WildFish.

RIVERFLY CENSUS

REVISITED

A NATIONAL EMERGENCY

High-resolution invertebrate monitoring highlights water quality pressures across 12 English rivers

Figure 1: Map to show the 12 Riverfly Census rivers surveyed

RIVERFLY CENSUS
REVISITED

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A NATIONAL EMERGENCY

We are in a biodiversity crisis, with **freshwater species declining quicker than any other.**[1]

In the UK, wild fish populations continue to decline, with salmon populations failing to meet even the most basic conservation limits.[2]

ONLY
16%
of our rivers are ecologically healthy[3]

100%
of our rivers are failing chemical standards[3]

13%
of freshwater species are threatened with extinction[4]

KEY ASKS

Four years on from our original Riverfly Census[5], the 2021 results show that England's rivers are not improving. In fact, certainly in the case of chemicals, the picture appears to be getting worse.

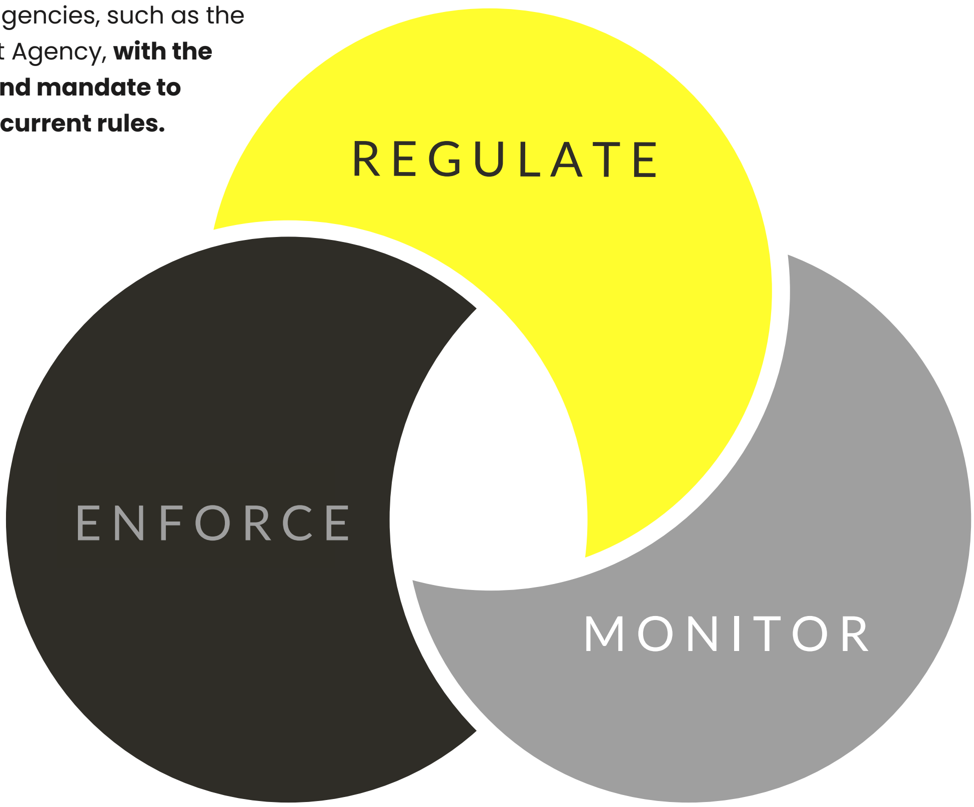
We believe the solution to achieving real on the ground improvements to rivers and their wildlife is clear. Government must first **monitor**. Then with a coherent and comprehensive picture of the state of the freshwater environment in England, regulators must **enforce** against current **regulations**.

Many are guilty of being dazzled by the promise of new regulations, but often these are just old rules re-packaged or even weakened. We do not need lots of new regulations. We need regulatory agencies, such as the Environment Agency, **with the resources and mandate to enforce the current rules.**

THE GOVERNMENT MUST:

- Reinstate comprehensive monitoring of the water environment.
- Allow the Environment Agency to deliver regulatory functions in a robust manner, where the threat of detection and prosecution provides a real deterrent and the polluter pays principle is applied with charges which truly reflect the damage caused.

Only then, with a solid foundation and baseline, can we build a more resilient environment.



DEATH BY A MILLION CUTS

Our original Riverfly Census (2015-2017) highlighted that many of the threats facing our rivers were from chronic diffuse pollution.[5]

Runoff from agricultural and urban land, and sewage and industrial discharges all feed into river systems. These contribute combinations of excess fine sediments, phosphates, nitrates and toxic chemicals. A death by a million cuts situation for our rivers.

The Environment Agency are responsible for protecting our freshwater environment. Yet, they are severely under-resourced and their statutory powers have been dramatically weakened by successive reforms favouring economic development.

These cutbacks in monitoring and enforcement have left the Environment Agency unable to protect the natural environment.

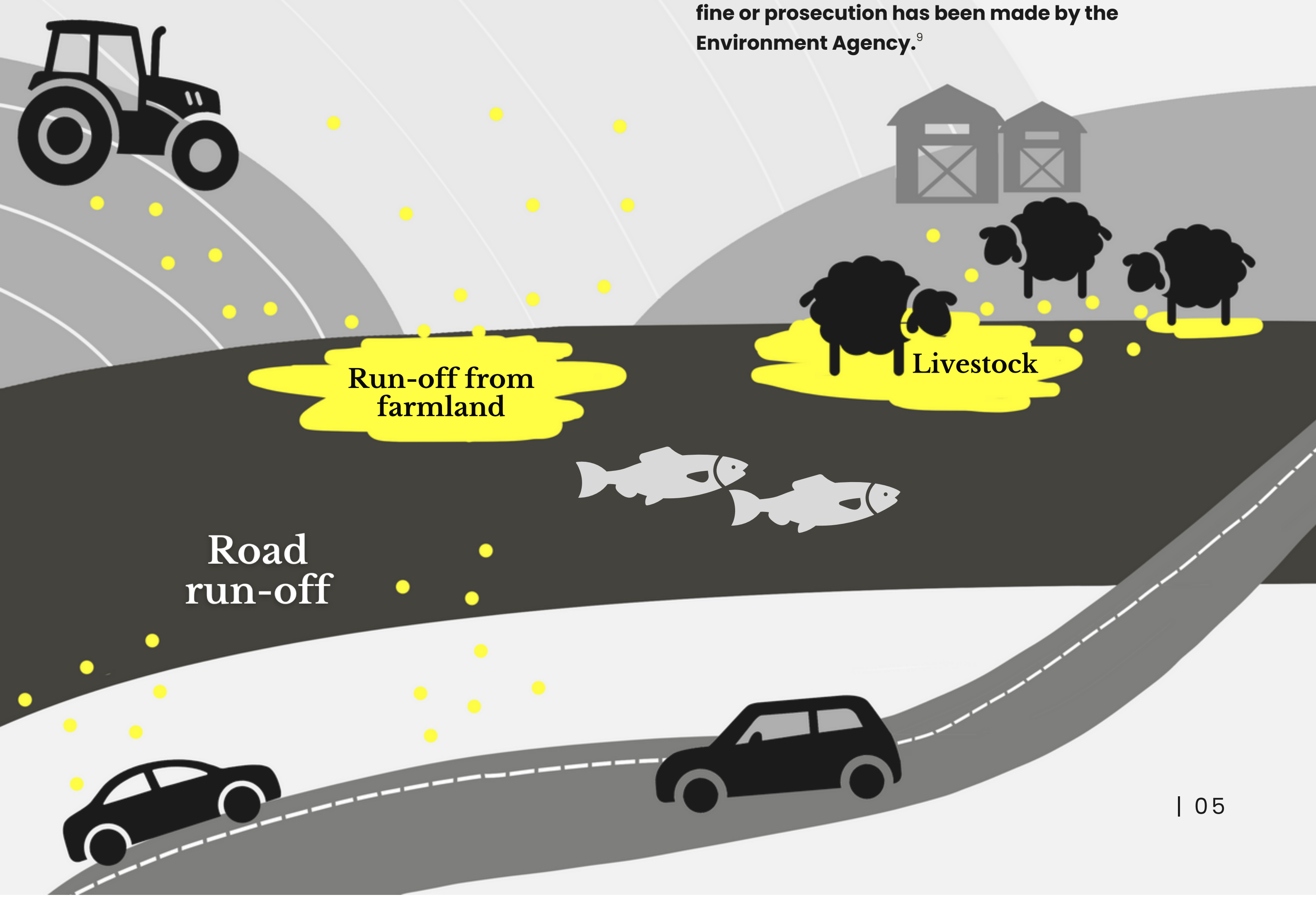
Small changes will no longer be enough; we need a shift change in political commitment and investment if we want to stop the crisis impacting our rivers and their wildlife. Recent exposure of unlawful sewage pollution by water companies has been very welcome, but we must not forget the impact of agriculture of our rivers.

Agriculture covers **70% of England**.[6] Agricultural land management practices currently contribute to:

- **40%** of waterbodies failing to achieve good status.[7]
- **35%** of the phosphorus load to rivers. This is expected to increase to about 50% by 2027.[6]
- **75%** of the sediment loads and 50-60% of the nitrate loads.[6]

Commonly known as the '**Farming Rules for Water**'- The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018 came into force on 2 April 2018, giving the Environment Agency the enforcement power to address diffuse agricultural pollution.[8]

Despite the introduction of this legislation there is no on the ground enforcement. Not a single fine or prosecution has been made by the Environment Agency.[9]



Our research shows pollution of our rivers, particularly by chemicals and fine sediments, continues to impact their invertebrate populations- the base of the food web.

RATIONALE & METHOD

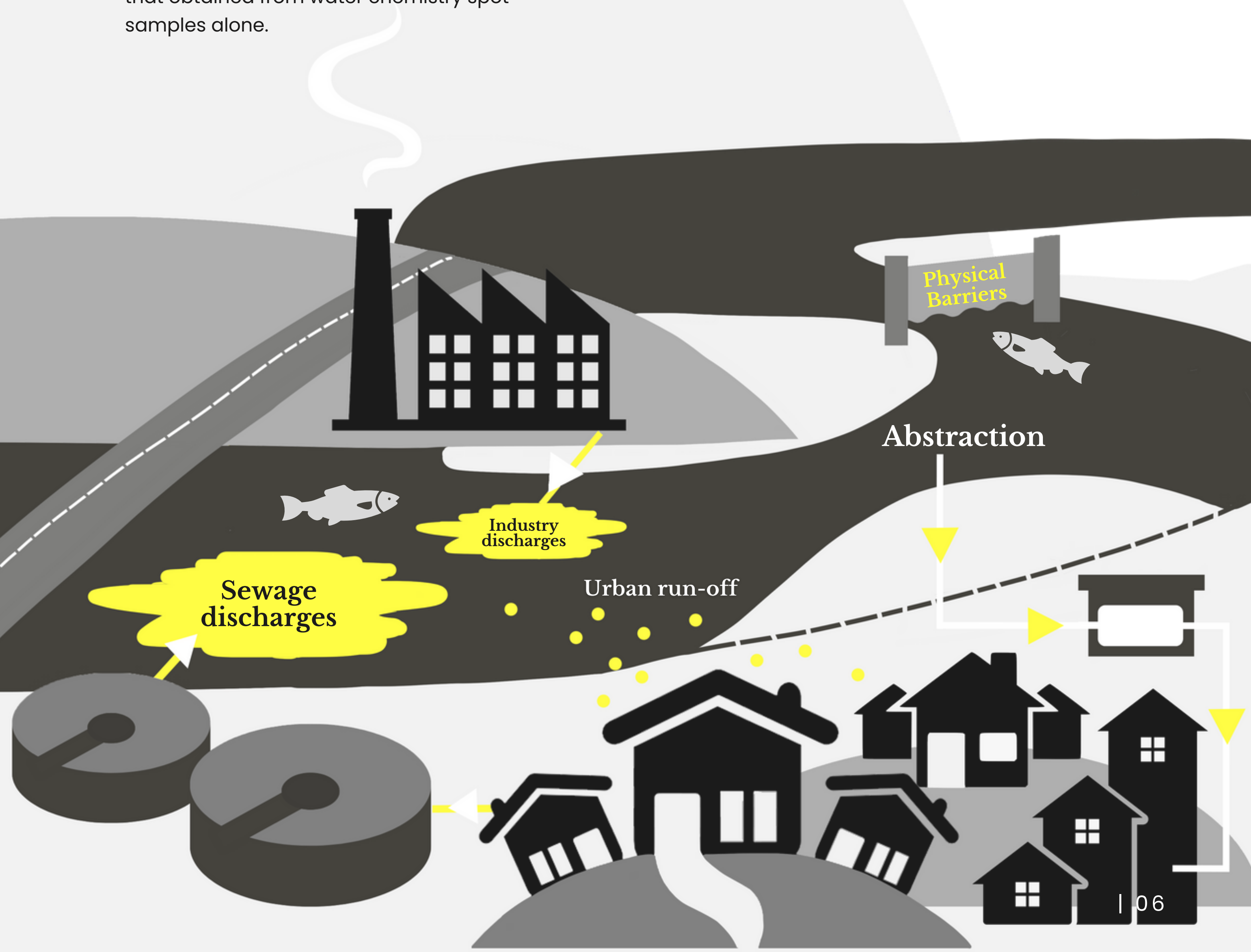
Unpicking water quality pressures is not straightforward. Unlike land, where pollution is more localised, rivers are constantly moving.

The Riverfly Census starts to untangle this complicated web of pressures by using invertebrates. In their larval stages, invertebrates are constantly exposed to the water, which means their presence or absence can indicate what pollution a river may be experiencing. This provides a broader picture of river health than that obtained from water chemistry spot samples alone.

Technique:
Invertebrate samples were collected in spring and autumn via a 3 minute kick-sweep sample. Samples are then identified to species-level and counted. Invertebrates have standardised tolerance 'values' for various water quality pressures. For each sample, species names and abundances are entered into a calculator, which looks up these values and generates an overall impact score for sediment, chemicals, phosphorus, organic pollution and flow.

Coverage:
The Riverfly Census covered 12 English Rivers, 4 - 6 sample sites were selected on each river and these were surveyed in spring and autumn. The Census originally began in 2015 and ran for three years. We repeated the survey in 2021.

Ground truthing:
To have confidence in our comparison of 2021 to the original 2015-2017 Riverfly Census results, we evaluated climate and rainfall data from 2015-2021. No extreme variations were observed.



NATIONAL OUTPUTS

Compared to our original survey, by far the greatest change we observed was an increase in chemical pressure.

Greater pressure from chemicals was indicated at more sites in 2021 than the 2015-2017 Riverfly Census (**31%** and **47%** of sites exhibited greater chemical stress in spring and autumn respectively).

63% of sites in spring and **67%** of sites in autumn exhibited the same sediment stress as our original survey.

Less pressure from phosphorus than the original Riverfly Census was indicated overall (**40%** of sites in spring and **35%** in autumn). However, it is worth noting that some of the most impacted sites on the Welland, Wensum and Axe were unsampleable in autumn 2021, so these are missing from the calculations.

47%

of sites in autumn exhibited greater chemical stress than the original 2015 - 2017 Riverfly Census

RIVER RANKINGS

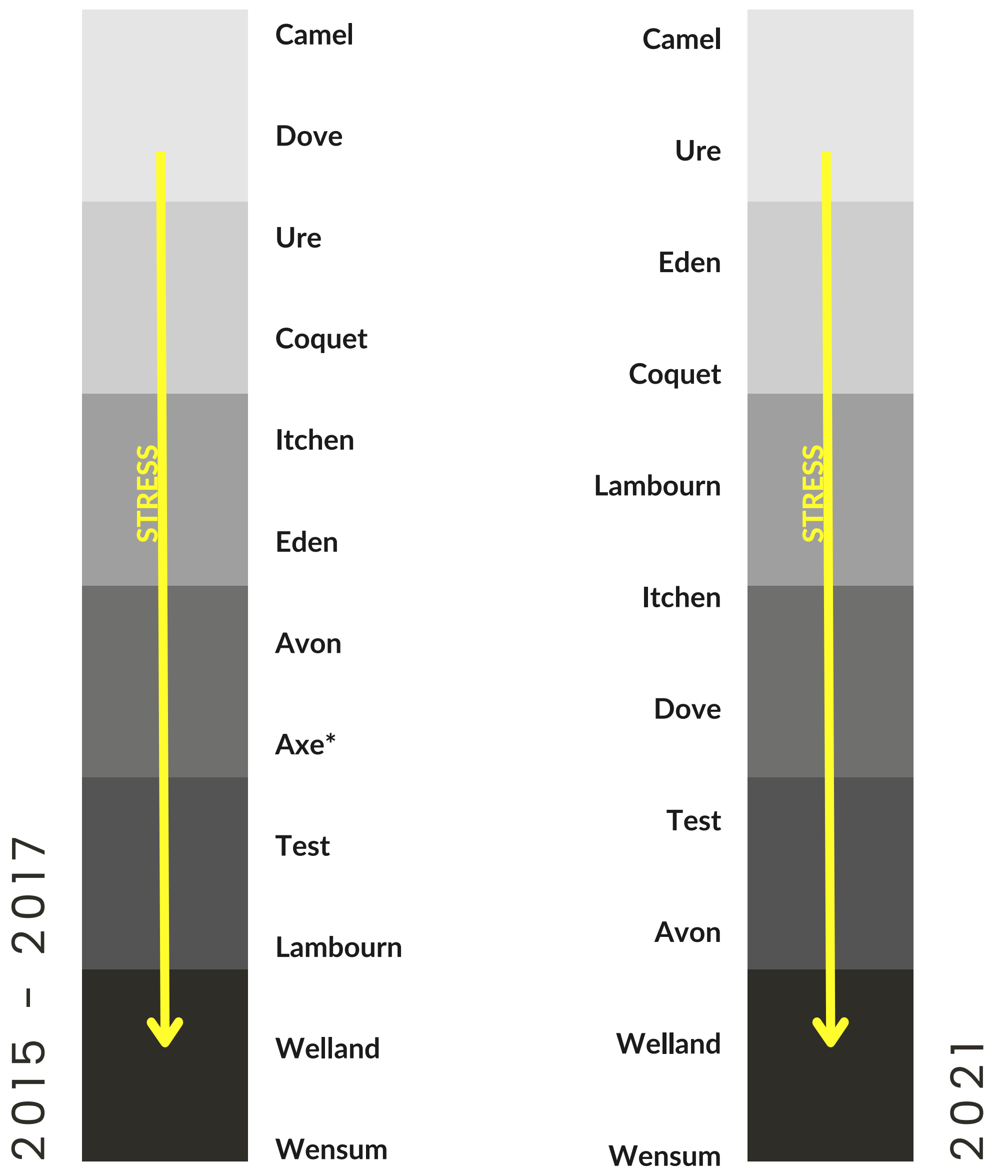
In our previous report we combined sediment, phosphorus and chemical scores for each river over the 2015-2017 period to see, based on the invertebrate community, which exhibited the greatest stress overall. We repeated this with the 2021 data (figure 2).

The Welland and Wensum remained bottom of the list with the most pressure indicated.

The Camel exhibited the least pressure and remained top of the list.

Notable changes in the rankings included the Rivers Dove and Avon. The invertebrate communities in the Avon exhibited greater chemical and phosphorus stress in 2021 than previous years. On the Dove, sediment impact was slightly more pronounced in 2021, but chemical impact was considerably greater.

Figure 2: Riverfly Census rivers ranked by cumulative water quality stress (sediment, phosphorus and chemical combined) for 2015-2017 and 2021



**the River Axe was unsampleable in autumn 2021 so could not be included in 2021 rankings.*

CHEMICAL POLLUTION

Chemicals have many routes into the freshwater environment after their intended use.

From fertilisers and pesticides washed into rivers by the rain to antibiotics and pain killers passing through the sewage system into rivers, chemicals mix in the water and within organisms into an **unknown, poisonous cocktail which can devastate freshwater biodiversity.**[10]

Despite this, the threat to ecosystems posed by chemicals is usually assessed on an individual chemical basis, even though exposure to mixtures is known to cause harm below the safe level for individual chemicals.[11]

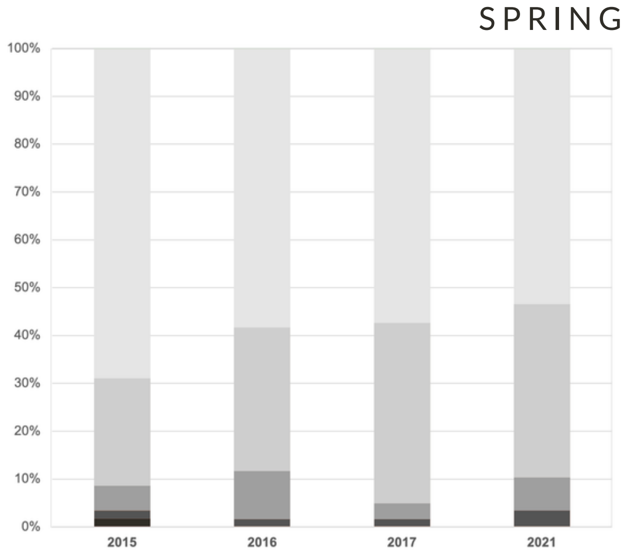
OVER

350,000

chemicals and mixtures of chemicals are registered for production and use[12]

OUR FINDINGS

Chemical pressure was significantly worse in autumn 2021 compared to autumn 2017 (p=0.041).



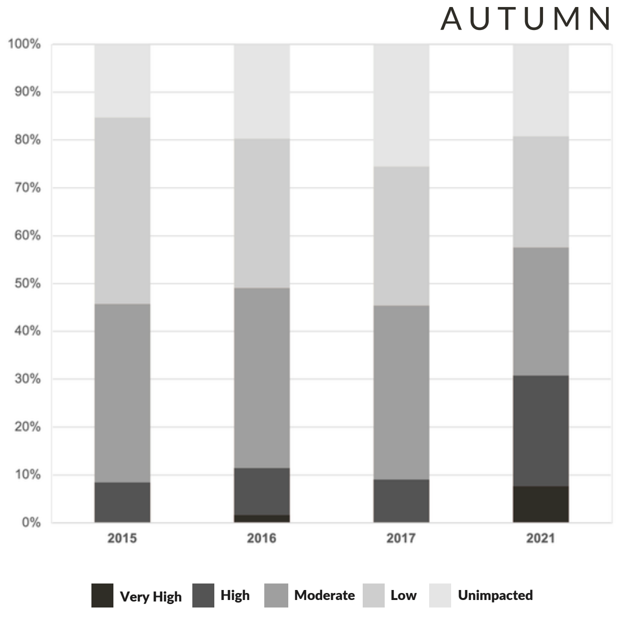


Figure 3: Chemical impact scores exhibited for all the monitored sites over the four Riverfly Census years

There was no significant difference between the years in spring, but in autumn 2021 chemical pressure was significantly worse than 2017 (p=0.041). In 2021 the invertebrate communities indicated the greatest chemical stress was on the Welland.

The chemical metric (**SPE**cies **A**t **R**isk: **SPEAR**) does not indicate which chemicals are present. Quantifying this requires further investigation and catchment information. In the case of the Welland the land-use is predominately agricultural, suggesting this is the main sector responsible for the pollution. Farming is mainly arable, with some livestock, so the river will likely be receiving a mixture of pesticides and veterinary pharmaceuticals.

Case Study:
A Bakkavör salad washing plant at Alresford, Hampshire

The original Census recorded low numbers of *Gammarus* and mayfly species in the river Itchen headwaters and filamentous algae below Alresford.

Because of this, in June 2018 we made a formal notification of environmental damage to the Environment Agency, in accordance with the Environmental Liability Directive. This forced the Environment Agency to undertake further research into pollution that we suspected was coming from the Bakkavör salad washing plant.

Subsequent monitoring by the Environment Agency found a suite of 37 pesticides, including Acetamiprid, from the neonicotinoid group of chemical substances which is seriously dangerous to aquatic life. This was being washed off salad leaves and entering the river via discharge water.

After continued pressure, Bakkavör was required to monitor and report all pesticides which could be present in their discharge. In late 2020 Bakkavör announced, rather than invest in measures to prevent the chemical pollution, they would close the salad washing plant at Alresford.

This case has uncovered systemic problems in the regulation and monitoring of chemicals in England.

- There was no monitoring of pesticides and other chemical pollutants in the discharged wastewater because the permit holder had not told the Environment Agency they could be present.
- The Government has no process for monitoring and regulating synergistic and/or additive effects of chemicals in discharges. In this one discharge there was a cocktail of chemicals, which individually might be just below 'safe' thresholds. But, where mixed together, and continually discharged, the impact on the aquatic environment had not even been considered.

SEDIMENT POLLUTION

Unsustainable volumes of sediment are being transported into freshwater habitats.

This sediment can cause **considerable loss of biodiversity**.[13] It is harmful because the sediment clogs the gills of aquatic organisms, buries, and kills sedentary organisms such as invertebrates and fish eggs, blocks out light and binds to harmful chemicals causing them to persist in the ecosystem.[14]

Poor agricultural practices result in compacted soils, reducing infiltration and creating more run-off. This transfers top soil with nutrients and pesticides to rivers, and can increase flood risk downstream. A study of UK soils found that 67% of the samples had multiple residues of hazardous chemicals, 25% had more than six, with around 4% containing **traces of more than ten pesticides**.[15]

75%

of sediment pollution in English rivers comes from agricultural activities[16]

OUR FINDINGS

There was no significant change in sediment pressure between the original Riverfly Census years and 2021. However, it remains a major pressure with 24% of sites exhibiting moderate or greater stress.

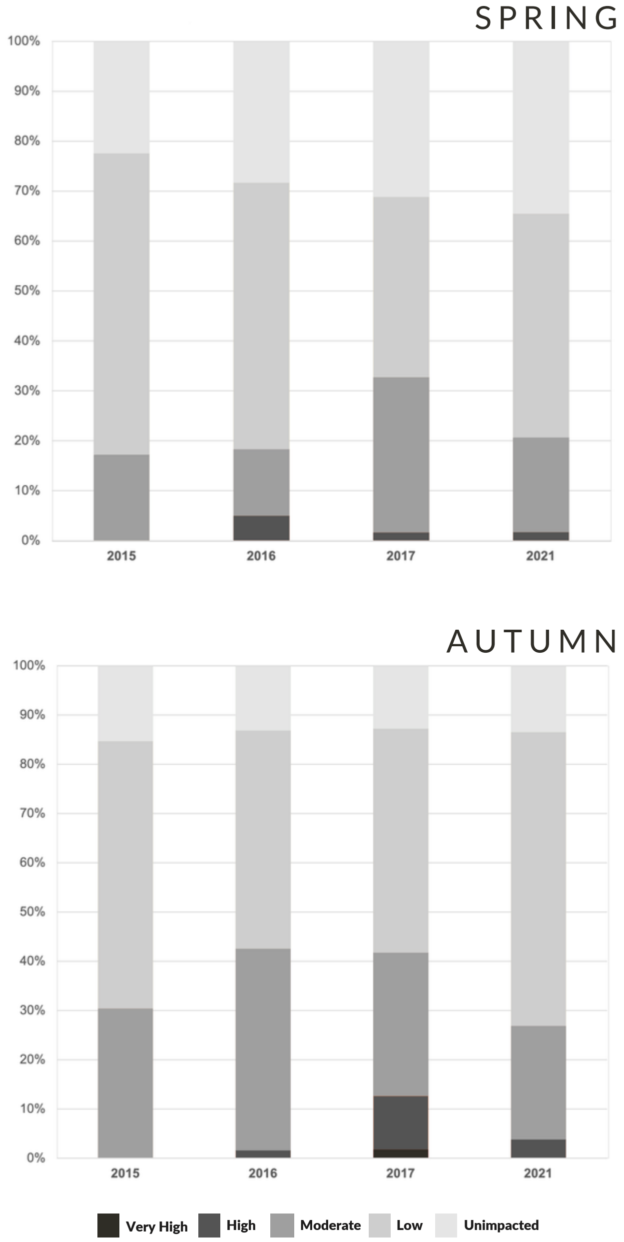


Figure 4: Sediment impact scores exhibited for all the monitored sites over the four Riverfly Census years

Moderate scores are indicative of significant disturbance to natural ecosystem processes. It is also worth remembering that whilst being a pollutant itself, sediment also acts as a mode of transportation for chemicals and nutrients, which easily bind to it on land.

Case Study:
A decade of catchment research, but still no targets

Consistently our worst performing river, the River Wensum was one of the chosen catchment areas as part of the government funded 2009-2019 'Demonstration Test Catchments' (DTC) project. This project was designed to provide robust evidence regarding diffuse agricultural pollution and improving water quality.

The risk mapping tool SCIMAP (Sensitive Catchment Integrated Modelling and Analysis Platform) was used in the DTC project to predict where diffuse pollution is most likely to originate across a landscape, using land use, rainfall patterns and terrain analysis. The idea is that once the source is traced, targeted interventions can be put in place.

Despite sediment from agriculture being highlighted as a key pressure and high risk areas being identified from this research, still no national standard or local targets for sediment currently exist.

The lack of standards or targets makes enforcement of baseline regulation such as Farming Rules for Water even more important as it provides one of the only opportunities to reduce this significant impact on ecology. Only a small fraction of the Environment Agency's total budget is allocated for regulatory visits and enforcement action on farms.

Across the 2020/21 and 2021/22 financial years:

- There were 2,053 Environment Agency total inspections on farms.[17]
- These inspections found 497 violations of the Farming Rules for Water.[17]
- 0 fines or prosecutions occurred on the back of these violations.[17]

If you take an average of the past two years of Environment Agency inspections, **0.97%** of farms would be inspected each year. **This is clearly insufficient to enforce Farming Rules for Water and protect our rivers from agricultural pollution.**

PHOSPHORUS POLLUTION

Humanity passed the planetary boundary for phosphorus use over a decade ago.[18, 19]

Poor phosphorus management and inefficient use, particularly via the waste water treatment and agricultural sectors, introduces large quantities into the environment.

Influxes of phosphorus can **cause eutrophication, disrupting food webs and causing biodiversity loss**. Many freshwater species of invertebrate, fish and even plants are sensitive to high concentrations of phosphorus and are unable to survive.[20]

26,200
TONNES
of phosphorus are lost into the aquatic environment each year -the weight of **2,071 double decker buses**[21]

OUR FINDINGS

The results for phosphorus pressure did indicate improvement, with more unimpacted sites than previous years.

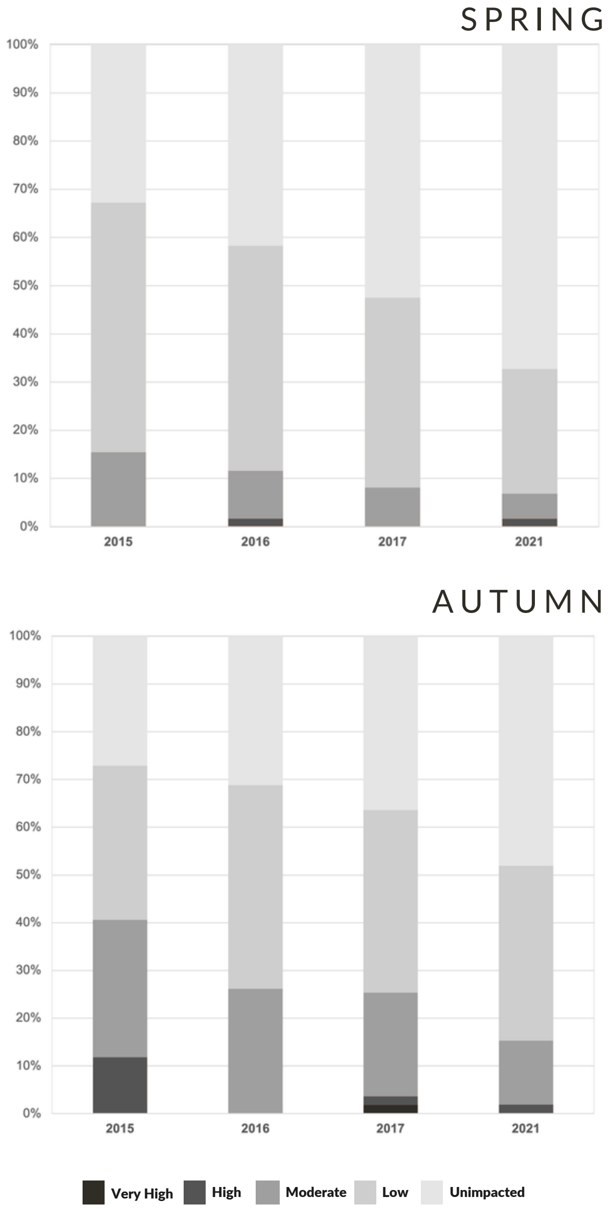


Figure 5: Phosphorus impact scores exhibited for all the monitored sites over the four Riverfly Census years

2021 was significantly different to 2015 in both spring (p=0.0009) and autumn (p=0.005). Spring 2021 was also significantly better than spring 2016 (p=0.01). The Axe, which indicated considerable phosphorus pressure in previous years, could not be sampled in autumn 2021.

This missing data could be potentially making the autumn figures appear better than they actually are. In spring 2021 the greatest phosphorus stress was indicated on the Wensum and the least on the Eden. In autumn 2021 the Welland exhibited the greatest pressure and the Lambourn the least.

Case Study:
Action for the River Avon

On the River Avon, Salisbury & District Angling Club (SADAC) have continued the Census monitoring via our SmartRivers programme. They now survey the original Census sites, plus six more.

The data collected has flagged an increase in phosphate pressure between Amesbury and Salisbury. The number of sites exhibiting moderate stress from phosphorus, increased from 0 in 2015, to 2 in 2016 and reached 3 in 2017. The SmartRivers hub alerted the Environment Agency to the rising levels of phosphate in the Avon and requested action in 2018 and 2019. In 2020, phosphate thresholds under the Water Framework Directive were breached at the Stratford site. As a result of phosphate loading, the site failed to achieve 'good' status and was classified as 'moderate'. Having accurately projected the deterioration of the river, the hub alerted the Environment Agency again requesting immediate action.

The increase in phosphate has been partly attributed to increasing phosphate discharge concentrations from local sewage treatment works, specifically Ratfyn, where the concentration of phosphate has increased substantially since 2018. Data from 2021 found the number of sites between Amesbury and Salisbury indicating moderate phosphorus pressure remained at 3. SmartRivers data will be available for these sites later in 2022, and we will continue to work with the hub to lobby the Environment Agency to take action.

Although the UK water industry have invested £2 billion in phosphate stripping since the Urban Wastewater Treatment Directive was introduced in 1991, **more investment is needed where phosphate enrichment remains a significant problem**, for example on vulnerable headwaters where cost/benefit analysis currently does not permit investment.[22]

Current phosphate monitoring also only measures one form of solute phosphate and ignores particulate phosphates, which are typically the largest component of agricultural phosphate pollution. This reiterates the **need for enforcement of baseline regulation** to protect rivers from agricultural pollution.

THE SEWAGE PROBLEM

Sewage pollution has become increasingly topical, following widespread illegal activity at sewage treatment works (STW's), prompting a nationwide investigation by the Environment Agency and Ofwat.

According to the Water Framework Directive, 36% of water bodies are failing to achieve good ecological status due to wastewater from STW's and combined sewer overflows (CSOs).[23]

Pollution from STW's contain a mix of phosphorus, faecal microbes, industrial chemicals, plastics and pharmaceuticals. Untreated sewage and urban run-off is also present in CSO discharges.

400,000

The number of times sewage was pumped into rivers and seas nationwide in 2020[24]

Of our 12 Riverfly Census rivers, 10 had at least one sewage treatment works that was regularly spilling untreated sewage in 2021.

Due to the huge diversity of substances contained in sewage pollution, it is capable of elevating more than one pressure. These increased pressures were evident downstream of sewage treatment works on a number of Riverfly Census rivers, including on the Camel and Ure, our least stressed rivers.

Case Study 1: River Lambourn

Situated in close proximity to the River Lambourn is East Shefford STW.

The CSO at this works is very active, with **over 2,750 hours of spills** in 2020 and 1,400 in 2021.[a]

After receiving data, via a Freedom of Information (FOI) request to Thames Water, we were able to identify 82 - 90[b] early spill days in 2020 and 64 - 65 early spill days in 2021. These occur when the works discharges untreated sewage before the instantaneous flow rate reaches the overflow setting. We were also able to identify 48 - 95 dry spill days in 2020 and between 21 - 58 dry spill days in 2021. These occur when untreated sewage is discharged when there has been no rainfall on the day of (or the day prior) to the spill. **Both early and dry spills are illegal.**

East Shefford STW is located upstream of the four Riverfly Census sample sites. The closest site is approximately 0.5km downstream from the work's storm discharge point.

The Spring 2021 samples were collected in April. During that month there were a series of illegal spills. The results identified that, of the four sites, the site closest to the works was indicating the greatest chemical, phosphate and organic pressure.

a. Numbers obtained from Environment Agency data and FOI requests.
b. Permits do not contain an exact measurement for rainfall or a set minimum percentage below the overflow setting. We established our own spill day ranges using 0-5mm rainfall and 67-75% for the overflow setting.

Case Study 2: River Welland

Throughout the Riverfly Census analysis- the River Welland has remained in the bottom two rivers for water quality.

Great Easton STW discharges into the river and is situated between two of the sample sites. **The works has the highest duration of spills out of all the works studied on Riverfly Census rivers in 2021 -** there were 95 early spill days and 9-52 dry spill days. In 2020, there were 31 early spill days and 6-28 dry spill days.

In the spring 2021 Riverfly Census data, the site downstream of Great Easton STW indicated less organic and phosphorus stress compared to the site upstream of the works, despite continuous illegal spilling of raw sewage the month prior to sampling. On the Welland, intensive arable farming makes up a large proportion of land cover, including on low-lying land. The site located upstream of Great Easton STW is in close proximity to an intensive livestock farm.

Our research has shown Government must urgently review water company discharge permits as they lack any specificity concerning the conditions in which CSO discharges are permittable (e.g. a measure for rainfall). Without updating these permits water companies cannot be held to account for the pollution they are causing.

River Welland, near to Market Harborough

Riverfly Census data reinforces that sewage treatment works are only **one of the many sources** of pressure impacting our rivers.

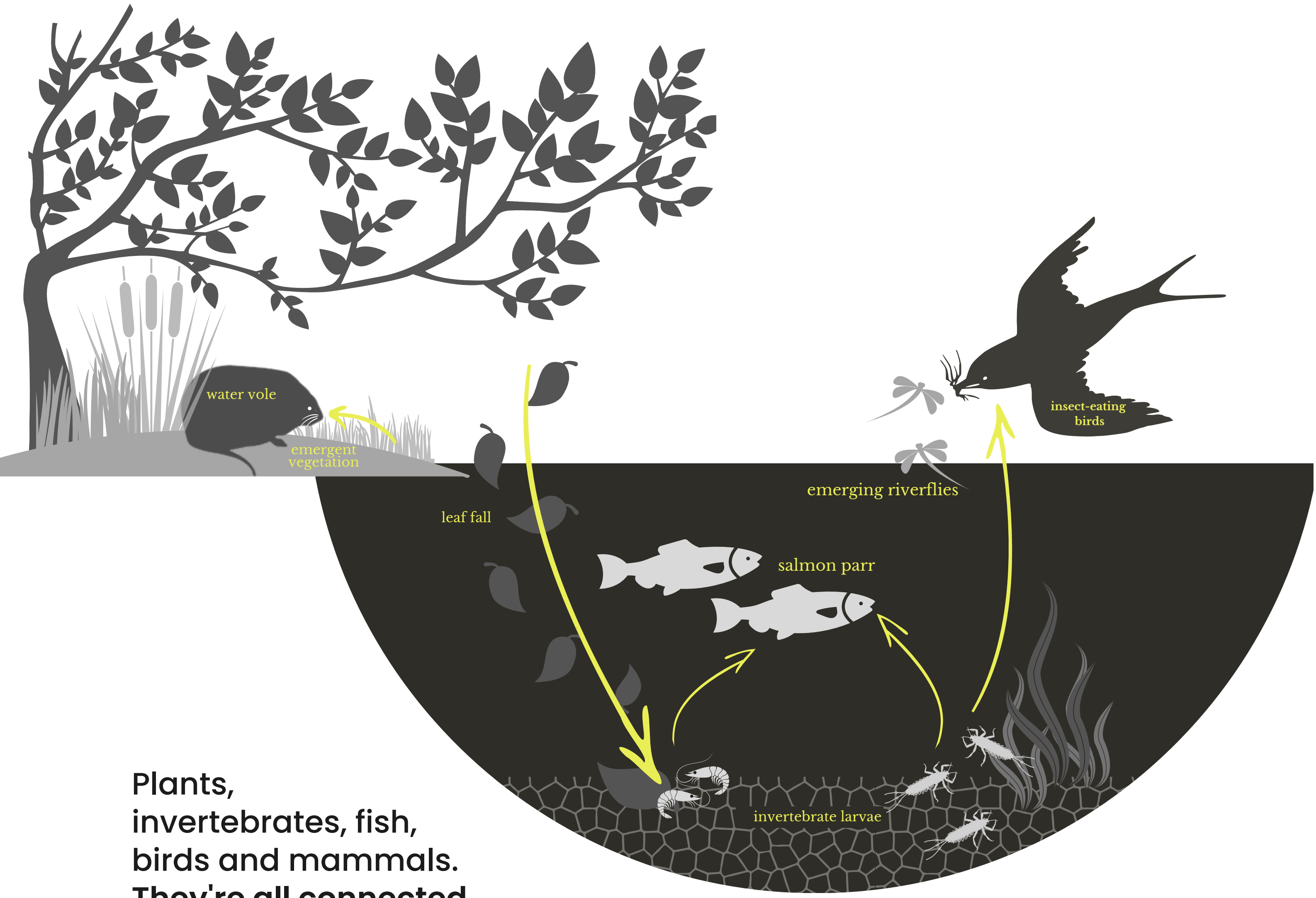
A DELICATE BALANCE

We are losing freshwater biodiversity at an alarming rate.

Freshwater habitats support a disproportionately high amount of biodiversity relative to the area they cover, but are extremely vulnerable to many threats.[25]

TWO THIRDS

of freshwater and wetland species in the UK are in decline[26]



Plants, invertebrates, fish, birds and mammals. They're all connected.

Invertebrates have an essential role in river ecosystem functioning. In addition to being a vital food source, many are ecosystem engineers and shape the environment around them. Because of this, changes in invertebrate diversity and abundance will alter the natural balance of river systems. This has implications for other species, like birds and fish.[27]

Species loss in any environment is a sign of stress. **Of the 724 aquatic insect species documented in Great Britain, 11 have gone extinct, and a further 68 are threatened with extinction**. Many have also experienced declines in abundance and distribution.[28]

In Britain, more than 270 species of mayflies, caddisflies and stoneflies have been recorded. Eight of these are threatened and recognised as a priority for conservation by the government.[27] We also have several species that are endemic, found nowhere else in the world.[29]

The Riverfly Census revealed that in many of the rivers found to be indicating the least pressure, rarer species are still present. On the river Camel, there was high presence of the golden-ringed dragonfly (*Cordulegaster boltonii*). The large green dun (*Ecdyonurus insignis*), a mayfly with a relatively limited UK distribution, was also identified. On the river Ure, a rarely seen stonefly from the genus '*Capnia*' was detected.

Golden-ringed dragonfly larva. Photo: Cyril Bennett

EPT SPECIES DIVERSITY

2021 had lower mean diversity of mayfly, stonefly and caddisfly species than the original Riverfly Census.

EPT stands for Ephemeroptera, Plecoptera and Trichoptera, which are orders of aquatic invertebrates better known as mayflies, stoneflies and caddisflies. As a general rule 20 or more EPT species in a sample indicates high water quality. A variety of EPT species, rather than just high abundances of one or two species, is what we're looking for in a healthy system.

Numbers of EPT species present across all of our sample sites were evaluated for each Riverfly Census sample year (figure 6).

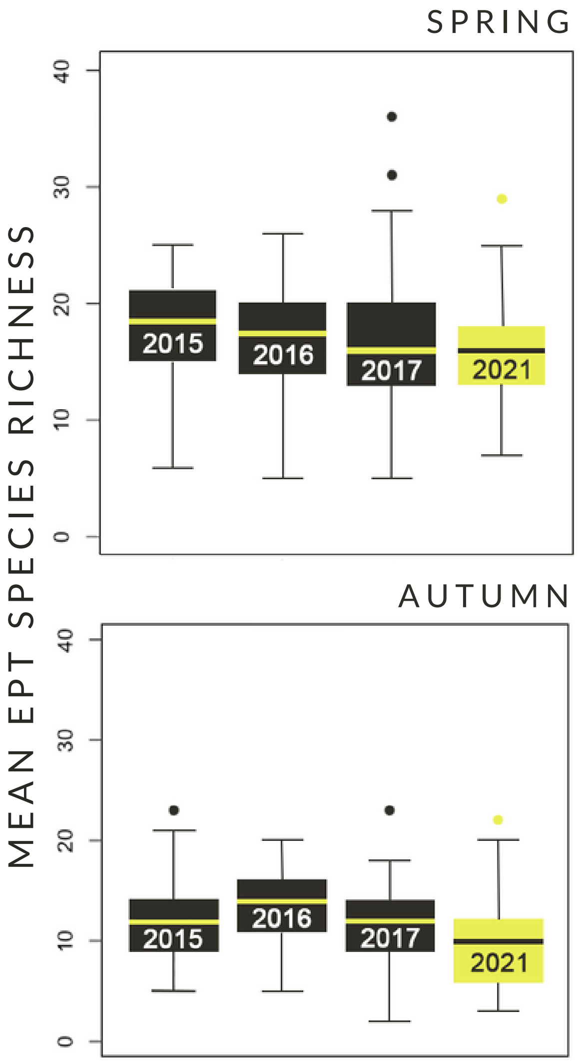


Figure 6: Mean EPT species richness in spring and autumn for each Riverfly Census year

Mayfly larvae

Stonefly larvae

Caddisfly larvae

In spring, 2015 had the greatest EPT richness, with a mean of 18 species. The other years had lower mean richness (2016 = 17 species, 2017 = 16 species and 2021 = 15 species) but only 2021 was significantly lower (p=0.025).

In autumn, 2016 had the greatest mean EPT richness (13 species). 2017 and 2021 were significantly lower (11 species, p=0.038 and 10 species, p=0.0007 respectively).

MAYFLY SPECIES

Comparing 2021 to 1998* values, our chalkstreams have lost (on average) 41% of mayfly species.

Baetis rhodani larva - more tolerant to organic pollution than other Baetis species in Baetidae family. Photo: Cyril Bennett

In the original Riverfly Census we compared the annual mean number of mayfly species to historic values, where available for our sites. We repeated this with the 2021 values (figure 7).

In 2017 we agreed a bespoke target of 10 mayfly species for two chalkstreams (the Rivers Test and Itchen) with the local Environment Agency. This figure is based on what we would expect a healthy river of this type to be achieving. Mean annual mayfly species declined from **14** in 1998 to **7** in 2021 at Itchen St Cross.

Declines on other chalkstreams were also apparent. On the River Avon mean annual mayfly species declined from 9 at Stratford Bridge and Stonehenge in 1998, to 4 and 6 in 2021 respectively.

We also saw reduced diversity outside of chalkstreams. Temple Sowerby, a site on the River Eden, showed a reduction of annual mean mayfly species from 19 in 1987 to 7 in 2021.

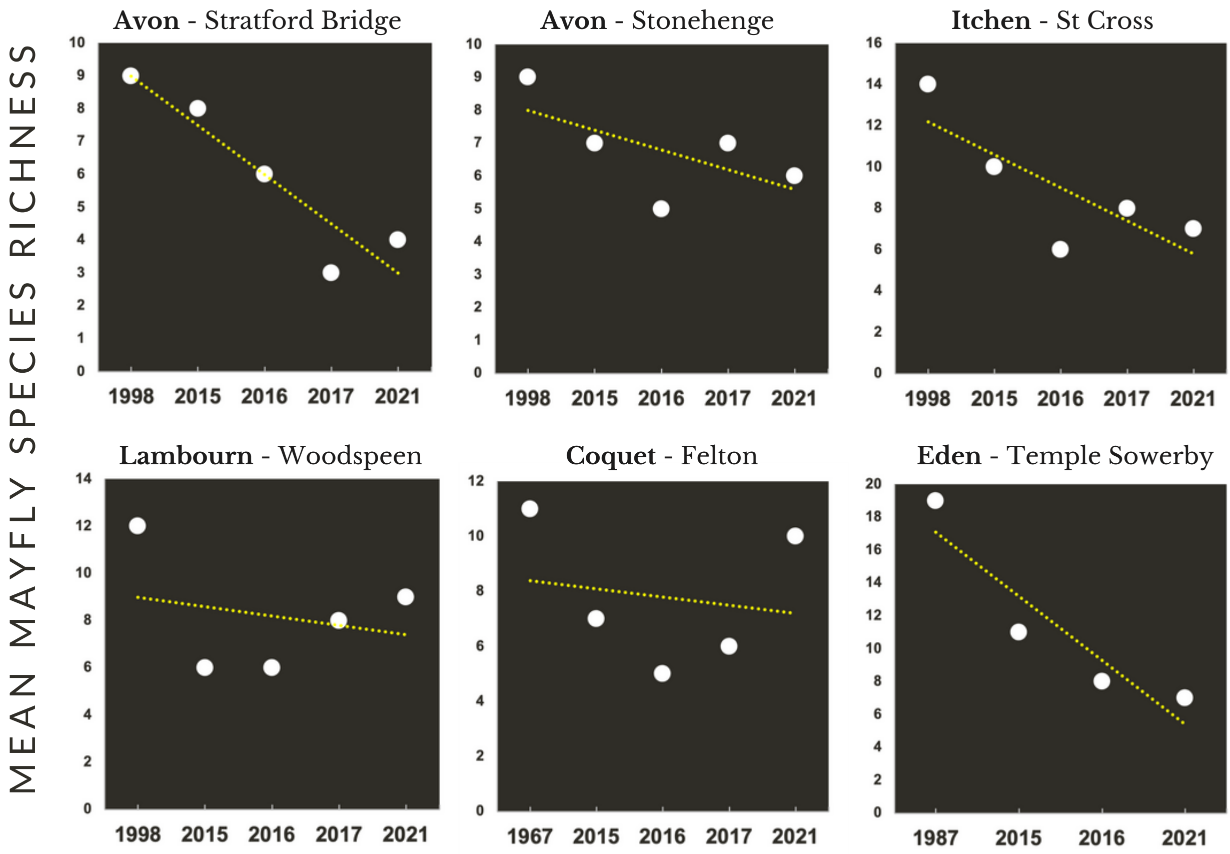


Figure 7: Annual mean mayfly species richness from available historical data compared to Riverfly Census data*

Historical data from Wright et al. (1998), Wise (1976) and Prigg (2002)[a, b, c]

KEEPING MOMENTUM

Thanks to SmartRivers, the volunteer arm of the Riverfly Census, we continue to grow our evidence base.

SmartRivers enables volunteer 'hubs', supported by an Institute of Fisheries Management certified training scheme, to sample and analyse invertebrates to near-professional standards.

24
HUBS

are currently enrolled in SmartRivers, covering **145 monitoring sites**

River Halladale

Flow Country Rivers Trust (FCRT) are using SmartRivers to 'catalogue' invertebrate communities. Shifts in temperature baselines can lead to changes in the diversity of animals present in a river, so this hub are using the species lists to track the future effects of climate change in the northern rivers.

Some of the FCRT's invertebrate identification team. Photo A Youngson.

How to join SmartRivers:

Establish a hub and recruit volunteers
You will need an organisation to host the hub. Around 10 volunteers are required to launch a hub and a hub lead/coordinator (this is commonly a local conservation group). Hubs are river based.

Site selection
You will need to choose 5 sample sites. It is helpful to think about what are you keen to investigate? For example sites above and below restoration projects or potential polluting discharges.

Get a professional benchmark
We'll organise a professional scientist to come and complete an initial benchmark on your chosen sample sites, in spring and autumn. This provides a scientific 'baseline' for your river.

Get trained
Training takes two full days and is usually run in conjunction with benchmarking. The course is certified by the Institute of Fisheries Management.

Contact smartrivers@wildfish.org for more information

Figure 8: 2022 SmartRivers hub locations

River Chew

To better understand the water quality pressures influencing the River Chew, Bristol Avon Rivers Trust (BART) enrolled in SmartRivers in 2019. The results have been reported and excess sediment was revealed to be the pressure of most consistent concern at all but one of the sites.

With BART, we will be using the report to facilitate discussions with local stakeholders and working in partnership to develop a targeted action plan to reduce impacts at the worst sites.

URGENT APPEAL

The future of our rivers and their wildlife remains bleak. Current management is not stopping the deterioration.

Recently, Government confirmed a review of the Farming Rules for Water, the Nitrate Pollution Prevention Regulations and the Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations. Now is not the time to cut red tape.

To achieve healthy rivers with thriving wild fish populations we need to build from strong foundations. This means restoring a comprehensive monitoring network, investing in environmental regulators and directing them to enforce current legislation, so the threat of prosecution deters would-be polluters.

Through SmartRivers and other citizen science projects, we have an army of people who can help protect our rivers. But, the government needs to take the lead and establish a strong foundation for these projects to build on. Only then will we be able to truly improve river health.

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