant Monitoring Scheme (NPMS) to ensure robust, proven, systematic and replicable methods were adopted allowing for long term detection of change and to benchmark against wider trends.

Chilterns National Landscape staff manage the project including allocation of squares, validation of data, and the setting up and delivery of a wide-ranging training programme.

Method development

In 2023, the Smarter Water Catchment initiative funded the expansion of Tracking the Impact into the Chess catchment, increasing the number of possible survey squares to 78 for BBS, 72 for WCBS and 72 for NPMS.

Map of 1km² survey squares in the Chess Catchment

Meadow Brown

Skylark

Hawridge Common Grid reference: SP9406

Butterflies – Total records: 225 Richness: 19
Taxa: Speckled Wood, Peacock, Holly Blue, Orange Tip, Green-veined White, Large White, Small Heath, Ringlet, Meadow Brown, Marbled White, Large Skipper, Gatekeeper, Comma, Small/Essex Skipper, Red Admiral, Purple Hairstreak, Brimstone, Small Copper, Small White.

Birds – Total records: 131 Richness: 26
Taxa: Mallard, Pheasant, Stock Dove, Woodpigeon, Sparrowhawk, Red Kite, Jay, Magpie, Jackdaw, Blue Tit, Great Tit, Skylark, Chiffchaff, Blackcap, Wren, Song Thrush, Blackbird, Robin, Dunnock, Pied/White Wagtail, Greenfinch, Goldfinch, Yellowhammer, Kestrel, Carrion, Crow, Goldcrest.

Main findings

2024 marked the fifth complete year of Tracking the Impact which has seen a steady increase in survey coverage, species recorded and records generated. Trained volunteers have covered 74/78 BBS squares, 53/72 WCBS and 39/72 NPMS squares, recorded over 500 species and submitted over 20,000 records.

Despite the short term nature of the data set generated so far data have been analysed in a number of ways from online interactive maps for birds, butterflies and plants to distribution maps of key species assemblages all of which are freely available on the TTI website.

BTO and UKCEH have also carried out initial analysis of bird and butterfly data to look at emerging trends over time. The graph on page 51– **Figure 22** for the Gatekeeper butterfly shows that annual fluctuations mirror those of a wider regional comparison. As our data set grows in coming years the confidence attached to trend graphs will increase.

The project is also focused on growing and up-skilling citizen scientists. Over the five years of the project over 270 volunteers have registered of which 113 are actively carrying out formal surveys and the remainder have been supported through a package of 15 survey methodology training courses and 28 species ID courses and an active WhatsApp group.

Evaluation has shown how much volunteers and farmers value the project.

Quote from volunteer

'I feel I am part of something bigger and something that matters to me'.

Quote from farmer

'I have always taken an interest but all of the survey work has encouraged me to look more and inspired me to do more as well – it's been a really exciting couple of years!

Getting acclaim for what I've being doing for decades. It inspires me to do more. That makes me feel really proud'.

Next steps

As a result of the success of Tracking the Impact in the Central Chilterns and Chess Catchment, the Chilterns National Landscape team is intending to expand the reach of Tracking the Impact surveys further out across the Chilterns from 2026.

The continued collection of this data will evidence long-term population trends based on the aggregated net impact of positive habitat related land management work and the negative impact of wider issues such as climate change and development.

Yellowhammer is a Bird Of Conservation Concern (BOCC) Red Listed species and iconic of the Chilterns arable farmed landscape, preferring the field margins and thick mature hedgerow networks. National and regional trends show the species is in a period of long-term decline as shown in the national and regional graph (**Figure 23**) on page 51.

Rebel restoration

Thanks to joint funding from Rebel Restoration and SWC

The Central Chilterns Farmer Cluster has focused on Yellowhammer as one of a small assemblage of farmland birds over the last five years putting out over 60t of winter supplementary food, planting and/or coppicing c. 30km of hedgerows and creating and/or better managing over 900ha of grassland habitats.

Tracking the Impact surveys over the last five years have recorded a steady increase in the local population (see **Figure 24**). Despite the relatively short timeframe for the data the Yellowhammer ringing data gathered by the Hughenden Ringing Group has shown a gradual increase over 5 years in the number of first year birds suggesting a growth in the local population. The British Trust for Ornithology have analysed the data sets and have confirmed a 40/50% population increase.

Tracking the Impact is a perfect example of the power of long term systematic and repeated survey coverage by trained citizen scientists working alongside targeted, landscape scale habitat work by farmers on the ground leading to population changes in a red listed priority species.

Volunteers on bird ID course

Figure 22 – Tracking the Impact results for Gatekeeper compared to regional trend

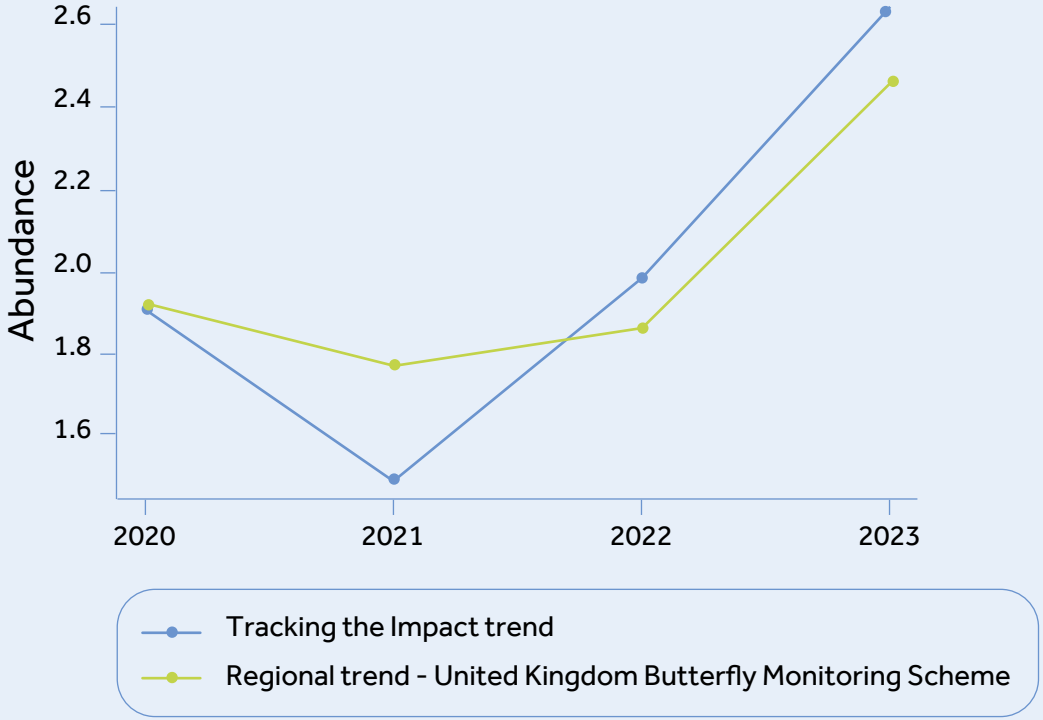
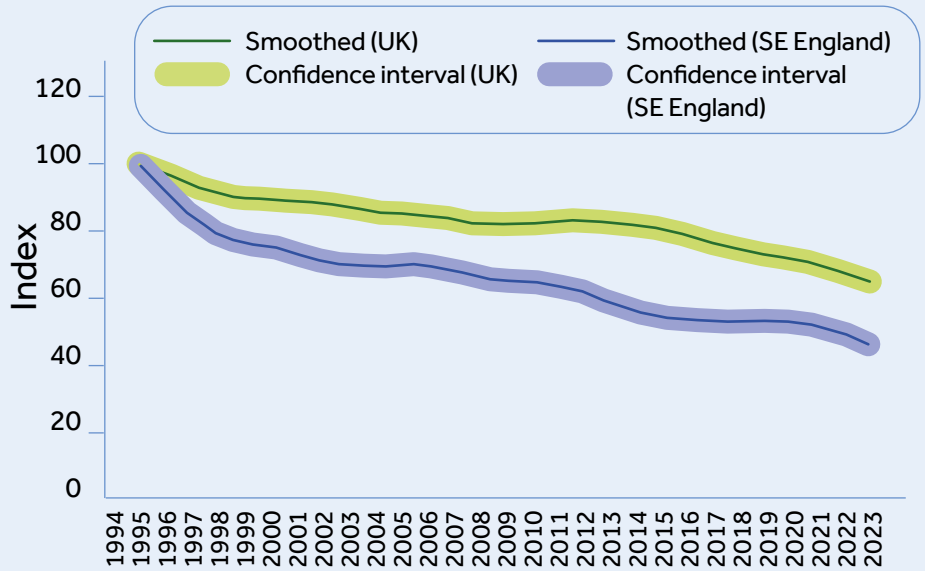


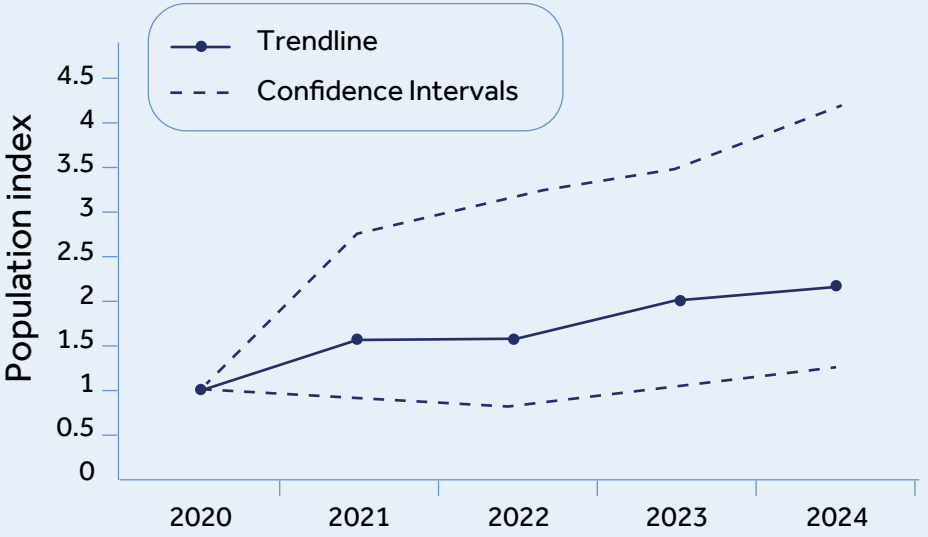
Figure 23 – Yellowhammer BBS index for UK and South East England 1994 – 2023



Gatekeeper

Yellowhammer

Figure 24 – Tracking the Impact Yellowhammer trends



Volunteers at the annual BBQ

Citizen scientist engagement

Creating a community of practice

Our citizen scientists are a dedicated group. To date (2021 to 2025) they have volunteered an amazing 2,939 hours (122 days) of their time to monitor the River Chess and its surrounding catchment, carrying out a wide range of activities as described in this report. Overall, we have trained 315 people across all our different methods, although many people have taken part in multiple activities and often one training session seems to lead to another. Seven particularly keen people have attended training in between five and eight different methods. We are extremely grateful for everyone's support, interest and hard work.

Why do they do it?

Figure 27, on page 54 captures some of the different reasons why our volunteers are taking part in the initiative. Reasons for getting involved in the first place include a strong personal passion for nature and the local area as well as finding working alongside like-minded individuals a rewarding experience. Participants tell us that their involvement has led to increased knowledge of local ecology and scientific practice. They also report a wide variety of mental and physical wellbeing benefits; citing time spent outdoors, connection with nature and a sense of community as contributing factors.

We run social evenings for our citizen scientists to help support a growing sense of community. At the events volunteers can network whilst listening to a guest speaker, discuss a topic of interest such as research, learn new identification skills, or project outcomes.

An amazing 2,939 hours have been volunteered to date

Main findings

SmartRivers at Restore
Hope Latimer

Hours volunteered and number of citizen scientists trained

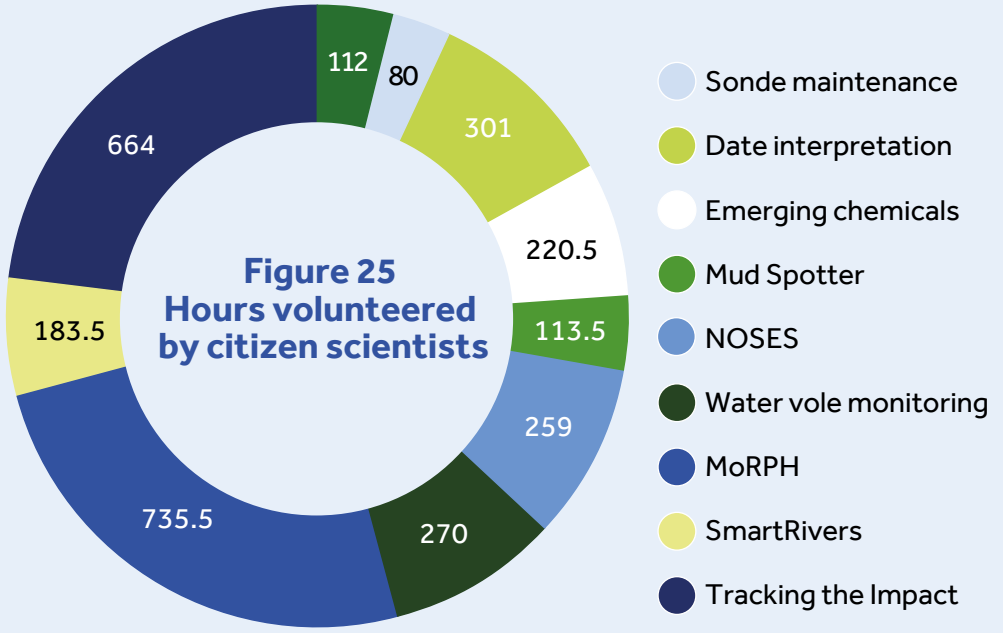


Figure 25
Hours volunteered by citizen scientists

- Sonde maintenance
- Date interpretation
- Emerging chemicals
- Mud Spotter
- NOSES
- Water vole monitoring
- MoRPH
- SmartRivers
- Tracking the Impact
- Reptile and amphibians

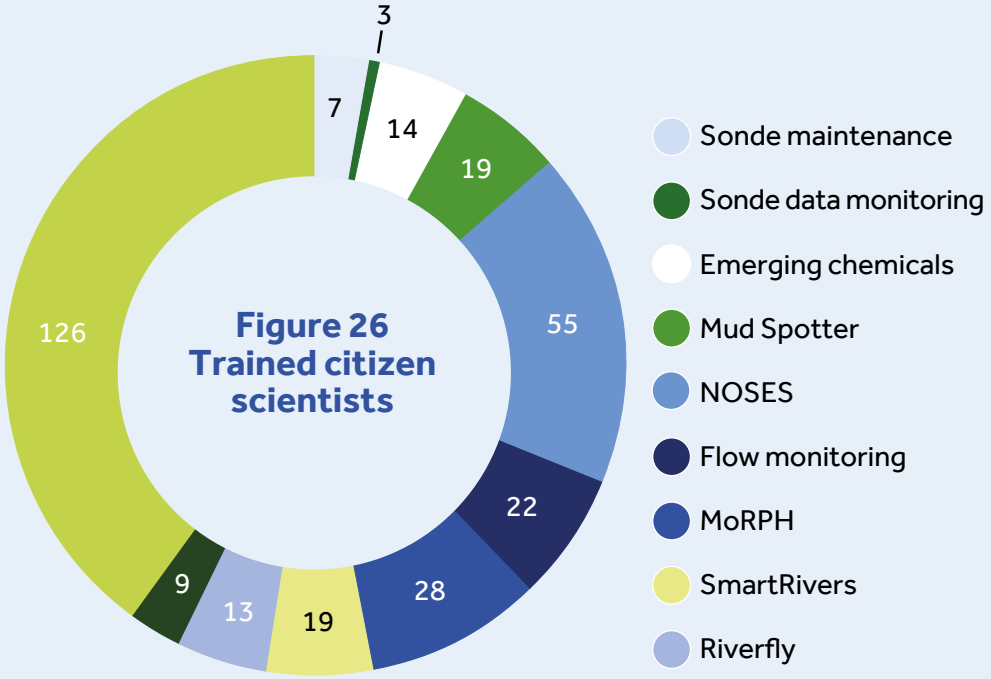


Figure 26
Trained citizen scientists

- Sonde maintenance
- Sonde data monitoring
- Emerging chemicals
- Mud Spotter
- NOSES
- Flow monitoring
- MoRPH
- SmartRivers
- Riverfly
- Water vole monitoring
- Tracking the Impact (survey training)

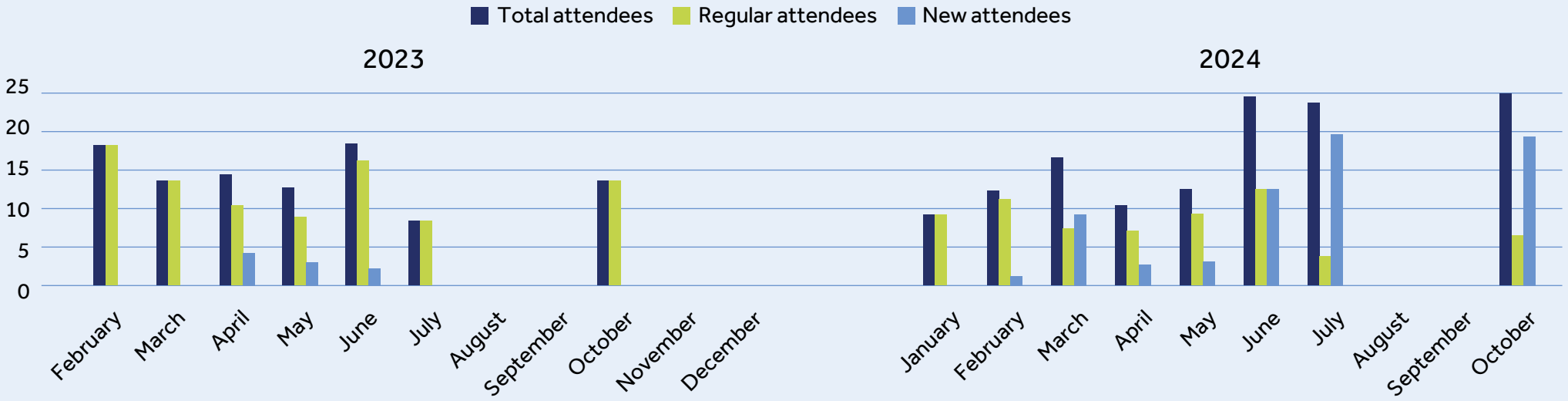
Phosphate analysis

Taking water samples


Figure 27
Reasons why our citizen scientists are taking part
Seeing and being part of the river and surroundings
Helping keep the river safe
Being connected to the Chess
Knowing there are other people concerned about the Chess
Seeing the results used in research
Learning more about my local environment
Accessing parts where you can't normally go"
Visiting the river, helping with river health
Plenty of opportunity to see more stretches of the Chess
Seeing the feedback from the data
Helping to make a difference
To learn more about an area
Being out on the river
Involvement in my local river
Adding to a large body of data
Getting to work with so many different people who care about the Chess
The opportunity to work in a really nice area
Seeing the details of the river I wouldn't usually notice
Helping get the baseline data
Meeting others with similar environmental interests
Helping wildlife prosper
Gaining a deeper understanding of the river and the pressures affecting it

Main findings

Figure 28 – Chess SWC social evening engagement



Examples of social evening topics include:

- Dragonflies (Herts and Middlesex Wildlife Trust)
- Central Chilterns Farmer Cluster (Chilterns National Landscape)
- A vision for Countryside Access (Chilterns National Landscape)
- Water Vole Recovery Project (Berks, Bucks and Oxon Wildlife Trust)
- Great Crested Newt Surveys at Chorleywood (Chilterns National Landscape)
- Are you a Chessnut? (Chess Smarter Water Catchments team)

We are indebted to all our speakers who have offered their time over the past few years. The social events have enabled citizen scientists, who might be carrying out very different activities, such as home-based data interpretation or cleaning of water quality sensors, to meet and form a community of proactive surveyors as a legacy of the project.

"I just wanted to say a huge thank you to Claudia and the team for a fantastic walk on Thursday. I absolutely loved it and came away full of knowledge."

"Thank you for an amazing outing to Chorleywood Common to look for newts. It was so well organised and inspiring. You managed us so well as well as providing us with such detail about each of the species."

We also hold an annual BBQ and an annual presentation evening to update our volunteers on the findings from our various survey methods. At our annual presentation evenings, we run a social survey with our attendees to collect their thoughts and feelings about their involvement, our methodologies and our priorities.

Through their feedback we have identified a need for:

- Clear scheduling of potential activities with which volunteers can get involved
- More succinct communication and spreading the word about the great work being undertaken
- More detailed training in the different survey methods on offer

In 2021 our citizen science co-ordinator, Hannah Parry-Wilson, commissioned an innovative web-based Citizen Science portal. This is now helping us communicate with our many volunteers effectively whilst also enabling participants to message one another and share information and photographs.

Ensuring good quality data has been a critical aim from the start

Water sampling at Sarratt

Lessons learnt

We are extremely grateful to Cara Fogarty, MSc student at Imperial College London who carried out semi-structured interviews with 12 stakeholders involved in citizen science in the Chess catchment to map citizen science activities, assess benefits to stakeholders from citizen science engagement, and understand the barriers to action and what should be put in place to overcome the identified barriers.

Cara's work has offered the following insights into the Chess citizen science programme:

Funding and capacity

Throughout the UK, the catchment-based approach (CaBA) has been designed to use citizen science projects embedded within collaborative partnerships to improve the evidence base for river management, but the initiative has faced challenges due to lack of funding and staff.

Whereas in the Chess catchment, a five-year funding commitment through the Chess Smarter Water Catchment programme has enabled the team to employ a full-time Citizen Science Coordinator. This has provided capacity to support training in different methodologies, coordination of the activities associated with the methods and follow-up training for volunteers and support for social events. The length of funding has ensured continuity of approach so that methods become common practice for the volunteers.

Benefits of citizen science data

The programme has enabled us to collect high spatio-temporal resolution hydrological and water quality data for the River Chess. We have been able to link water chemistry and ecological data in a meaningful way, such as establishing a clear link between nutrient concentration and invertebrate health. We have (i) filled gaps in the Environment Agency dataset and knowledge of the river health, (ii) contributed critical understanding of the water quality changes that have arisen due

to storm tank overflow events; and (iii) generated an evidence base for issues, such as fine sediment and emerging contaminants, that are affecting the river. Through working with academics and research organisations we are contributing to innovative research into issues in the River Chess that are facing many rivers.

"Having the continuation of data is the most valuable thing – that's where we've had problems in the Chess in the past – there's been a project, you do it for a year, it stops. And you've just got these bits of data which joining them up is next to impossible"

Environment Agency

Ensuring good quality data has been a critical issue from the start, with maintenance and calibration of equipment a critical component of the programme alongside training programmes with follow-up to ensure protocols are followed. Maintaining quality assurance is an on-going consideration as new citizen scientists are recruited and an annual budget for training and refresher workshops is needed.

"It's a difficult one (data quality assurance), but it doesn't mean we shouldn't do it (citizen science), it just means we need to think of rules and methods and standardisation nationally to think about how we can do this"

Water company

Building communication networks for effective decision-making

The initiative has built trust and connections between stakeholders that has enabled difficult conversations between the water industry, regulators and stakeholders to be held in response to water quality and quantity issues.

Local organisations have benefited from improved levels of understanding and confidence in their knowledge, enabling them to become more empowered to contribute to effective decision-making. Shared ownership of data and co-creation of knowledge has enabled trust in a common baseline to build initiatives from. Participants have noted that the networks now extend beyond the river corridor into the catchment, for example by creating ties with farmers for nature recovery.

Sustaining volunteer motivation

Citizen scientists are volunteers giving up their precious time to collect data and investigate problems on the River Chess, so they need to feel that the activities are both enjoyable and worthwhile. To help with a two-way exchange of data and information, and so that we support a community of interested volunteers, Chess citizen scientists receive regular feedback through a monthly newsletter, via our citizen science portal and in-person meetings every two months. Some of our activities have been time-limited (e.g. one year of monthly water sampling to assess emerging contaminants of concern or a one-day water blitz to measure phosphate concentrations) but others are measuring long-term trends and for these activities there is a need for on-going recruitment and repeated training of volunteers.

"The challenge will be to keep engagement, keep interest. And a lot of that will depend on the guidance from the project itself, although interested people will be quite willing to maintain the project going forward with less and less hand holding as they become more adept at fulfilling the needs of data collection."

Citizen scientist

"It keeps you going to know what you're doing is contributing to something. Having feedback on how the project is going and any results is a good thing."

Citizen scientist

Enjoying river restoration activities

Searching for signs of water vole activity

Project legacy

There are now many volunteers trained in different citizen science activities in the catchment with an improved and shared understanding of interacting river processes such as ecology (species and habitat), flow and water quality.

These citizen scientists are all new voices to advocate for the river and to help explain to others the importance of chalk streams, the challenges of river health, and how these challenges might be overcome. Through using toolkits such as Mud Spotter they are a group of volunteers with expert local knowledge of how water and sediment flow to the river via overland flow.

We have brought together different styles of citizen science toolkits in an holistic approach to assess chalk stream health and fill knowledge gaps about the river. We have proof-of-concept and have demonstrated a successful approach with an understanding of resource requirements (staff and consumable costs) that can be rolled out to other chalk streams in the Chilterns and beyond.

Over the last few years, we have presented our approach to other rivers groups and run a workshop to share our experiences with others.

Together, our monitoring efforts have delivered an improved baseline understanding of the environmental state of the river and its catchment which augments existing Environment Agency and other datasets, including some horizon scanning of emerging contaminants that may be causing harm to aquatic life. This leaves us better able to plan effective actions to improve river health, and provides a clear rationale for mitigation measures.

We have a variety of datasets and proven ways of monitoring that will enable us to track changes in river health in response to mitigation measures, such as river restoration projects, in the river and

on the river banks, and nature recovery actions such as changes in farming practice and natural flood management measures across the catchment.

Through training in the various citizen science toolkits we have more stakeholders in the catchment who understand the scientific method of investigation; are interested in an evidence-led approach to river management; and can help trial innovative techniques for river research.

By linking citizen science to undergraduate and postgraduate research we've been able to build on and develop our own activities whilst supporting a next generation of scientists in their career development. The links that we have established with the research community have led to new initiatives being focused in the catchment.

For example, the River Chess has been chosen as one of three locations, from across the UK, for the implementation of UKRI's innovative Flood and Droughts Research Infrastructure (FDRI) project, which will advance our understanding and predictions of how, when and where floods and droughts occur in the UK.

Further information at **www.fdri.org.uk**

"Our community has given us a clear signal that participatory knowledge production is core to FDRI's innovation strategy. The citizen science activities in the Chess are a great opportunity to build new partnerships and co-produce innovative science."

Professor Wouter Buytaert, FDRI Innovation Lead Imperial College London

FDRI
FLOODS & DROUGHTS RESEARCH INFRASTRUCTURE

River Chess Association and citizen scientists working with the FDRI team in the River Chess

Citizen science activities in the river catchment wouldn't have been possible without the hard work and dedication of many volunteers. We want to thank you all!

Acknowledgements

An amazing team of Chilterns National Landscape and Chilterns Chalk Streams Project staff and partner organisations have supported us along the way:

Partners

- River Chess Association
- Chiltern Society
- Buckinghamshire Council
- Environment Agency
- Queen Mary University of London
- Affinity Water
- Thames Water
- Hertfordshire and Middlesex Wildlife Trust

A special thanks to all at Restore Hope Latimer. Their continued support and commitment to the project from the start has been especially important to us.

We have used pioneering methodologies developed by:

Cartographer
Wildfish
ARMI Riverfly
Imperial College London
University College London
Berkshire, Buckinghamshire and Oxfordshire Wildlife Trust
Natural History Museum
Nottingham University
Birmingham University
Freshwater Habitats Trust

We are particularly grateful to external speakers who have given freely of their time at our social events, Haydon Bailey, Tony Booker, Tim Hill, David Willis Julia Lofthouse, Phil Townsend, Marina Muttik and John Morris.

Our work has benefited from conversations and the exchange of ideas with some of the many local rivers groups across the country, all developing their own citizen science methodologies and monitoring campaigns.

We would especially like to thank the following groups and people who have invited us to share our experiences with them:

- Ver Valley Society
- British Geological Survey
- River Lark Catchment Partnership
- River Cam Catchment Partnership
- RevIvel
- Vitacress Conservation Trust
- Chartered Institute of Water and Environmental Management
- River Beane CaSTCo project
- UK Centre for Ecology and Hydrology
- Wild Trout Trust
- Pillhill Brook Association
- Will Hobhouse
- Sir Charles Walker
- Nick Meacham
- Shaun Leonard
- Joe Crowley
- Martin Salter
- Pete Davey
- Jake Rigg
- Feargal Sharkey
- Charley Rangeley-Wilson
- Craig Macadam

CHILTERNS
CHALK STREAMS
PROJECT

River Chess
Smarter Water
Catchment

Chilterns
National
Landscape

chesssmarterwatercatchment.org

Designed by: dianaedwardsdesign.co.uk