SALMON & TROUT CONSERVATION

Riverfly Census

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NATIONAL OUTCOMES

POLICY RECOMMENDATIONS

Salmon & Trout Conservation

KEEPING OUR WATERS WILD · EST 1903

Photo: Jack Perks

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FOREWORD

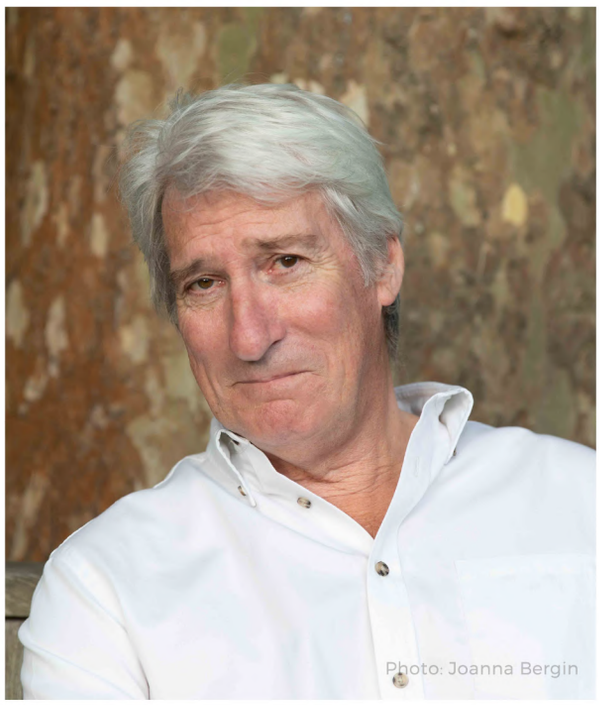


Photo: Joanna Bergin

'It's being so cheerful as keeps me going,' was the catchphrase of the gloom-sodden Mona Lott in the wartime radio comedy, ITMA, and there's a sense that reports like the one you're about to read only ever tell a gloomy tale. So why bother worrying?

The fact is that when Mona Lott and rest of the cast were goofing around in the 1940s , Britain's rivers were in a much better condition than they are today. 'Nonsense!' cry the ignorant. Look at the state of the River Tyne – or even much of the Mersey. They used to be dark and dank and awash with chemicals, oils and even sewage. It's true: they used to be like that and now they're clean enough for trout and salmon. I swam in the Thames – above the London area, of course - recently, and it was delightfully clear. And surprisingly warm.

But the true nick of our rivers is another story. As ITMA audiences knew (the initials stood for 'It's That Man Again', referring to Hitler), you don't worry about the bullet you can see. It's the one you don't see that kills you. There is so much that we're not seeing. Anyone who went on a summer car journey fifty years ago accepted that they'd have to stop at some point to clean smashed insects off of the windscreen. No need to do that nowadays. There are no smudges, because there are no insects.

We've had numerous reports from scientists right across Europe who have investigated what has been called 'Insect Armageddon'. The Riverfly Census is a pioneering report looking at the condition of insects and rivers, in and around which so great a proportion of them live. No-one much cares about it, because creepy crawlies find it harder to make allies than do soft and cuddlies. Ludicrously, even pests like grey squirrels have more friends.

That is why the Riverfly Census matters. The one group of people who consistently know and care about water-borne insects have taken the trouble - over a period of more than 3 years - to discover the facts. The scale of the sample is unprecedented, and the findings are deeply worrying to anyone who cares about England's natural history.

The authors of this report are restrained and responsible. They largely stop short of blaming those who are clearly responsible. But they confirm what has been informed gossip for years among those who spend any time on the rivers. It is time for the speculation and persiflage to stop. This report shows we have a very serious problem on our hands. It is time for some action.

JEREMY PAXMAN

OUR RECOMMENDATIONS

Wild fish numbers are declining and only 14% of our rivers are healthy. Our rivers may no longer be suffering from gross industrial pollution, but now more subtle, deadly pressures are dramatically changing the environments we love. Water quality, particularly in rural areas, is in a perilous state. It is still possible to reverse this decline, but political commitment and action is required now.

The Riverfly Census has highlighted some missing pieces in the puzzle regarding current water management and policies in the UK. Only once all the pieces are in place will we achieve good water quality that supports flourishing river ecosystems, from the smallest invertebrate to the biggest salmon.

Photo: Alan Ward

POLICY STEPS TO ACHIEVE GOOD WATER QUALITY

Further investigations into the biological impact of phosphorus spikes. Without this work, the validation that discharge permits, based on an annual average of monthly samples, are providing for the protection of our rivers is highly questionable.

Chalkstreams should have their own classification targets within WFD.

To establish a standardised approach to monitoring fine sediment in our rivers and set appropriate river-specific standards.

Develop a national programme of species-level monitoring to provide the resolution required to detect pressures such as excess phosphates, sediment and damaging chemicals, and the benchmarking on which to make informed decisions.

To include SPEAR analysis in River Basin Management Planning within WFD, to allow the biological impacts of chemicals to be assessed alongside other pressures, and requirements for additional supplementary chemical monitoring prioritised where necessary.

Ensuring the environmental protection offered by European legislation is transposed into and implemented through UK law, including the creation of Water Protection Zones where existing measures fail to protect water quality and river ecology.

A review of discharge permit guidance to include measures to assess the cumulative and legacy impacts of multiple chemicals within the discharge.

Whilst WFD classification targets are being developed, all chalkstreams should have bespoke invertebrate targets to drive forward improvements.

INTRODUCTION

80% OF SPECIES ON OUR PLANET ARE INVERTEBRATES, THE FOUNDATIONS OF FOOD-WEBS[1]

Freshwater biodiversity is declining at a faster rate than that in terrestrial ecosystems

Since 1970, the Freshwater Living Planet Index[2], showed an 83% decline in the populations of the 880 freshwater species monitored across the globe. This is not a developing world problem; fish, invertebrate and bird populations are declining and disappearing here in the UK too.

Photo: Don Stazicker

In 2015, Salmon & Trout Conservation (S&TC) launched the Riverfly Census to collect high-resolution, scientifically robust data about the state of our rivers and the pressures facing them.

We frequently talk about missing flylife and lack of fish compared to the 'good old days', but anecdotal evidence like this has little weight in environmental decision making.

River insects spend the majority of their lives in the water as nymphs, making them brilliant indicators of river health. Their continuous exposure to water makes examining them much more informative than, for instance, government agency once a month spot chemical samples.

RIVERFLY CENSUS FACT

We have sampled 34,000 organisms from more than 480 macro-invertebrate taxa.

THE CENSUS PROCESS

The Riverfly Census utilises the invertebrate assemblage: presence, absence and abundance of certain invertebrates and the specific set of conditions they need to thrive, to indicate the types of stress our rivers are experiencing. This species-level resolution shows pressures which family-based Water Framework Directive (WFD) methods fail to capture.

The Riverfly Census has spanned 3 years, across 12 rivers in England. Multiple sample sites were carefully selected on each river.

Kick-sweep sampling was completed in spring and autumn to EA accepted guidelines, at all sample sites. Sampling and species-level identification were carried out by professional entomologists at Aquascience Consultancy Ltd.

Species data were inputted to Aquascience's biometric calculator to obtain scores against key stress types- chemical, nutrient, sediment and flow. The data was then evaluated in a whole catchment context to pinpoint the likely suspects contributing to the river's deterioration.

The data was compiled for, and is being reported to, local stakeholders and policy makers, to improve management and conservation of our rivers.

59% OF UK INSECT SPECIES HAVE BEEN LOST SINCE 1970[3]

SPECIES LOSS IN ANY ENVIRONMENT INDICATES ECOSYSTEM DISTRESS

Loss of insects has become an issue of international concern, and globally, aquatic insects are faring the worst, with 33% of species threatened compared to 28% of terrestrial taxa.[4]

Closer to home, over 30 years of monitoring on the River Tywi in Wales revealed that freshwater invertebrates are becoming extinct twice as fast as any other ecosystem.[5]

% OF KNOWN AQUATIC INSECT SPECIES IN DECLINE/ LOCALLY EXTINCT ACCORDING TO IUCN CRITERIA.[4]

- **75%** OF CADDISFLY SPECIES IN DECLINE
- **54%** OF STONEFLY SPECIES IN DECLINE
- **44%** OF DRAGON/ DAMSELFLY SPECIES IN DECLINE
- **40%** OF MAYFLY SPECIES IN DECLINE

RIVERFLY CENSUS FACT

We found a loss in mayfly species of up to 44% in our chalkstreams, compared to 1998.[6]

% LOSS IN MAYFLY SPECIES FROM PAST VALUES COMPARED TO OUR MEAN 2015-2017

		%LOSS
AVON	STRATFORD BRIDGE - 1998	37%[6]
ITCHEN	ITCHEN ST CROSS - 1998	43%[6]
LAMBOURN	WOODSPEEN - 1998	44%[6]
TEST	ROMSEY - 1998	37%[6]
COQUET	FELTON - 1967-1968	45%[7]
EDEN	TEMPLE SOWERBY - 1987	58%[8]

WE ARE BLIND WITHOUT BENCHMARKS

Only with robust, long-term monitoring can we truly understand the changes occurring in our freshwater habitats. The small amount of high-resolution historical data we have found has been invaluable in confirming the problems our waters are facing. Without a reliable 'benchmark,' it is impossible to properly quantify deterioration or recovery.

The Riverfly Census has started to address the lack of widespread, high resolution 'benchmarking' but a lot more work needs to be done.

POLICY RECOMMENDATIONS

Effective management requires species-level benchmarking and monitoring.

- Develop a national programme of species-level monitoring to provide the resolution required to detect pressures such as excess phosphates, sediment and damaging chemicals, and the benchmarking on which to make informed decisions.

OUR KEY FINDINGS

4 OUT OF 5 RIVERS IN ENGLAND AND WALES ARE FAILING THEIR ECOLOGICAL HEALTH TARGETS[9]

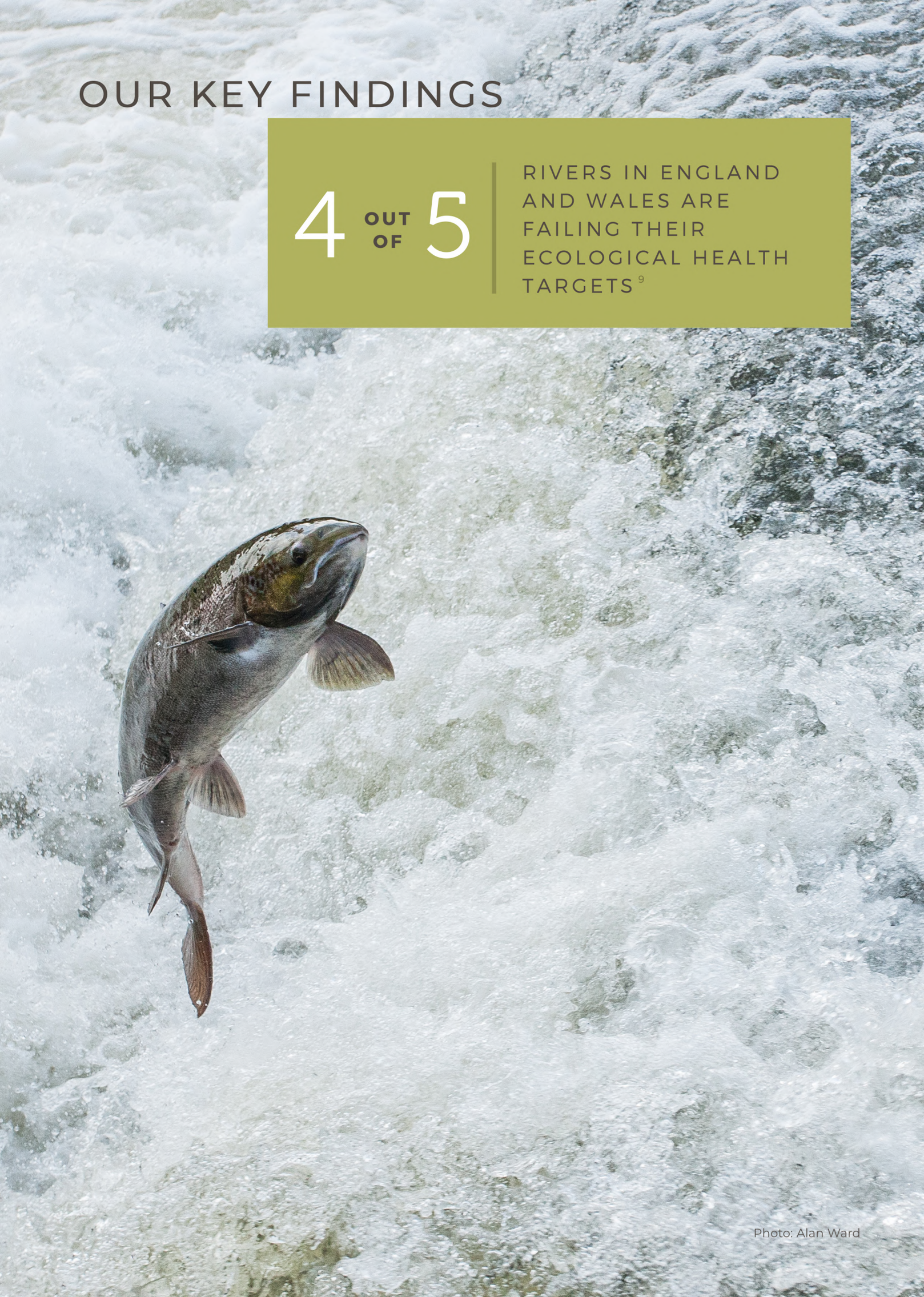
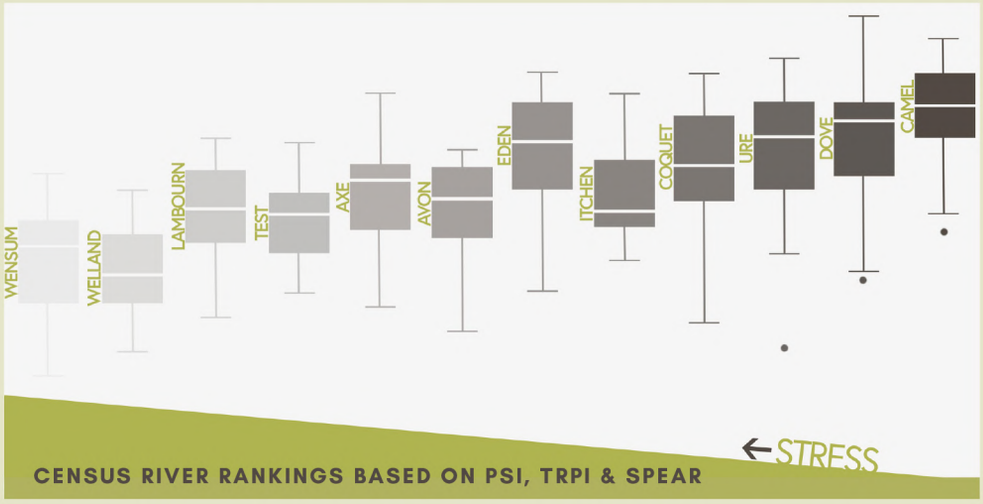


Photo: Alan Ward

CENSUS RIVER RANKINGS

From the 12 rivers sampled across England, we found that the three main pressures impacting these rivers are chemicals, fine sediments and phosphates.



We combined the sediment, nutrient and chemical biometric scores calculated from our species-level invertebrate data and have ranked the Riverfly Census rivers in terms of their water quality. Multi-biometric fingerprinting of species level data has provided a powerful investigative toolkit for determining the spatial and temporal state of our freshwaters.

Overall, the Wensum and Welland ranked the worst for water quality. These rivers differ in their geology (the Wensum is a chalkstream and the Welland is a rain-fed river) but both catchments contain intensive agriculture, predominately arable farming, and water withdrawal. This can impact water quality through run-off of top soil, pesticides and fertilisers.

Water quantity is also essential for good water quality. Reduced flows from excessive water withdrawal and impoundments mean that rivers are less able to shift excess sediments, while pollutants such as pesticides are more concentrated.

The least stressed rivers were the Camel and the Dove. Both rivers still exhibited some pressures, but these were site specific, localised issues and not widespread across the catchments.

The Census also confirmed that biometric scores, particularly nutrient and sediment, tended to match up with the physical appearance and sediment measures of the river beds. Photographs of the Camel showed clear gravels, whereas photographs of the Welland exhibited thick mats of sediment and benthic algae.

Concerningly, WFD classified the Wensum and Welland as 'High' status for phosphorus in 2016, which is the best score a watercourse can achieve. Clearly, by considering the biological scores and the photographs of these riverbeds covered in benthic algae, this classification is questionable. The upper Wensum also scored 'High' for invertebrates, despite the fact that, on some occasions, our survey revealed mayfly species diversity to be only 20% of expected levels. A healthy chalkstream should support over 10 mayfly species, however some Wensum sites had only two.

85% OF ALL THE CHALK STREAMS IN THE WORLD ARE FOUND IN ENGLAND[10]

CHALKSTREAMS: WATER FRAMEWORK DIRECTIVE'S WEAK SPOT

Chalkstreams are England's rainforests; they are ecologically important and rare. The Riverfly Census has also confirmed that chalkstreams are biologically distinct, exhibiting different dominant groups of invertebrate communities compared to non-chalk rivers. They are also under severe pressure. Their current management, in terms of generalised WFD targets, is not achieving healthy chalk rivers.

Bespoke species targets can be used to drive river improvements. In 2017, a minimum target of ≥500 *Gammarus pulex* in autumn and 10 mayfly species for the Test and Itchen, respectively, was agreed by S&TC and the local Environment Agency, for the middle to lower reaches. These targets were based on a combination of historical records and our data, and a recognition that WFD 'good' is not good enough for these chalk rivers.

CENSUS RIVER 'SIMILARITY' ANALYSIS* BASED ON INVERTEBRATE SPECIES PRESENT

*Distance between the names represents how similar the river's invertebrate communities are

DOMINANT INVERTEBRATE ASSEMBLAGES IN THE CENSUS RIVER CLUSTERS

NOT CHALK		CHALK
GROUP 1	GROUP 2	GROUP 3
Baetis (Mayfly)	Potamopyrgus (Snail)	Gammarus (Freshwater Shrimp)
Hydropsyche (Caddisfly)	Gammarus (Freshwater Shrimp)	Baetis (Mayfly)
Simulium (Blackfly)	Hydropsyche (Caddisfly)	Simulium (Blackfly)
Orthocladiinae (Midge)	Simulium (Blackfly)	Agapetus (Caddisfly)
Gammarus (Freshwater Shrimp)	Dytiscidae (Beetle)	Dytiscidae (Beetle)

The Wensum and Welland rivers, which are chalk and non-chalk respectively, also came out of our analysis as a distinct group. The grouping was the result of a high abundance of tolerant snails and midges, confirming the rivers' degraded habitats.

POLICY RECOMMENDATIONS

WFD targets are not appropriate for the management of chalkstreams.

- Chalkstreams should have their own classification targets within WFD.
- In the interim, all chalkstreams should have bespoke invertebrate targets to drive forward improvements.

MAIN PRESSURES: CHEMICALS

MORE THAN

300,000

REGULATED CHEMICALS ARE CURRENTLY IN USE. OUR RIVERS ARE ONLY CHECKED FOR **45** OF THESE[11]

Chemical pollution is a major cause of degradation and biodiversity loss in aquatic ecosystems, yet it remains poorly understood and often considered too difficult to deal with. Rivers are net receivers of many different types of chemicals from a variety of origins, from pesticides in agriculture to antidepressants in wastewater effluent.

Current EA monitoring only covers a tiny fraction of the chemicals entering our waterways, and extensively ignores the 'cocktail' mixture effects to which fish and invertebrates are subjected.

Photo: Jack Perks

RIVERFLY CENSUS FACT

Overall, our analysis revealed that 46% of our autumn samples failed the proposed WFD standard for chemicals.[12]

We ran our species data through the indicator SPEAR (SPEcies At Risk), which uses invertebrate trait information to identify chemical pressure and ecological effects in rivers.

Riverfly Census data indicated the River Wensum had alarming SPEAR results, consistently failing the proposed WFD SPEAR target over the three-year study period. The WFD Watch List chemical monitoring on the Wensum indicated concentrations of three neonicotinoids, a nonsteroidal anti-inflammatory drug and an antibiotic. Despite all these chemicals being within their Environmental Quality Standards (EQS) in 2016, the invertebrate communities exhibited a consistent chemical pressure in the upper catchment from 2015 to 2017. This could suggest the cumulative effect of the chemicals was impacting the invertebrates. The EA's monitoring does not consider cumulative effects of chemicals at a point in time nor does it consider the impact of a build-up of these chemicals in the environment over time.

This case study on the Wensum demonstrates biologically that there are clear chemical pressures that are being overlooked by the existing monitoring regime. Running SPEAR analysis on all invertebrate data is a very easy and cheap process, would help fill this gap and allow targeted chemical monitoring to take place where an issue was highlighted.

SPEAR

SPEcies At Risk:

A measure to assess the impact of exposure to chemical toxicants on the invertebrate community

CENSUS IN ACTION

Concerns with low *Gammarus* numbers and species richness in our Riverfly Census monitoring of the upper Itchen led us to conduct supplementary invertebrate sampling directly downstream of the Bakkavor salad washing plant and the Watercress Company cress farm near Alresford.

The SPEAR results at this site suggested there was a chemical input entering the river from one or both of these sources, which subsequent chemical monitoring has confirmed.

This has led to:

- Bakkavor replacing the overnight chlorine-based cleaning products with alternatives [Note the replacement chemicals are still being discharged to the river rather than the sewage system].
- EA conducting extensive pesticide monitoring in the Watercress Company's discharge, where the presence of multiple potentially toxic compounds were found. The concentrations were again below EQS standards, but this again raises the question as to whether the cumulative impact and legacy effect of these chemicals is impacting the river's ecology.

This is ongoing, but an example of how we will use scientifically sound evidence to drive action.

POLICY RECOMMENDATIONS

- A review of discharge permit guidance to include measures to assess the cumulative and legacy impacts of multiple chemicals within the discharge.
- To include SPEAR analysis in River Basin Management Planning within WFD, to allow the biological impacts of chemicals to be assessed alongside other pressures, and requirements for additional supplementary chemical monitoring prioritised where necessary.

MAIN PRESSURES: FINE SEDIMENTS

SOIL IS BEING LOST FROM LAND

10 times FASTER

THAN THE RATE IT IS BEING CREATED[13]

Sediment loss from the land to rivers is a natural process. However, excess fine sediments can have severe impacts. Too much sediment can choke wildlife, change habitats by reducing light and increasing turbidity, and exacerbating concentrations of toxic compounds which become bound to it. The agricultural and land management sector accounts for approximately 75% of the sediment load entering watercourses in England.[14]

Current WFD monitoring does not include a sediment target.

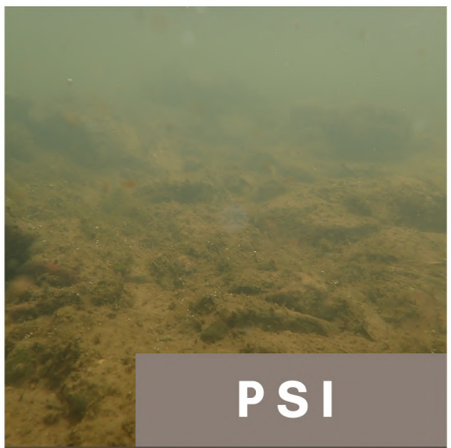
RIVERFLY CENSUS FACT

58% of our census rivers indicated concerning pressure from sediment at three or more of their sampled sites.

The value of river bed photos. Using river bed photos taken at our sample sites to access the percentage observed sediment, there was a strong correlation between the PSI biometric scores and the appearance of the river beds - as the percentage of observed sediment increased, so did the biological stress. There is currently no monitoring standard for deposited sediment in our rivers, so a simple approach like photography may be invaluable in our progress towards achieving this - if a river looks sedimented, it is probably ecologically damaged.

It is not just the extent of sediment coverage that is detrimental to river ecology; the compaction and depth of the sediment layer is also a concern. The more solid the compaction, the less oxygen is able to access the gaps between gravels, which is especially problematic for benthic invertebrates that use these gravel spaces as refuges, and for salmonid eggs that need to obtain oxygen through their membranes to survive.

We are keen to see some trials developed in conjunction with the Environment Agency to start testing and standardising some of these approaches to sediment monitoring.



PSI

Proportion of Sediment-sensitive Invertebrates:

A measure of stress caused by excess fine sediment on the invertebrate community.

CENSUS IN ACTION

The rivers Wensum and Welland indicated the greatest biological pressure from sediment in the Riverfly Census. Both catchments are dominated by arable farming (approx. 65% and 80% respectively), as well as some livestock farming. These rivers have both experienced heavy modifications, altering flows and reducing their ability to shift excess fine sediment inputs. They are also prone to eutrophication (these two rivers also indicated the greatest phosphorus pressure) and proliferation of blanket weed growth can trap sediment and facilitate build up.

The key difference between the Wensum and Welland and the less sediment-impacted Census rivers (the Camel and Ure) was the high coverage of arable farming, often right up to the river's edge. Harvesting of crops and ploughing of the land leaves soil bare at key times and at high risk of washing off during rain events. This could be easily avoided by implementing water-friendly farming techniques such as cover crops, buffer strips, and where feasible, zero tillage.

Business as usual in managing sediment inputs to rivers is no longer an option.

We strongly support incentives for land managers to protect our rivers, but where these fail, effective enforcement must be properly resourced.

POLICY RECOMMENDATIONS

- To establish a standardised approach to monitoring fine sediment in our rivers and set appropriate river-specific standards.
- Ensuring the environmental protection offered by European legislation is transposed into and implemented through UK law, including the creation of Water Protection Zones where existing measures fail to protect water quality and river ecology.

MAIN PRESSURES: PHOSPHORUS

45% OF RIVERS IN ENGLAND EXCEED THEIR PHOSPHORUS STANDARD[15]

Phosphorus in freshwater is a major concern globally; it can cause algal blooms and eutrophication which deplete oxygen. This increases mortality of invertebrate and fish eggs. Agriculture accounts for over 25% of phosphorus loading to the water environment, with 8,391 tonnes of phosphorus being lost from fields annually in England.[16] However, the greatest source of in-river phosphorus in the UK (up to 70%) is waste water discharge from sewage works.[17]

Currently, the EA only routinely monitor phosphorus in the water column. Other forms of phosphorus such as those bound to sediments, are not monitored.

Photo: Jack Perks

RIVERFLY CENSUS FACT

100% of the chalkstreams we sampled exhibited concerning nutrient stress at one or more sites.

At many of our sample sites located downstream of major sewage works, the invertebrate communities exhibited nutrient stress (using the biometric TRPI) compared to upstream sites. Even on the Camel, our highest scoring river for water quality, we found elevated nutrient signatures downstream of where the two wastewater treatment plants that receive the majority of the catchment's sewage, operate. Population growth is projected to be significant in the areas these two sewage works cover. But the Camel is not alone; all over England, rapid urban expansion is taking place.

Many of the sewage works that discharge to our rivers, particularly those in rural areas, are not equipped to deal with such growth. There are also a vast array of homes using private sewerage. Where these private systems are not maintained correctly, excess nutrients can find their way into watercourses. As rules around private sewerage are advisory and there is a lack of governance, their contribution to phosphorus in our rivers remains largely a mystery.

It is essential that we begin to grasp the contribution private sewerage is making and that suitable infrastructure is put in place to protect watercourses from excessive phosphorus loading.

TRPI

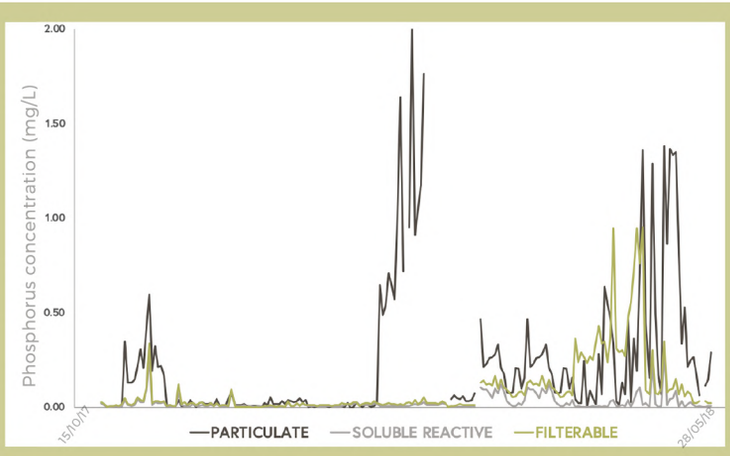
Total Reactive Phosphorus Index

A relatively new metric developed to indicate nutrient pressure on the invertebrate community.

CENSUS IN ACTION

According to EA figures, concentrations of biologically available phosphorus, also known as orthophosphate, have decreased in the River Itchen since the 1970's. Despite this, the invertebrate communities in the Census are still exhibiting nutrient stress and there is an abundance of filamentous algal growth. So, why is the ecology still suffering?

We conducted daily water quality sampling and investigated the concentrations of different forms of phosphorus (see graph on right).



We have found:

- Large spikes in concentrations of SRP that lasted 24 hours or more, which are overlooked when monthly averages are calculated by the EA, who use monthly spot samples to create an annual average which sets the accepted standard. The impact of these short-term spikes is still not known, but laboratory research has shown that extended exposure to phosphorus will kill mayfly eggs.
- Large quantities of other forms of phosphorus, such as particulate, which are not measured in current government agency monitoring.

This suggests we are only dealing with part of the phosphorus problem, and raises the question as to what impact these other forms may be having on riverine ecology.

POLICY RECOMMENDATIONS

- Further investigations into the biological impact of phosphorus spikes. Without this work, the validation that discharge permits, based on an annual average of monthly samples, are providing for the environmental protection for our rivers is highly questionable.

NEXT STEPS: SMARTRIVERS

The Riverfly Census was just the beginning.

SmartRivers is taking the Census methodology national by training volunteers to sample and analyse river invertebrates to species-level.

MONITORING WITH A MEANING

Our Riverfly Census data has highlighted the subtle but lethal pressures facing these rivers from phosphate, sediment, abstraction and pesticides. But we need help to extend species-level invertebrate analysis to many more rivers.

SmartRivers will enable volunteers, supported by a national training scheme, training videos, an invertebrate-identification App and support programmes, to monitor the water quality in their rivers to a near-professional standard. Volunteer sampling is underpinned by the collection of an initial solid scientific benchmark by a professional sampler, which adds confidence to detecting improvement or deterioration in water quality.

SmartRivers compliments existing Riverfly Partnership monitoring but provides more information. The data is directly comparable with the Environment Agency's own monitoring and actually pinpoints pressures a river may be experiencing. This helps to focus management efforts for the best results - conserving time and money. The high-resolution nature of the data also means that S&TC is able to work with the Environment Agency and others to address the causes of poor water quality and drive forward positive change.

THE SMARTRIVERS PROCESS

SAMPLE

We will take spring and autumn benchmarks to provide a baseline and understand which invertebrates are in your river.

We will also train you to sample at your sites using the Environment Agency's 3-minute kick-sweep protocol and preserve the sample in alcohol, so you can take your own samples in future years.

ANALYSE

Record and analyse the samples to species level, following the training we provide and using the SmartRivers App.

If you do not want to analyse your samples, we can help organise for them to be sent to a professional entomologist to do it for you (at a modest cost).

REPORT

Send your raw data to us to derive a detailed invertebrate analysis of water quality at your sites. The analysis indicates the impact of: organic pollution, nutrient enrichment, sediment, river flow and chemicals.

Your data is stored in our open-access database for you, and all those working to improve our rivers, to use.

ACT

You will have the ability to use the data to work with S&TC to drive improvements in water quality in your river.

For example, you can use the data to assist in river management and assess river restoration projects.

And we can use the data to work with the EA and others to address the causes of poor water quality.

TO TAKE PART IN SMARTRIVERS GET IN TOUCH!

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