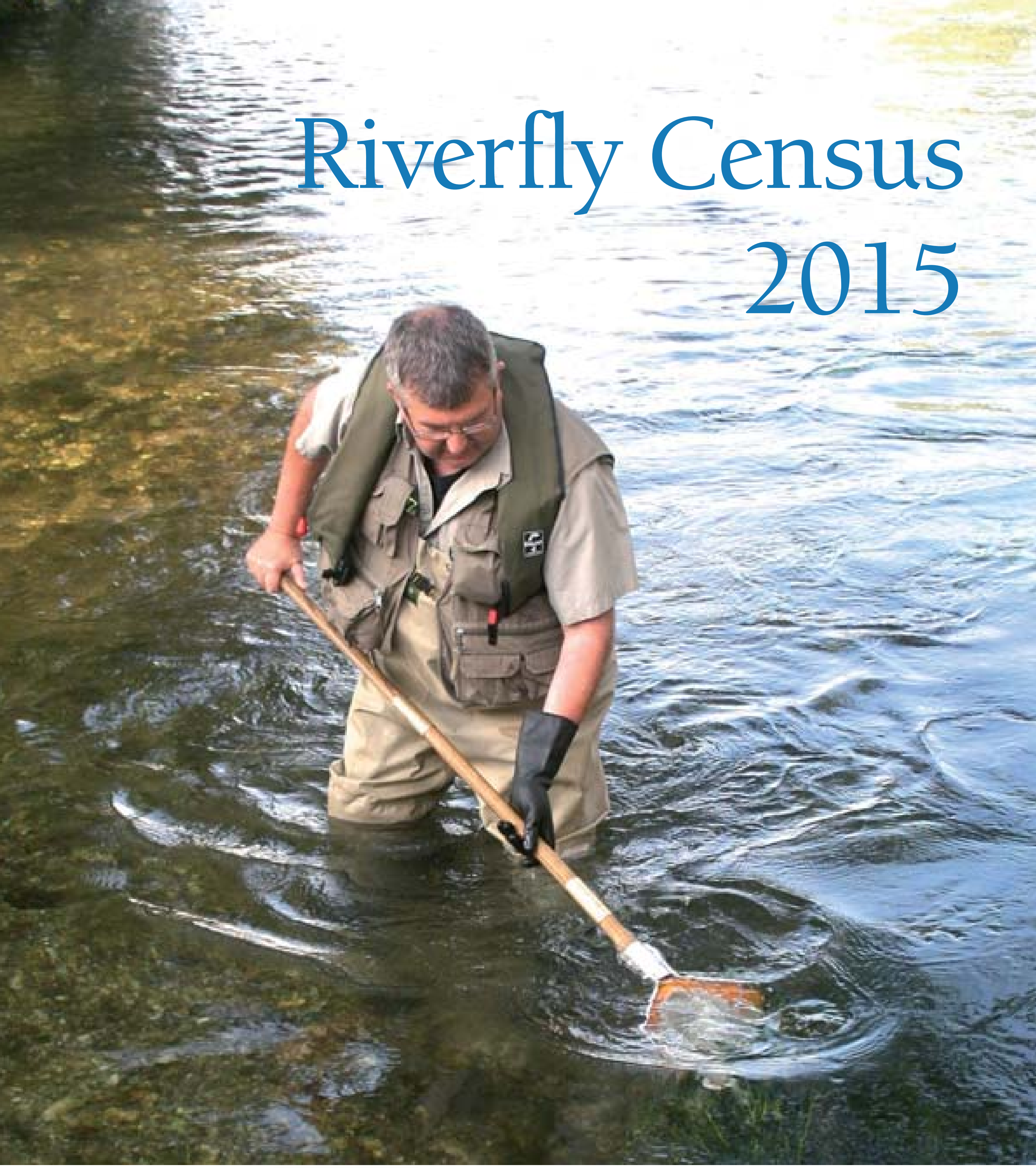
Riverfly Census 2015



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Front cover picture: Kick-sweep sampling for invertebrates.

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Foreword

The other day I was talking to a well-known politician. “You know,” he said, “we’re always talking about problems. But so many things are much better than they were. Just look at how clean our rivers are.”

It’s an easy enough observation to make: plenty of them do look much better – and I speak as someone who enjoys swimming in the Thames. But appearances can be deceptive. Cleaner does not necessarily mean healthier.

A few hours with any fishing book written a century ago is depressing enough. All that talk of the riverbank air being heavy with flies. Anyone old enough to recall wiping splattered insects from car windscreens in the Sixties will have a similar sense of loss. ‘Où sont les mouches d’antan?’ as the French medieval ballad might have put it.

“...appearances can be deceptive. Cleaner does not necessarily mean healthier.”

Something has gone very wrong and those of us who care about it are an eccentric minority. Yet experience tells us that almost everything in nature is connected. A decline in fly life on rivers will have consequences.

The only way we will enlist any popular support – and the possibility that someone might care enough to realise the risk we face – is to gather evidence. That is why the Riverfly Census matters.

Jeremy Paxman

Blue-winged Olive female dun (Serratella ignita). © *Stuart Crofts*

February Red female (Taeniopteryx nebulosa). *© Stuart Crofts*

The S&TC UK 2015 Riverfly Census summary

This report presents the results of our first England-wide Riverfly Census. Riverflies matter: they and other invertebrates are excellent indicators of water quality, in that they spend most, sometimes all, of their life in water; and they are vital base components of the aquatic food chain. They are leading indicators of ecological distress. Our aims for the Census are: to use the Riverfly data to provide a biological picture of the water quality within the target rivers from which we could gauge their ecological health; highlight any problems they might be facing; and take a first step towards identifying solutions to those problems.

We collected invertebrate samples from five sites in each of our 12 rivers in both spring and autumn 2015 – some 120 samples in total. The samples were analysed down to species level by professional freshwater biologists at Aquascience Consultancy Limited. They used cutting-edge biometric techniques to produce detailed ecological information for each site. This species-level approach is a much more powerful tool than traditional family-level analysis to highlight the pollution threats to our rivers.

- We found only 14 pristine, unimpacted sites out of a total of 120 sites sampled across spring and autumn. Some sites were unimpacted in both spring and autumn but most were not. The rest were suffering at least some impact from any or all of four common forms of stress:
    - Organic enrichment.
    - Nutrient (phosphate) enrichment.
    - Sediment.
    - Inadequate flow velocity.
- In particular, riverfly richness (number of species) and abundance (total numbers) have been particularly impacted where phosphate enrichment and sedimentation are working in combination.
- Three of our most highly protected chalkstreams, the Itchen, the Lambourn and the Wensum — all of which are designated Special Areas of Conservation (SAC) under the European Union's Habitats' Directive — rank poorly in our Census as does the River Test — a Site of Special Scientific Interest (SSSI) under the UK's Wildlife and Countryside Act, 1981. In many reaches of these rivers, flylife richness and abundance were both well below what might be expected for a chalkstream in reasonable, let alone good, condition.

"We found only 14 pristine, unimpacted sites out of a total of 120..."

Many significant species were impoverished in our samples and rarer (but expected) species were absent.

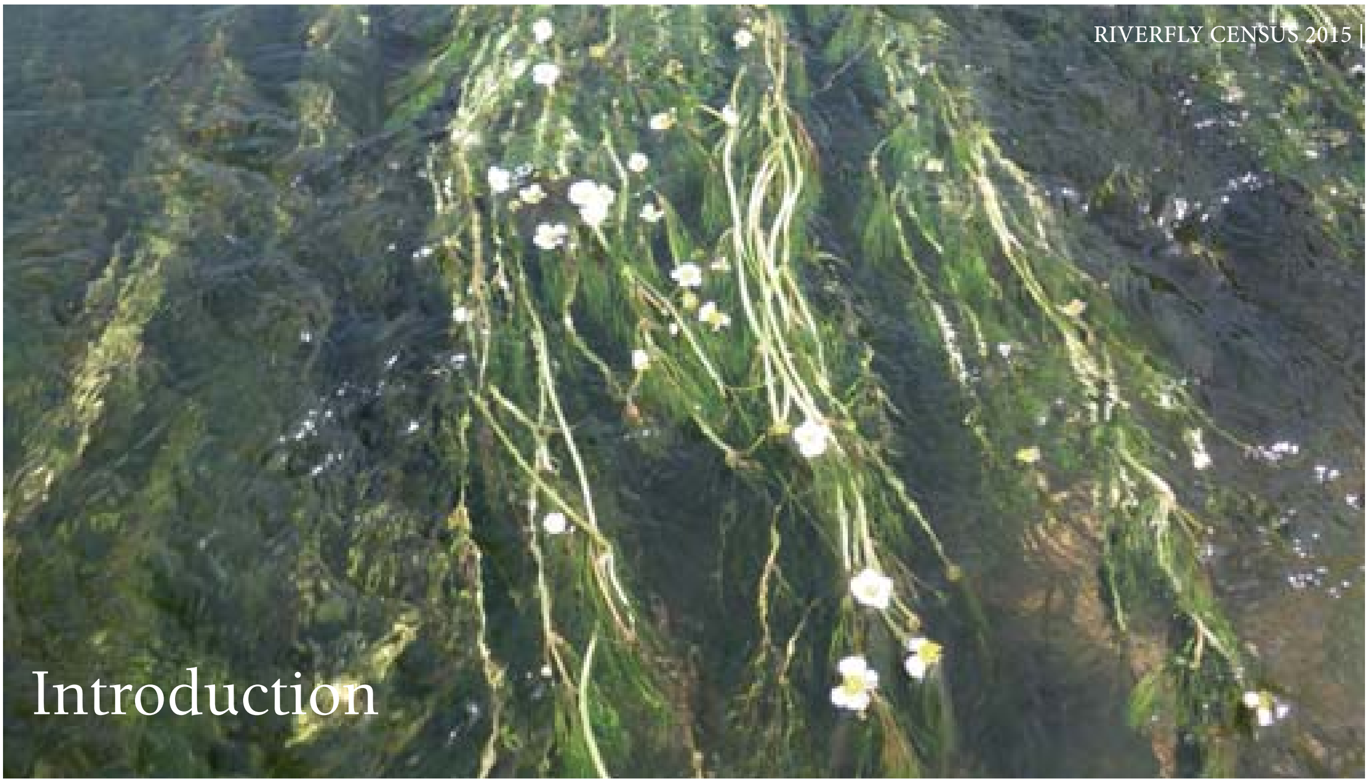
- Freshwater shrimp *(Gammarus pulex)*, a stable chalkstream taxon and an important element of the food chain for trout and salmon parr across many English rivers, recorded very low numbers relative to historic levels. Environment Agency (EA) records, where available, showed reaches with a long and sometimes marked decline in *Gammarus* abundance.
- The Water Framework Directive (WFD) measure of water quality struggles to capture the often-combined impact that nutrients, sediment and organic enrichment are having on the invertebrate life in our rivers. This seems especially true of the chalkstreams, but also of some freestone rivers across the country.

The next steps:

Our fundamental approach is to act on the Census results to tackle our rivers' problems. We have a five-point plan of action involving working with the EA, but also challenging them where necessary, especially over the urgent need to identify and regulate polluters.

- We will use chemical sampling to zero in on the causes of water quality problems. This work is well advanced on the Upper Itchen, where we have already been influential in imposing new phosphate (P) limits on watercress farmers, but much more remains to be done elsewhere to stop the rot in so many of our rivers.
- We are researching how P and sediment is harming the early life-stages of aquatic invertebrates, using blue-winged olives as our research species, a once-common fly which is now in almost universal decline.
- We will work with the EA to seek ways to take full account of the impact of P and sediment, in particular in the official ecological classification of rivers.
- We will challenge the Government and its agencies to tackle the sources of these and other stressors on our river systems.
- Finally, we will be repeating our Census of the 12 rivers in 2016 and 2017. We are looking for increased funding to extend the range of rivers and the life of the survey.

We believe this work is critical to understanding the true state of the water quality within our rivers and to gauge accurately the impact that poor water quality has on a river's ecology. Only then can we identify the most cost effective measures to restore degraded watercourses to anything like pristine condition.



Introduction

There have been great strides in recent decades to improve our once chronically polluted rivers such as the Mersey, the Thames, the Trent and the Tyne. The Government claims that our rivers have never been cleaner, but this assertion misses the point that 83% (2015 EA classification) of our rivers are failing to meet the standard of good ecological condition measured against the Water Framework Directive (WFD), which we do not consider to be particularly demanding.

The threat to our rivers has moved on from industrial pollution to a range of subtler ecological impacts on water quality such as nutrient enrichment, organic enrichment, sedimentation and flow. Although these forms of stress are less dramatic than fish-killing chemical spills, the long-term effects are equally profound. We have set up the Riverfly Census to build a database of evidence from which measures can be identified to tackle what we consider to be this water quality rot in many river systems.

Two factors led to the genesis of the project:

- Our phosphate (P) work on the Upper Itchen — one of the most highly-protected chalkstreams in England, which has some 80% of the World supply of these ecological gems. Our work on seeking to tackle excess P in the Upper Itchen, suggested that there were more problems with the river's ecology than a surfeit of P, bad though that is. Furthermore, as was the case with our own P monitoring, we feared that the EA's broad-brush approach might fail to detect these problems. And, if this were true of the Itchen — protected as a SAC under the Habitats Directive and one of the 17% of English water bodies achieving good ecological status under the WFD — how many other rivers, some of which are also classified as 'good' are failing to deliver the ecological conditions expected of them?
- A widespread concern amongst our members and others over the dramatic decline in riverflies right across the country. Historic angling literature refers to fly hatches that, sadly, are now a distant memory on many rivers, leading to comments such as, "When did you last see a prolific Iron Blue hatch or a Blue-winged Olive spinner fall?" These fishing memories are also supported by factual evidence (Frake and Hayes, 2011).

It appeared critical to us to quantify the situation. We want to persuade the EA and Natural England (NE) that the true state of water quality in our rivers is not being officially recognised. We need to stress that aquatic ecology is being dangerously impacted in many watercourses, including rivers classified as good under WFD objectives and also those which have the highest levels of environmental protection. Our message is that action, not talk, is now urgently needed. Thus, in early 2015, the S&TC UK Riverfly Census was born.

Nick Measham
Freshwater Campaigns Consultant

Why survey riverflies?

Southern Iron Blue nymph (Baetis niger). © Cyril Bennett

- Riverflies and other invertebrates are excellent indicators of the underlying ecological condition of our rivers. They live in water in their larval state for many months, years or, sometimes, entire life-cycles, and, thus, provide a continuous record of water quality. Different species of invertebrates demonstrate different tolerances to the various forms of ecological stress, and so they are often amongst the most sensitive aquatic species to pollutant stresses.
- Invertebrates are vital base components of the aquatic food chain on which fish, birds and mammals depend.

Thus, understanding how and why riverfly species and numbers are declining is a first step in the process of identifying measures to counter poor water quality and safeguard the aquatic environment into the future.

‘*Whether it is a rainforest, tundra, coral reef or wetlands like a river, a stream or a lake... reduced species richness is the most consistent indicator of ecosystem distress. It is one of those refreshing simplifications that natural systems, despite their diversity, respond to stress in very similar ways*’.

Clements, W.H. and Newman, M.C. (2002). *Community Ecotoxicology. Hierarchical Ecotoxicology Series.* John Wiley and Sons Ltd, Hoboken, USA.

The Census process

The 2015 census took samples from five sites on each of 12 rivers across England. We chose 12 rivers to provide a manageable and affordable sample set as a pilot project. The rivers provide a geographically and ecologically diversified sample across a range of conservation protection status — seven rivers are SACs and two are SSSIs.

We sampled the five sites in each river in the spring and autumn 2015 (120 data points) to derive a balanced seasonal invertebrate record.

S&TC UK Riverfly Census Rivers

River	County	Conservation status	Geology
Avon	Wiltshire	SAC, SSSI	Chalkstream
Axe	Devon	SAC, SSSI	Freestone
Camel	Cornwall	SAC, SSSI	Freestone
Coquet	Northumberland	SSSI	Freestone
Dove	Derbyshire	None	Freestone
Eden	Cumbria	SAC, SSSI	Freestone
Itchen	Hampshire	SAC, SSSI	Chalkstream
Lambourn	West Berkshire	SAC, SSSI	Chalkstream
Test	Hampshire	SSSI	Chalkstream
Ure	North Yorkshire	None	Freestone
Welland	Leicestershire/Rutland	None	Freestone
Wensum	Norfolk	SAC, SSSI	Chalkstream

Invertebrates are collected using the three-minute kick sweep sampling method.

The sampling method – three-minute kick-sweep sampling

We used the same three-minute kick-sweep and one-minute hand search sample protocol that the EA employs in its own invertebrate monitoring to aid comparability where relevant. In a three-minute kick-sweep sample, the river is typically sampled for 15 seconds at 12 points at the sample site to provide a habitat proportional range of sub-sample habitats. At each of these 12 points, the sampler stands upstream of a submerged net and gently kicks the riverbed and sweeps through submerged or marginal vegetation using hands or feet. The invertebrates wash into the net. The samples are then taken from the river, with the proportion of live animals recorded in-situ, fixed in alcohol and sent to the laboratory for analysis.

The analysis… performed at species level providing much higher resolution than family-level data

The difference between species and family-level analysis is akin to the resolution of a microscope compared to a magnifying glass. Thus, species-level analysis tells us more about the overall health of a river including the subtle early effects of decay. For example, certain species of riverflies such as the Mayfly *(Ephemera danica)* or the Large Dark Olive *(Baetis rhodani)* are more tolerant of siltation than the Blue-winged Olive *(Serratella ignita)* or Southern Iron Blue *(Baetis niger)*. So merely counting the number of olive nymphs will not tell you much about the impact of siltation. The same is true of other forms of stress.

Our analysis derives 10 measures of the ecological status of each sample site from the site's species-level community fingerprint. There are six 'traditional' measures and four 'biometric' measures.

The six 'traditional numeric measures,' which include species richness (the number of species) and abundance (number,) provide variable measures of ecological condition and broad-brush water quality. These are the Biological Monitoring Working Party (BWMP) score, Average Score Per Taxon (ASPT), Species Richness (R), Ephemeroptera-Plecoptera-Trichoptera (EPT) richness, Community Conservation Index (CCI) and total invertebrate abundance (brief descriptions are provided on page 8).

The four 'biometric' measures provide a fingerprint of the river's ecology in terms of the impact of four measures of environmental stress:

- Nutrient pollution (Total Reactive Phosphorus Index or TRPI).
- Organic pollution (Saprobic Index or SI) from, for example, slurry.
- Sedimentation (Pressure-Sensitive Index or PSI) from, for example, agricultural run-off.
- River flow (Lotic Invertebrate index for Flow Evaluation or LIFE) from, for example, water abstraction.

Different species of aquatic invertebrates have different tolerances to these four stress metrics. So, qualifying (and quantifying) the presence, absence, and numbers of a particular species and then comparing with four stress indices creates a biometric fingerprint of the river sample point. These indices correlate closely with chemical analysis results. For example, the high levels of P detected in our chemical sampling on the Upper Itchen correlate with the biometric results from the same sites.

Thus, from an analysis of the richness and abundance of various species in the samples, the ecological state of the river can be accurately benchmarked.

The 10 biometrics are briefly described thus:

- **BMWP** scores water quality according to the pollution intolerance of invertebrate families. Less-tolerant families score most heavily and the higher the overall score the better the water quality.
- **ASPT** is an average of the BMWP score divided by the number of families making up the score. This gives an index from 0 to 10 and unlike BMWP takes more account of low scores to moderate the index instead of contributing to it.
- **R** is a measure of the number of all the aquatic invertebrate species in a sample. It is a fundamental yardstick of the health of an ecosystem and when combined with abundance a measure of biodiversity.
- **EPT** is the sum of all the riverfly families EPT(F) or species EPT(S) from these three invertebrate orders. It is based on the theory that cleaner streams have greater riverfly family or species richness.
- **PSI** is a biological measure of sedimentation. It is an inverse index; lower scores are worse.
- **SI** is a biological measure of organic enrichment and more extreme organic pollution, correlating with chemical measures of organic pollution such as ammonia or Biological Oxygen Demand (BOD) levels.
- **TRPI** is a biological measure of nutrient phosphorous (Total Reactive Phosphorous) levels. Again, it correlates with chemical bandings for TRP across different river types.
- **LIFE** is a biological measure of river flow velocity.
- **CCI** (Community conservation index) is a measure of the conservation value of the site in terms of the presence or absence of rarer species.
- **Total abundance** is the total aquatic invertebrate count in a three-minute kick sample.

This is a typical reporting table:

Key biometrics for River Itchen at sample Site 1 (SU 56506 31826)

	Biometric value	Interpretation
BMWP	173	RE1 (Good)
ASPT	6.41	RE1 (Good)
R (species richness)	38	Moderate biodiversity
Mayfly-stonefly-caddis EPT (Species)	20	Moderate riverfly richness
*PSI (S)	70.18	Slightly sedimented
**Saprobic index	1.88	Slightly organically enriched
***Total Reactive Phosphorous (TRPI)	72.73	Slightly [P] enriched
****LIFE	8.09	Good flow velocity
*****CCI	11.29	Fairly high conservation value i.e. not Good or Very Good (sites supporting at least one uncommon species, or several species of restricted distribution and/or a community of high taxon richness)
Total invertebrate abundance in no/3 minute kick-sweep	983	Low-moderate abundance for a chalkstream. *Gammarus* < 100/sample

**PSI measures sedimentation; **Saprobic index measures organic enrichment; ***TRPI measures nutrient (P) enrichment; ****LIFE measures flow; *****CCI measures conservation value*

We have also analysed historic EA data where we could obtain it. This has provided us with useful historic trends and comparisons, which we present alongside our Census results.

Aquascience Consultancy Limited (www.aquascienceconsultancy.co.uk) carried out the sampling and the laboratory analysis on our behalf. It was important this work was carried out by an EA accredited organisation such as Aquascience to provide us with high quality data, which could not be ignored.

In Appendices 1 and 2 (page 38) we present our measures of ecological condition together with the WFD classifications. Both measures classify water quality in terms of its departure from a reference state defined as one in which there is no anthropogenic impact. Water quality measurement is complicated but our species-level results suggest that family-level WFD ecological measures do not always capture the true ecological status of our rivers.

The 2015 Riverfly Census results

We present the results in aggregate here and by river in the section on River Results, (page 16). These results are very much work in progress, though we are already forming an action plan. Extending the sampling in to 2016 and 2017 will add greatly to the significance of our findings.

We took our detailed sample results for each river and scored them from one (bad) to five (good) against each of the 10 biometric measures to provide an aggregate 'score'. For example, an unimpacted outcome for TRPI scores 5 while moderate scores 3. See appendix 1 for the lookup table for the scores. The results, ranked out of a maximum of 50 for spring, autumn and an average, are in the table below together with the EA's WFD classification of ecological condition for each river in 2015. The table also includes the average numbers across each river's sampling sites of freshwater shrimp *(Gammarus pulex)*, which is a common invertebrate across all rivers, together with the riverflies (Ephemeroptera, Plecoptera and Trichcoptera), species richness and abundance. These biological measures are real 'canaries' in their sensitivity to the four biometric stresses and to other pollutants such as insecticides. Average total invertebrate abundance is also shown.

Our biometric rankings and the EA's WFD 2015 ecological condition classifications differ. A number of rivers which the EA considers ecologically 'good' fared badly in our Census. We discuss this below.

River ranking 2015

River		Spring ranking score	Autumn ranking score	Average ranking score	*Gammarus* average	Spring riverfly species richness	Riverflies average	Total abundance average	2015 WFD classification
Avon	SAC	39.4	40.2	39.8	2382	20	1102	4250	Good
Dove	SSSI	39.5	39.2	39.4	63	20	361	746	Good/Moderate
Camel	SAC	41.4	37.2	39.3	491	20	307	963	Good
Ure		41.0	35.0	38.0	2	21	282	553	Good/Moderate
Axe	SAC	40.0	35.4	37.7	17	20	400	809	Good
Eden	SAC	38.7	36.0	37.3	79	17	335	797	Good
Coquet	SSSI	38.2	34.6	36.4	21	19	448	899	Good
Itchen	SAC	38.0	34.8	36.4	144	19	264	708	Good
Test	SSSI	35.4	34.2	34.8	162	16	314	803	Good/Moderate
Lambourn	SAC	38.0	31.3	34.6	536	15	273	933	Moderate
Welland		33.2	34.0	33.6	4	14	271	689	Moderate
Wensum	SAC	33.2	33.4	33.3	205	12	127	701	Moderate

Conclusions and observations...

We make a number of comments on the back of the Census results. We address separately the important point that WFD measures – based in part on family-level analysis – do not give a full picture of water quality.

- We found only 14 pristine, un-impacted sites out of a total of 120 sampled. Some but not all of the pristine sites were pristine in spring and autumn. The rest were suffering at least some impact from any or all of four forms of stress: organic enrichment, nutrient (P) enrichment, sediment and impaired flow velocity. See the Results by River section (page 16) for details.
- The results showed incremental loss of overall invertebrate species richness and abundance as the biological signatures for sediment, organic and nutrient stress increased. Biological signatures for flow velocity do not correlate strongly with overall invertebrate loss or gain, but tracked the trends observed with the other biological signatures.
- There was evidence that **small but combined** increases in sediment, organic, nutrient and to a lesser extent flow velocity (which is linked with sedimentation), correlated with incremental loss of both riverfly species richness and abundance. For example, the Blue-Winged Olive appears

very susceptible to the combined impact of P and sediment.

- Three of our most highly protected SAC chalkstreams, the Itchen, the Lambourn and the Wensum, rank poorly in our sample, with worryingly low riverfly richness and abundance. In most reaches of these rivers, together with the SSSI-listed River Test, flylife is **at least** an order of magnitude below any reasonable measure of abundance, with many significant species impoverished and rarer species absent. The results are no respecter of the rivers' environmental status.

- Freshwater shrimp *(Gammarus pulex)*, a stable chalkstream taxon and an important element of the food chain for trout and salmon, recorded very low numbers relative to historic levels. Environment Agency (EA) records, where available, **often show a long and sometimes marked decline in *Gammarus* abundance.**

- S&TC P sample data for the Itchen match strongly with the biometrics. Many of these macroinvertebrate biological measures of riverine ecological condition were developed from, and have direct association with concomitant chemical band levels e.g. ammonia, BOD and Dissolved Oxygen levels for Saprobic indexes and total reactive phosphorous (TRP) with the TRP Index.

- These findings are firmly in line with a growing body of evidence in this relatively new area of more intensive aquatic species level benchmarking and investigation within UK rivers. In these studies, the loss of highly sensitive stonefly and caddis species were recorded with relatively small increases in mean watercourse BOD levels and gains in species richness were predicted for the same scale of BOD reductions (Clews and Ormerod, 2009, Durance and Ormerod, 2009, Everall, 2010 and 2012).

Silver Sedge larvae (Odontocerum albicorne). © *Stuart Crofts*

- It is the pristine river reaches that hold the key to protecting and enhancing the poorer reaches of our rivers. For example, there are two reasons why the ecological condition and environmental stress markers for the middle-upper Avon are so much better than those for concomitant reaches of the River Test and the River Itchen: first, there is less anthropogenic pressure overall; and second, any pressures are better controlled through tightly regulated sewage works discharges, septic tank incursions, agricultural practices and ameliorated by in-stream rehabilitation or improvement work.

The fundamental conclusion is the better the water quality measured by our biometrics, the better the invertebrate richness and abundance.

Good is not always good

We are concerned that the WFD ecological measure of water quality, which uses family not species-level invertebrate analysis, struggles to capture **the subtle, often-combined** impact that nutrients, sediment, organic enrichment and flow are having on rivers' flylife. In other words, a WFD classification of 'good' is not indicating good ecological conditions as measured by our Census. This seems especially true for the chalkstreams but is also true for some freestone rivers across the country.

The Upper Itchen is a case in point. It is classified as good ecological status in the 2015 River Basin Management Plans issued by the Department for Environment, Food & Rural Affairs (Defra) in February 2016. Our biometrics and WFD ecological measures (see Appendix 2) both rank sites in terms of the degree of departure from a state of nature unimpacted by anthropogenic pressures. 'Good' is defined by WFD as 'only a slight departure from the biological community which would be expected in conditions of minimal anthropogenic impact'. However, our results for the Itchen (page 18) show elevated signatures for P and sediment combined with a marked decline in species richness and abundance. This decline is much greater than what might be expected under the WFD's 'good' definition of only a 'slight deviation from natural conditions'.

As a result of our work on the Upper Itchen, the EA now acknowledges that there is an order of magnitude difference in *Gammarus pulex* numbers on the Upper Itchen from what might be expected for a good chalkstream.

We are already working with the EA to try to define a more meaningful definition of 'good' in relation to the Itchen and other chalkstreams.

Historic trend analysis

Historic riverfly data is immensely valuable in giving a record of change. We have analysed historic trends for a number of our rivers using EA data where we have been able to access it. This is work in progress as we build up our inventory of historic data. We are somewhat hampered in this because, until recently, the EA analysed mostly to family level. The EA has now adopted species level analysis nationally, which will help greatly in the future.

Our historic data is chalkstream centric for the simple reason this is where we have data currently. We hope to expand this trend analysis to freestone rivers in this year's Census.

Historic biometric trends

The biometric analysis of historic samples by Aquascience Consultancy Limited produced a mixed picture of improving, stable and declining river reaches. Figure 1 for the River Test at Broadlands, based on EA data, shows an increasing biological signature for sedimentation (PSI in yellow) over a 40-year period. PSI is an inverse index so lower is worse.

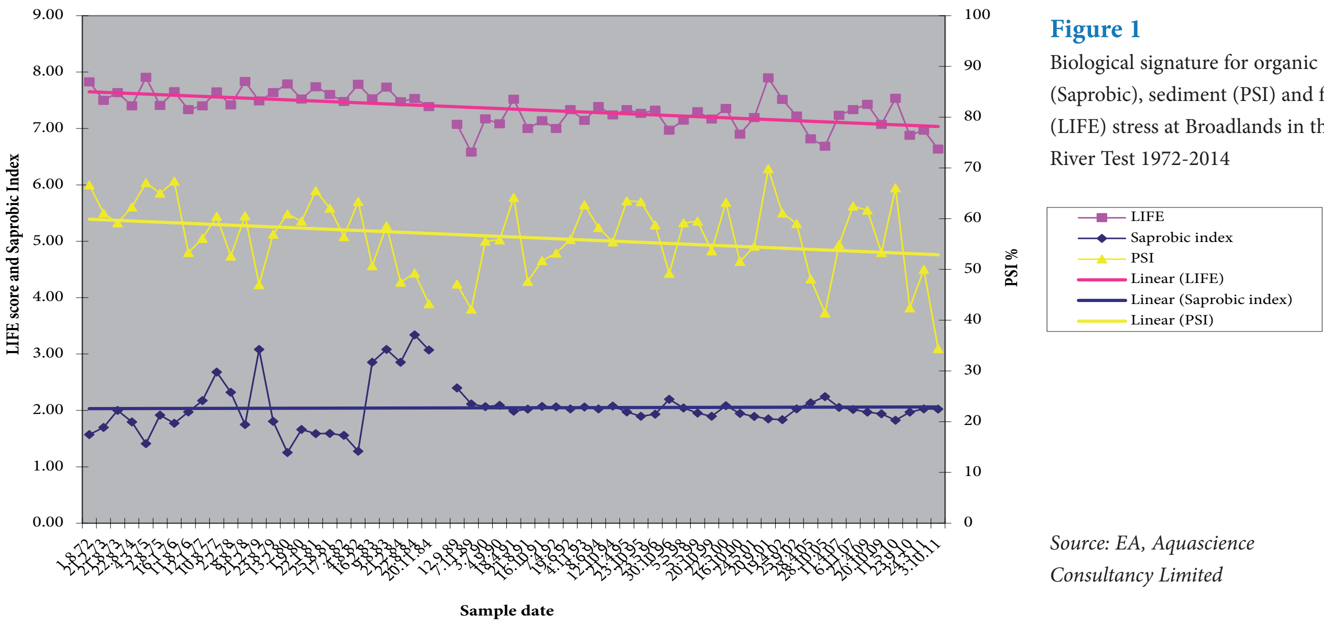


Figure 1

Biological signature for organic (Saprobic), sediment (PSI) and flow (LIFE) stress at Broadlands in the River Test 1972-2014

Source: EA, Aquascience Consultancy Limited

Figure 2 for the Itchen shows a long-term worsening trend for total reactive phosphorous in the autumn, which mirrored the chemical levels from continuous monitoring studies by the University of Portsmouth for S&TC. The results of these chemical studies showed P levels far in excess of acceptable chalkstream thresholds.

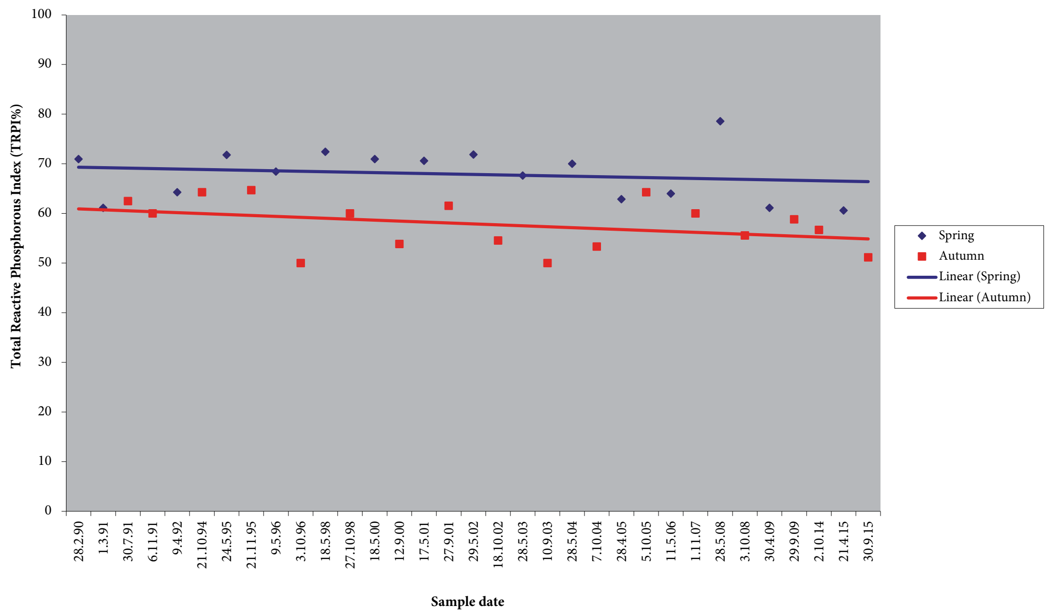


Figure 2

Biological signature for nutrient P stress at Itchen Abbas in the River Itchen 1990-2015

Un-impacted

Slightly impacted

Moderately impacted

Impacted

Heavily impacted

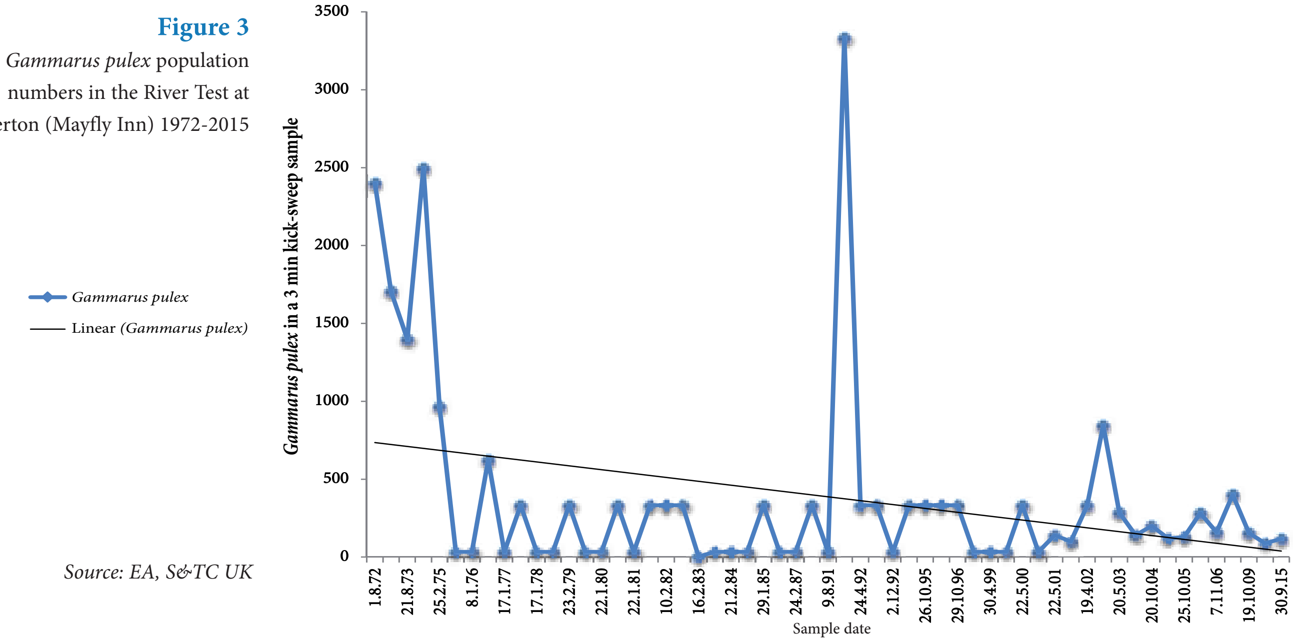
Source: EA, Aquascience Consultancy Limited

Historic species trends

There are some disturbing downward trends in freshwater shrimp *(Gammarus pulex)*, which is regarded as a stable taxon for chalkstreams and a very important component of the food chain. We show a selection of charts here from the Test and Itchen.

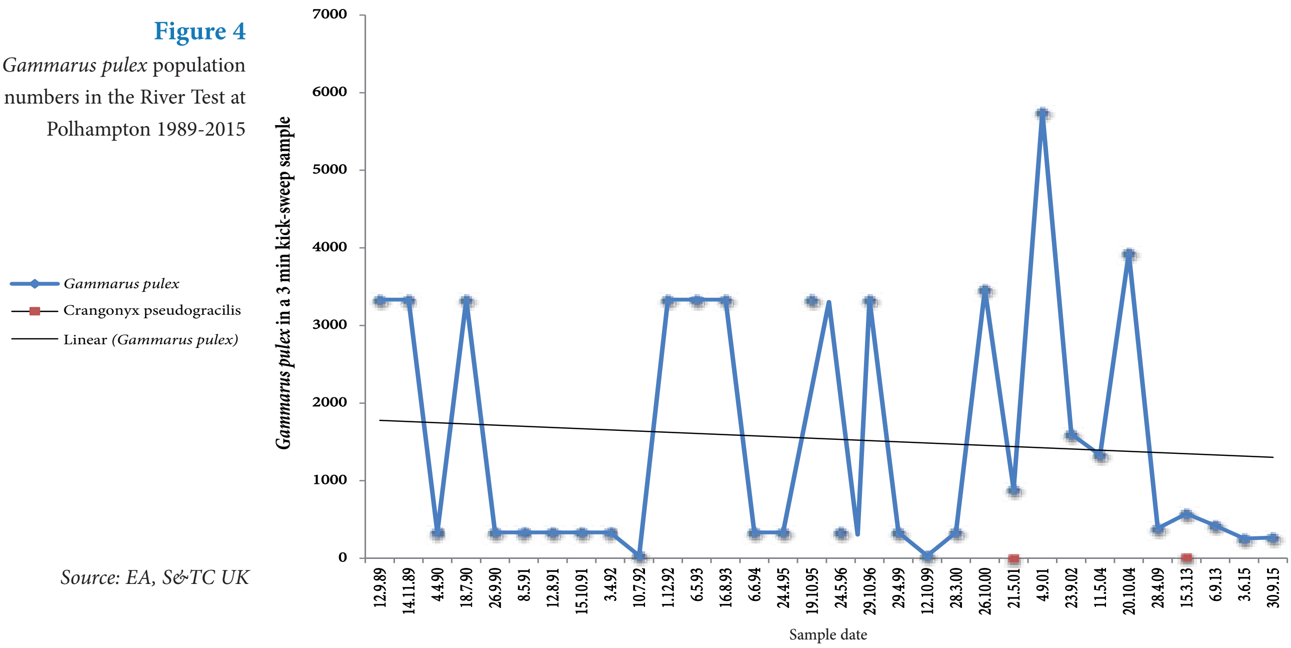
Figure 3 is from Fullerton on the Test (which is also one of our 2015 Census sites) from 1989 to 2015. Figure 4 is another from Polhampton, where the late Oliver Kite caught a leash of fat 3lb wild trout in the 1960s.

Figure 3
Gammarus pulex population numbers in the River Test at Fullerton (Mayfly Inn) 1972-2015



Source: EA, S&TC UK

Figure 4
Gammarus pulex population numbers in the River Test at Polhampton 1989-2015



Source: EA, S&TC UK

In 1989, over 3000 *Gammarus* were recorded by the EA. In the autumn of 2015, we recorded 269. This is degradation on an epic scale and totally unacceptable for a flagship river.

Gammarus pulex. © *Cyril Bennett*

The Upper Itchen fares as poorly as its big sister. The long-term decline at Itchen Abbas (Figure 5) is evident and *Gammarus* numbers have too frequently been well below those that could be reasonably expected from a chalkstream.

Similar trends were evident at Itchen Stoke (see Figure 6).

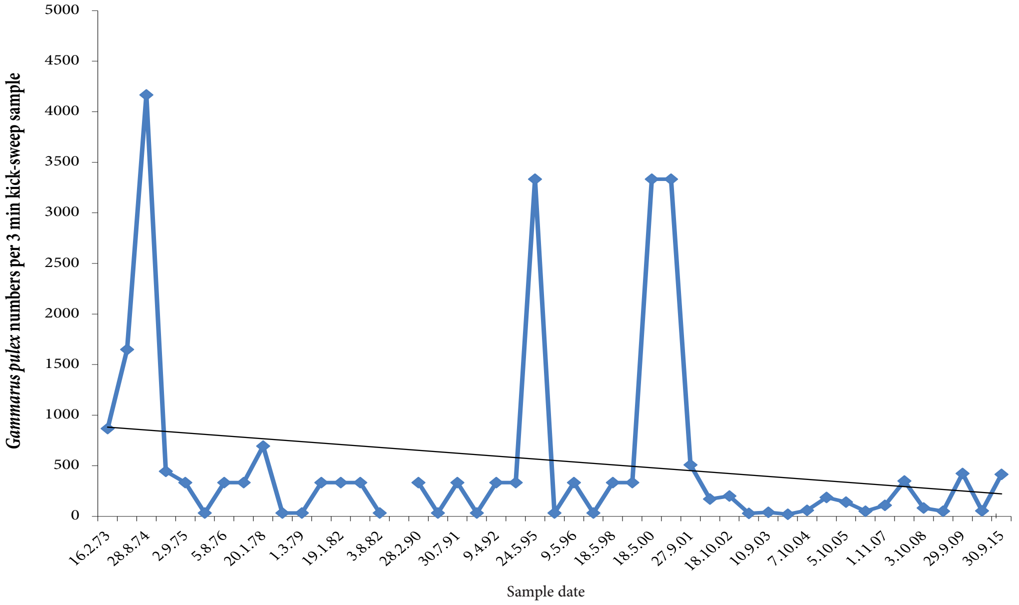


Figure 5

Gammarus pulex population numbers in the River Itchen at Itchen Abbas 1973-2015

Source: EA, S&TC UK

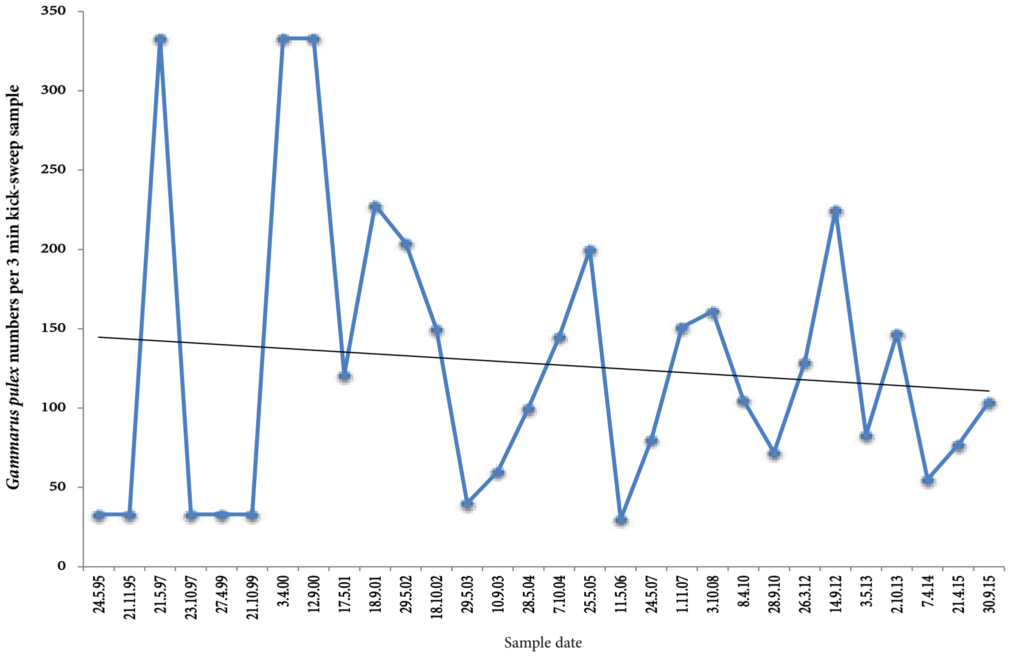


Figure 6

Gammarus pulex population numbers in the River Itchen at Itchen Stoke 1995-2015

Source: EA, S&TC UK

Riverfly woes...

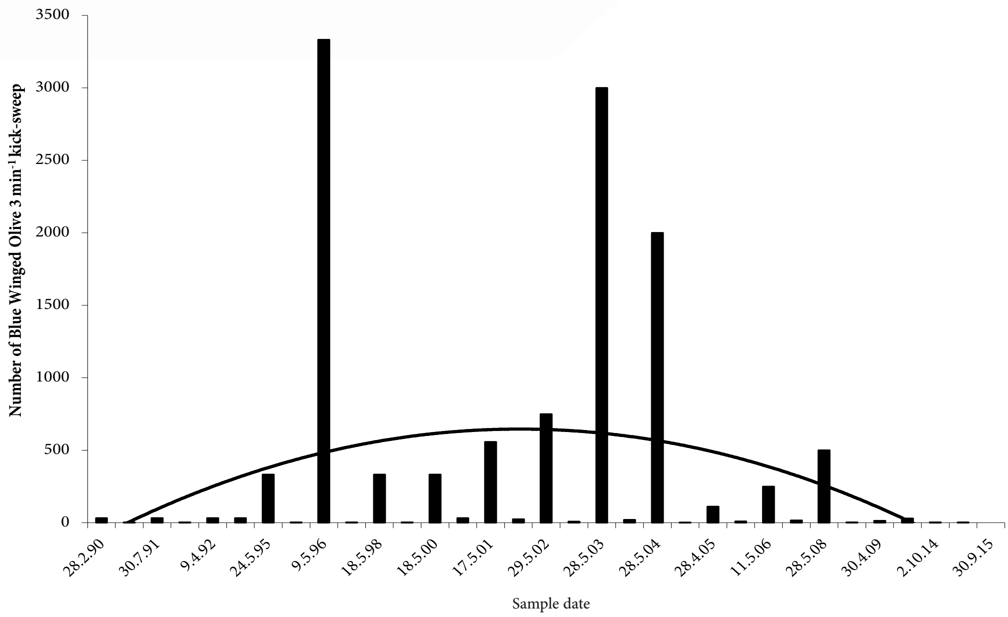
Blue winged Olive nymph (Serratella ignita). © *Cyril Bennett*

We have also analysed long-term trends for the Blue-winged Olive on the Itchen. It is particularly striking that from a position of relative abundance in the early 1990s, the population has collapsed. In our 2015 samples, no BWO nymphs were present at Itchen Abbas (Figure 7) and only a few were found at Itchen Stoke (Figure 8).

Figure 7

Population numbers of BWO *Serratella ignita* nymphs at Itchen Abbas in the River Itchen 1990-2015

Serratella ignita
Poly. *(Serratella ignita)*

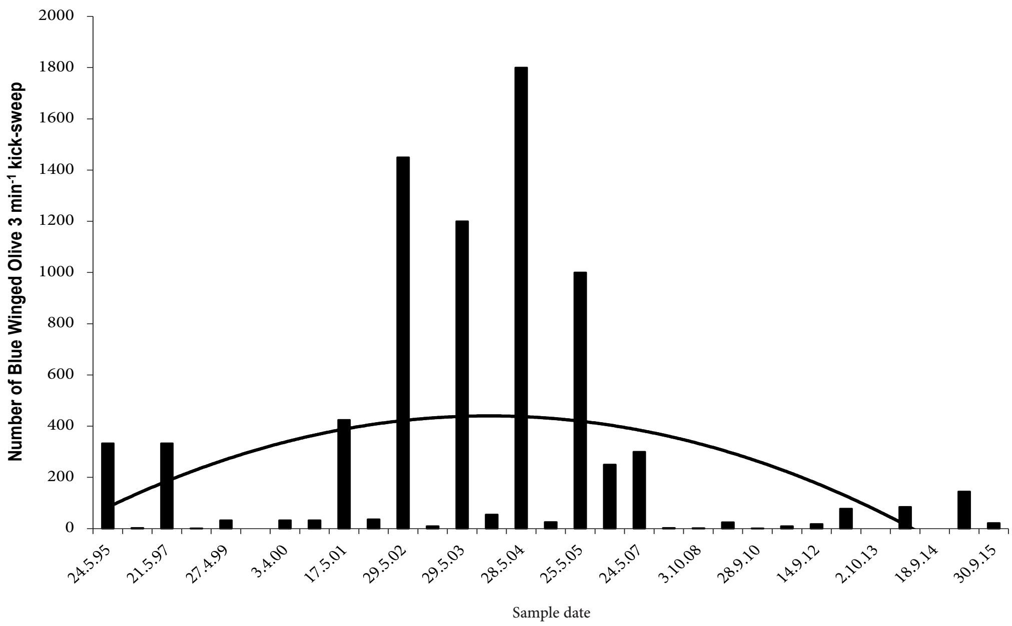


Source: EA, S&TC UK

Figure 8

Population numbers of BWO *Serratella ignita* nymphs at Itchen Stoke in the River Itchen 1995-2015

Serratella ignita
Poly. *(Serratella ignita)*



Source: EA, S&TC UK

These trends in blue-winged olives may be reflecting an earlier demise in BWO detected in the River Test at Fullerton and shown in Figure 9 from Bennett and Gilchrist (2010).

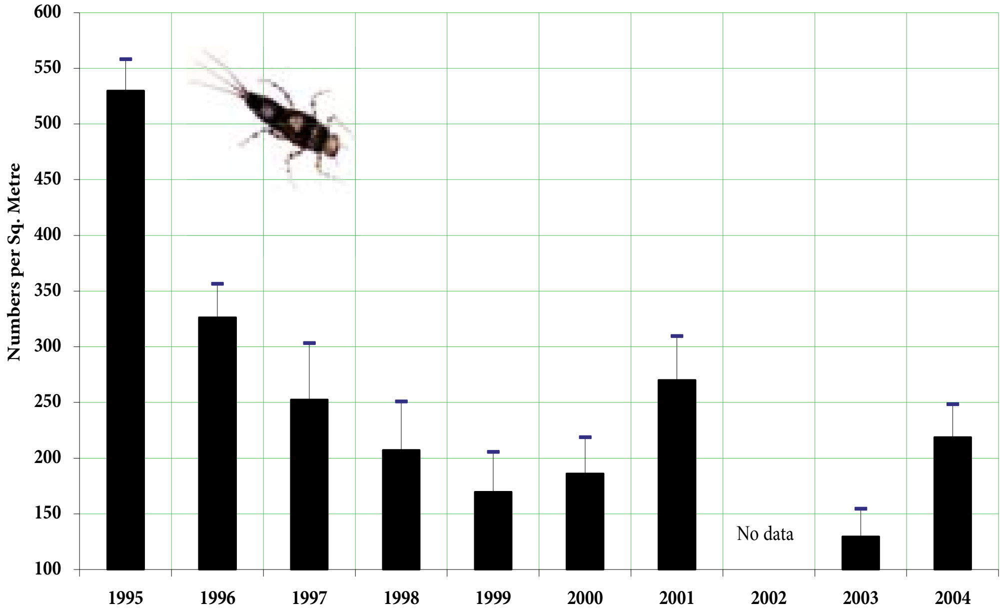


Figure 9

Blue Winged Olive *(Serratella ignita)* abundances at Leckford in the River Test

Bennett, C and Gilchrist, W. (2010). Chapter 22. Riverflies In: *Silent Summer. The State of Wildlife in Britain and Ireland*. Ed. N. Maclean. Cambridge University Press, Cambridge, 765pp.

Please note that the declines in *Serratella ignita* are not an artefact of seasonal sampling patterns. This species is well documented now to have several generations annually on both chalkstreams and northern rivers with secondary or more population peaks expected in clean rivers in August-September.

Nor is the decline likely to be due solely to temperature change. Recent studies of the impact of temperature rises on chalkstream invertebrates (e.g. Evaluating climatic effects on aquatic invertebrates in southern English Rivers, Durance and Ormerod 2008) show increases in river water temperatures. However, the temperature increases are similar across the rivers sampled and thus, do not easily provide an explanation for their differential invertebrate performance.

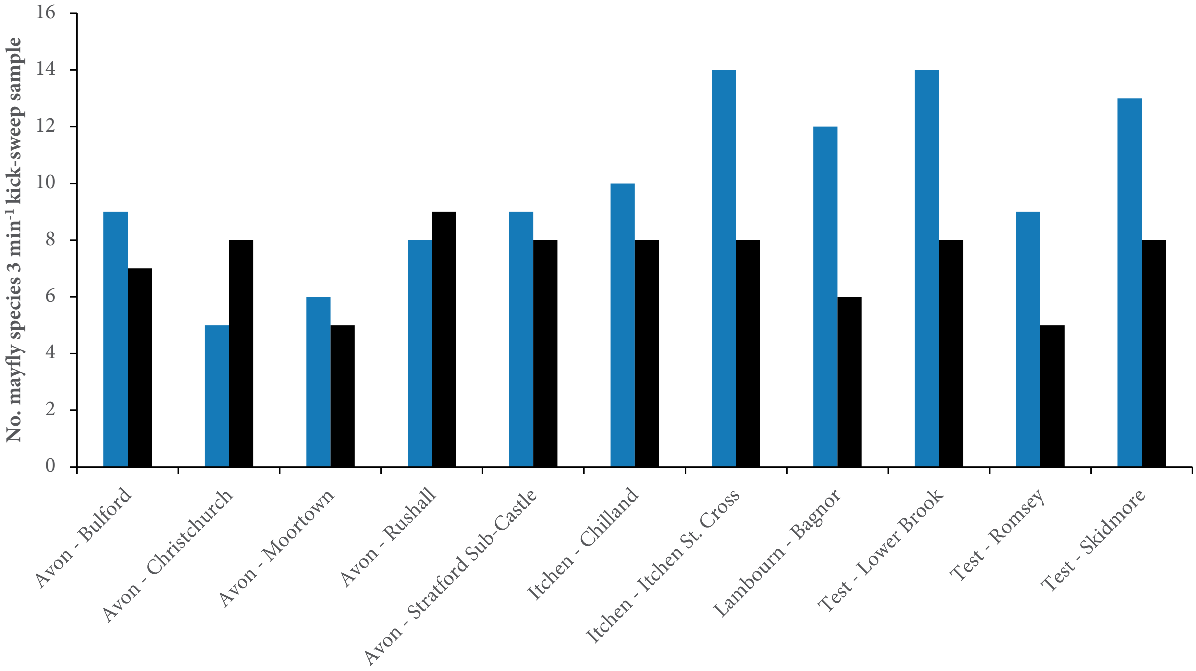
We have compared mayfly *(Ephemeroptera)* data from a 1998 report commissioned by the EA from the Institute of Freshwater Ecology *(A Scoping Study on the Ephemeroptera of Southern Chalkstreams, IFE 1998)* with our and Wessex Chalkstreams Rivers Trust's data collected in 2014-2015 for the same sites (see Figure 10). The changes over time in mayfly species richness is very similar to the picture we have already presented, albeit using a different historic data set. Note that the Avon changes are less marked than those on other rivers in the data set.

Figure 10

Mayfly species richness at chalkstream sites in 1998 and 2014-2015

IFE 1998

S&TC/WCSRT 2014-2015



The results by river

Mayfly dun female (Ephemera danica). © *Stuart Crofts*

We present the results by site on each river for spring and autumn. The four key forms of stress – organic pollution, nutrient enrichment, sedimentation and flow – are shown in traffic lights to indicate the degree of impact at each site. The biometric look-up table has been used to produce the 'traffic light' measure of respective biological stress signatures at our sites.

Traffic light measure of respective biological stress signatures

Stress level descriptor	Colour code	PSI (sediment) value	TRPI (nutrient total reactive P value)	Organic (Saprobic value)	Flow (LIFE value)
Heavily impacted	red	0-20	0-20	3.2 - 4	<6
Impacted	orange	21-40	21-40	2.7 – 3.19	6 - 6.49
Moderately impacted	yellow	41-60	41-60	2.3 - 2.69	6.5 - 6.99
Slightly impacted	green	61-80	61-80	1.81 - 2.29	7.0 - 7.99
Un-impacted	blue	81-100	81-100	1.0 - 1.80	>8.0

Source: Aquascience Consultancy Limited

Please note that both PSI and TRPI are inverse indexes i.e. lower PSI and TRPI values counter-intuitively represent higher sediment and total reactive P enrichment impacts respectively.

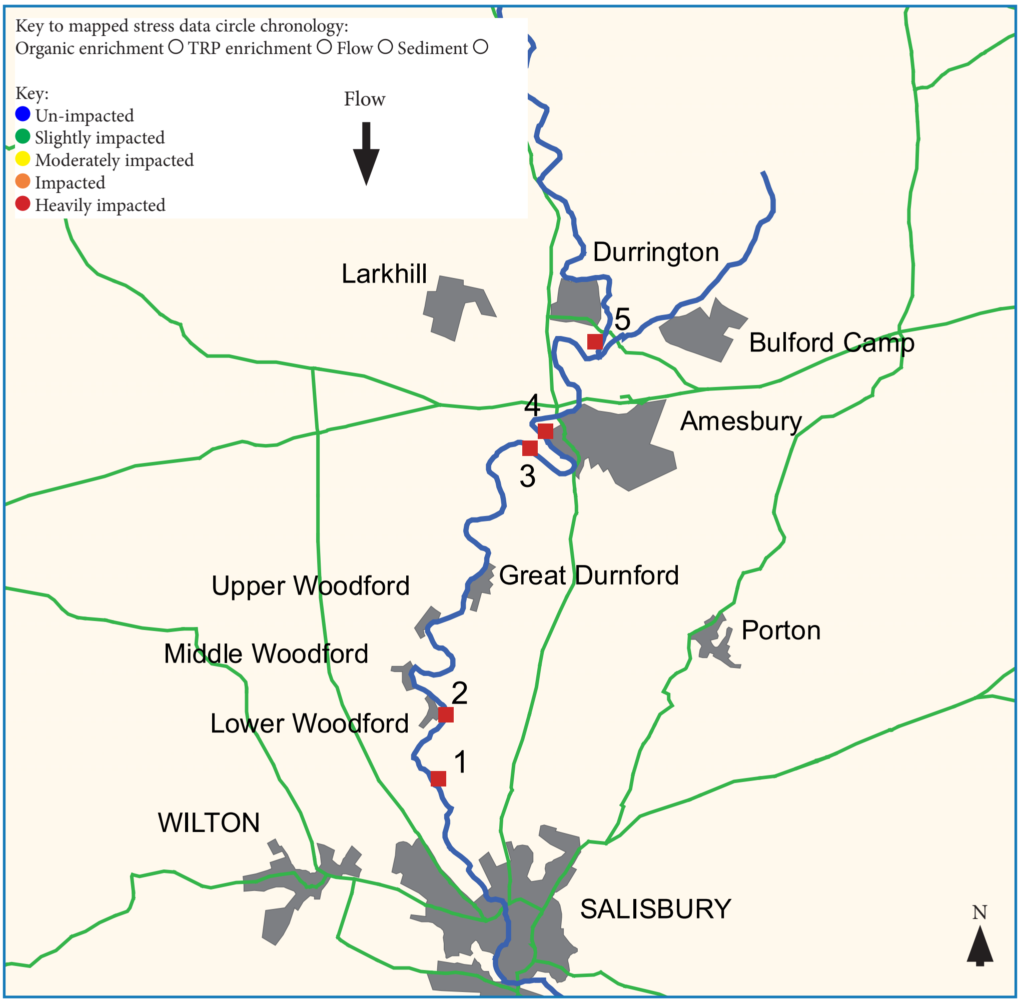
We also include a table of riverfly richness and abundance, plus *Gammarus* abundance for each site. This allows us to translate the impact of the four key stresses into actual riverfly and *Gammarus* results.

The results demonstrate the sensitivity of aquatic invertebrate populations to these forms of stress. While we are still working on refining our results, it is clear that even very small departures from pristine conditions have a big impact on aquatic invertebrates.

Upper River Avon

All our Upper Avon sites produced unimpacted or slightly impacted biological signatures in 2015. The result is that the river's fly life is significantly better than any of the other study Chalkstreams. The Avon is top in our ranking.

We suspect that the Upper Avon benefits from the lack of anthropogenic pressure as it crosses Salisbury Plain. We plan further research into this.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Avon in 2015

5. Stonehenge
Spring
Autumn

4. Queensbury Bridge
Spring
Autumn

3. Ham Hatches
Spring
Autumn

2. Little Durnford
Spring
Autumn

1. Stratford Bridge
Spring
Autumn

River Avon Riverflies and *Gammarus* 2015

Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	20	20	20	20	21	16	21	20	17	19	20	19
Abundance	1379	973	1718	1144	1644	700	465	1033	1116	841	1372	831
Gammarus												
Abundance	1931	2214	1145	929	1723	1334	3570	8220	584	2176	1588	3177

Source: S&TC UK 2015

The Upper Avon's biometric signatures translate into impressive riverfly and *Gammarus* abundance. This is an example of what other chalkstreams should be achieving but, sadly, are not. There were plenty of Blue-winged Olives *(Serratella ignita)*, a notoriously sediment intolerant species, present in our samples.

Upper River Itchen

The map shows our sites on the Upper Itchen with the traffic light depiction of the biometric stress results, which are far lower than we would expect from an SAC chalkstream.

In particular, the biological signatures for sediment, nutrient enrichment (P) and organic enrichment are worryingly high.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Itchen in 2015

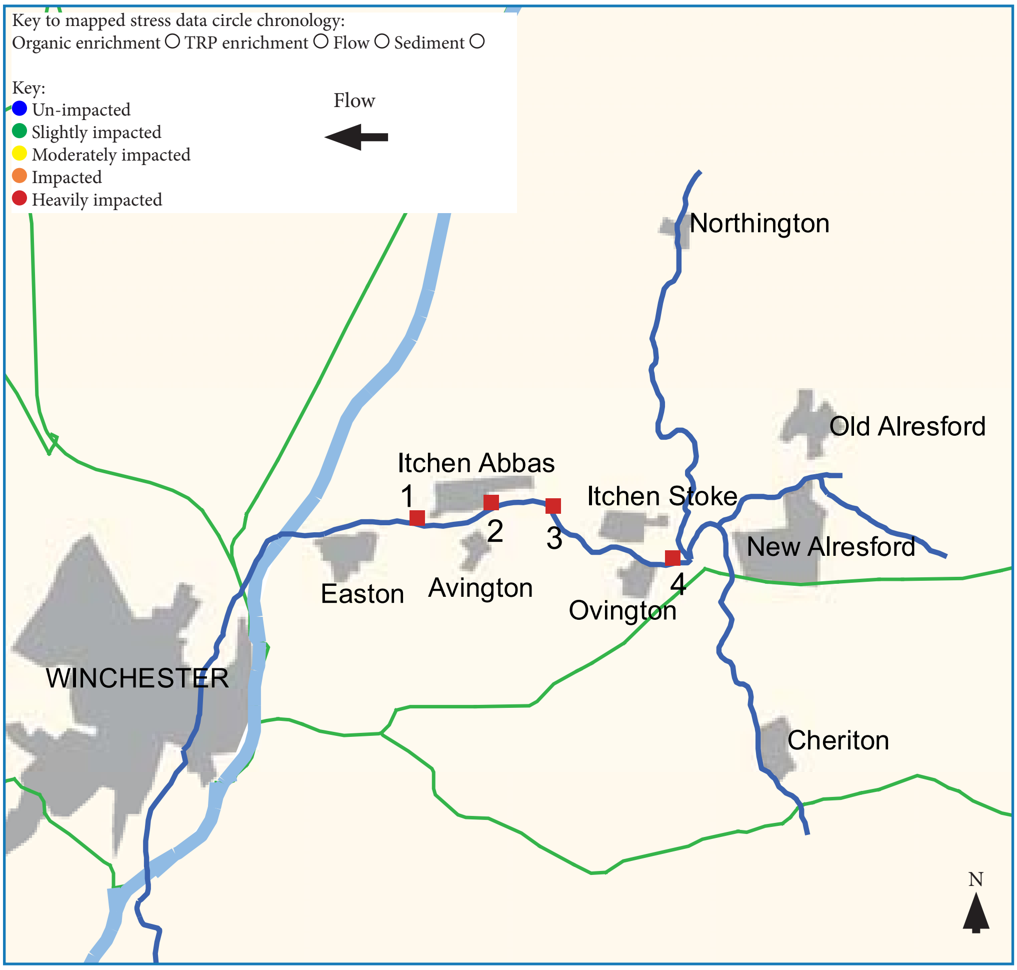
1. Chilland Mill
Spring
Autumn

2. Itchen Abbas
Spring
Autumn

3. Yavington
Spring
Autumn

4. Itchen Stoke Mill
Spring
Autumn

Source: S&TC UK 2015



Riverflies and *Gammarus*

The Itchen counts are low for what we would expect from the upper reaches of a chalkstream, which should arguably have 20 or more species, riverfly numbers to average 1000 or more and *Gammarus* counts of at least 1000.

Riverfly species, which are intolerant to sedimentation and P, are conspicuous by their scarcity (Blue-winged Olives) or absence (Southern Iron Blue).

River Itchen Riverflies and *Gammarus* 2015

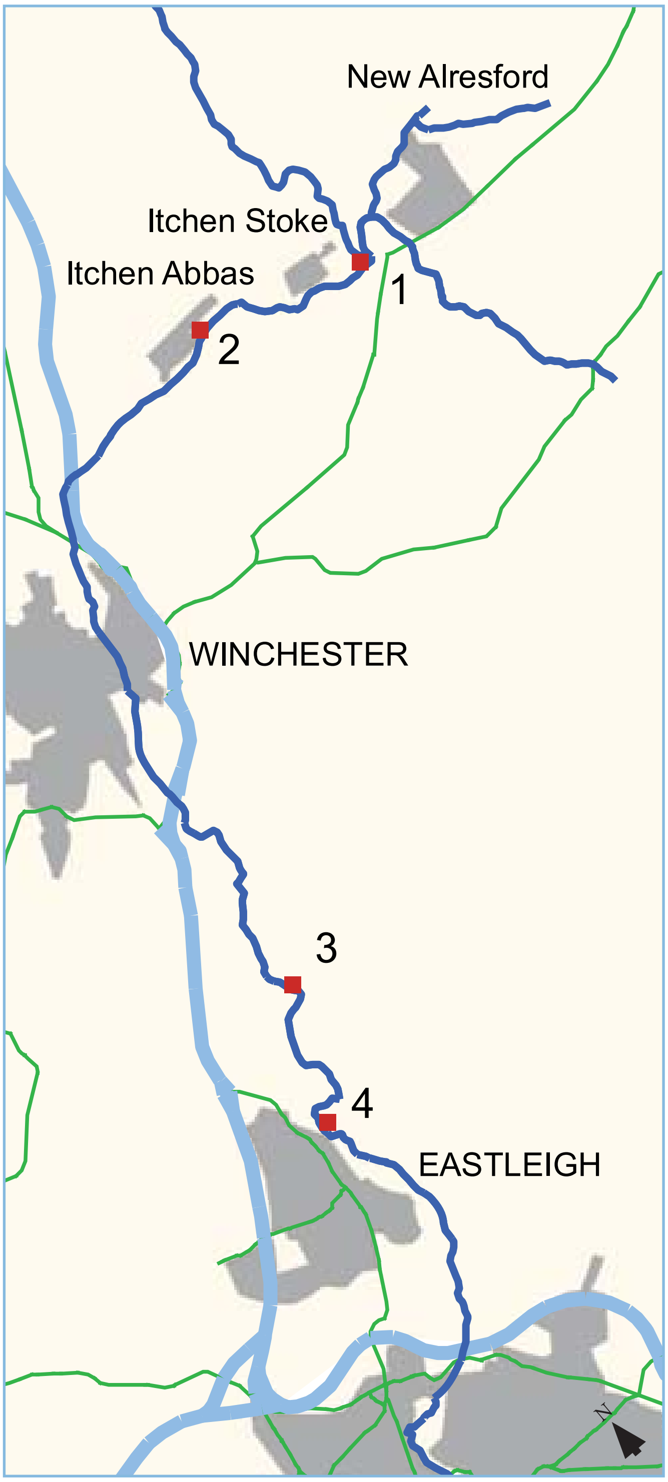
	Spring				Autumn				Spring	Autumn
Site	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**average**	**average**
Riverflies										
Species	20	19	17	21	14	11	17	13	19	14
Abundance	699	246	285	296	199	89	159	136	382	146
Gammarus										
Abundance	77	49	54	182	104	139	415	130	91	197

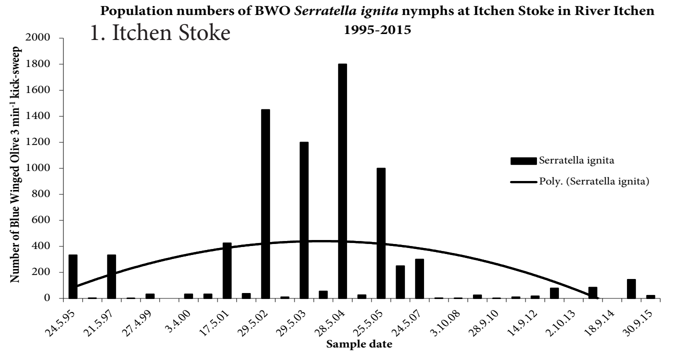
We include historic trends from EA data for *Gammarus* and Blue-winged Olives on the Itchen.

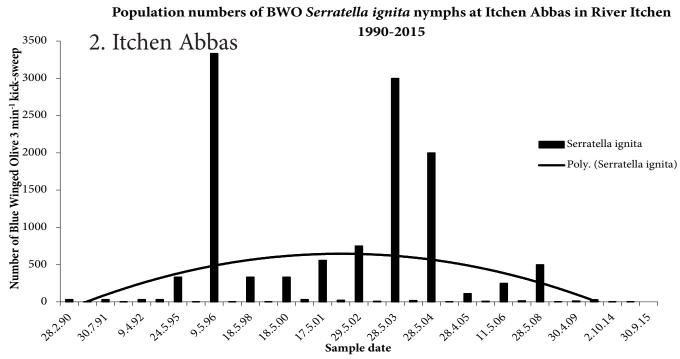
The overall *Gammarus* trend is negative across the various sample sites, with very low numbers now being recorded. The reasons for the decline are not entirely clear. Although P and sediment may be having an impact, we suspect that other factors are also at work. *Gammarus* are particularly sensitive to chemical pollution from pesticides and herbicides. Our work to investigate the cause is continuing.

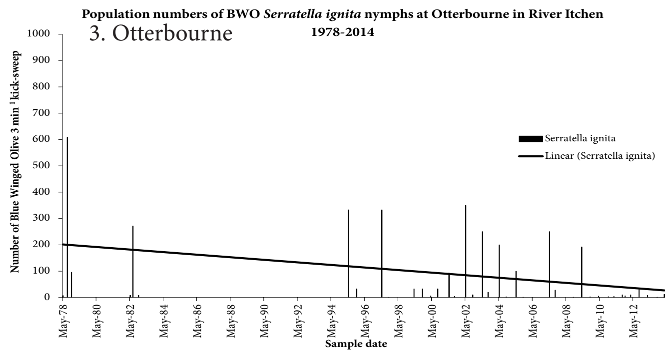
As already stated, the decline in Blue-winged Olives is likely to be due to the combination of P enrichment and sedimentation. We are currently researching the nature of these impacts in the laboratory. However, the association of BWO decline with increasing sedimentation and P enrichment in the field is very strong.

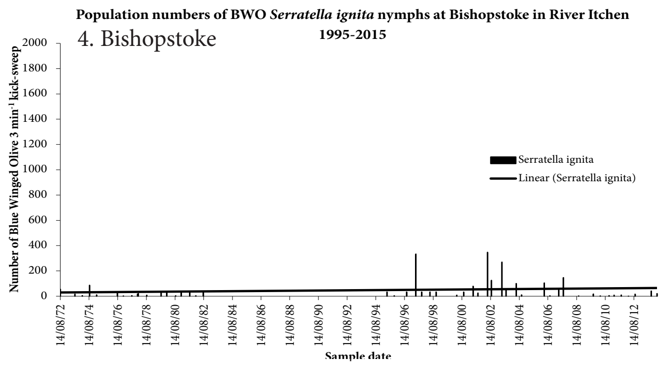
Blue-winged olives *(Serratella ignita)* in the Itchen 1978-2015







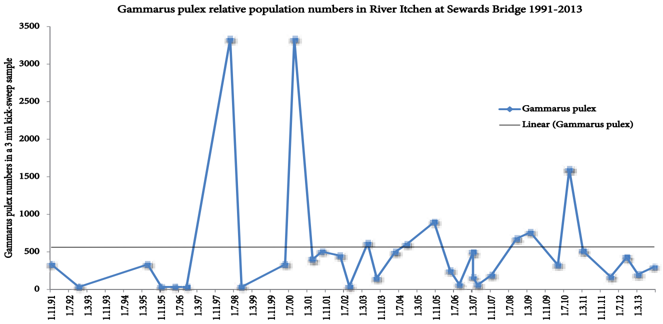




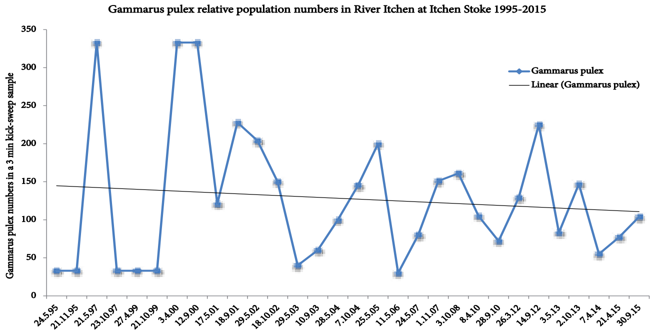
All charts sourced: EA, S&TC UK

Freshwater shrimp in the Itchen 1975-2015

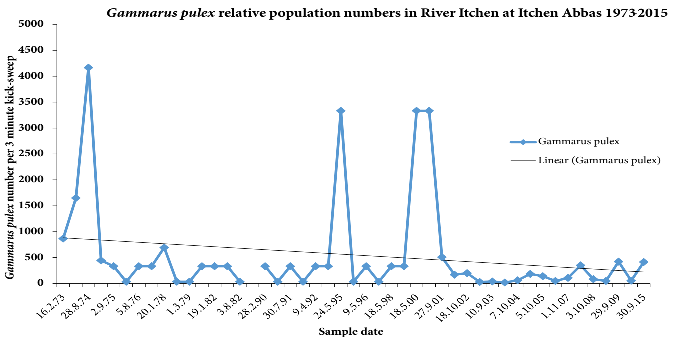
1. Sewards Bridge



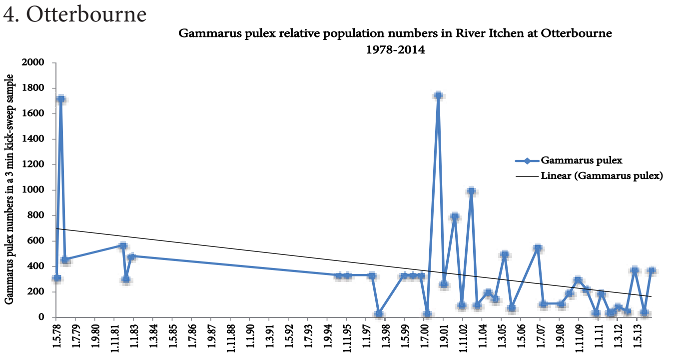
2. Itchen Stoke



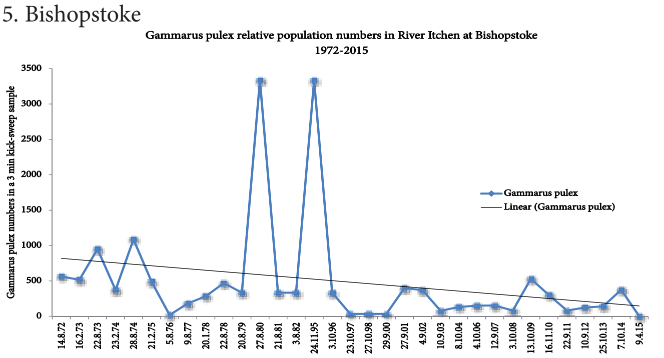
3. Itchen Abbas

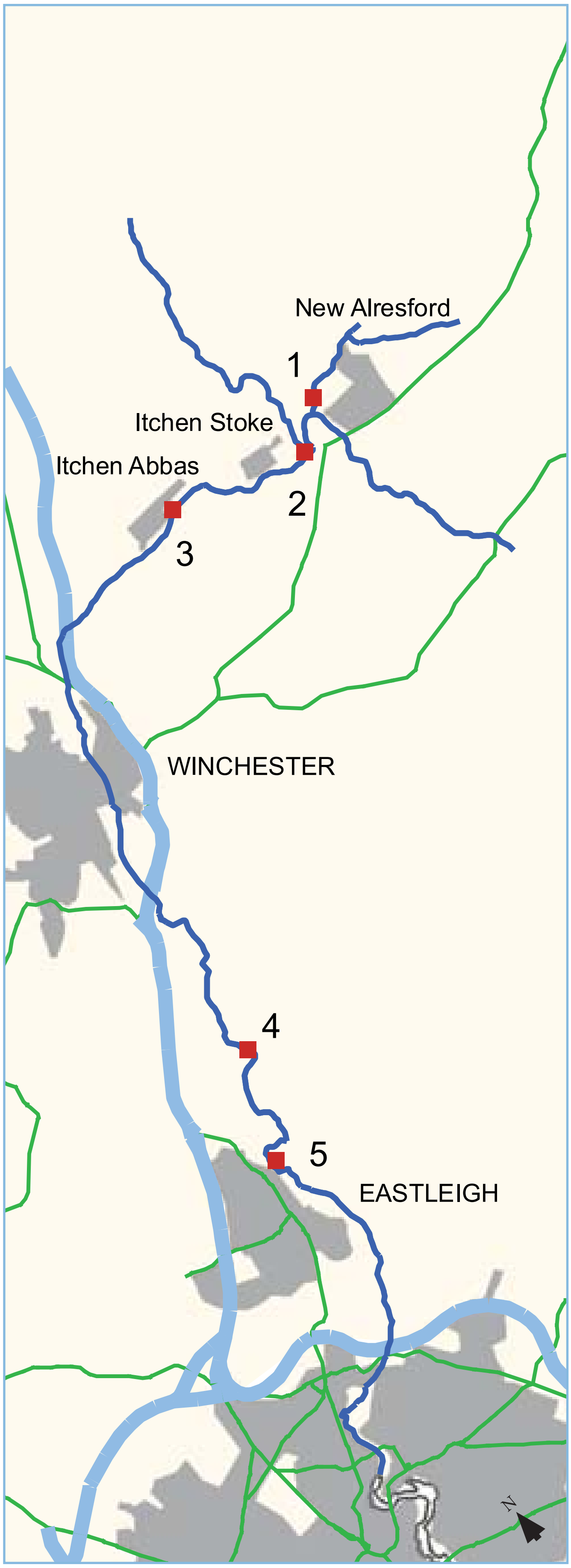


4. Otterbourne



5. Bishopstoke

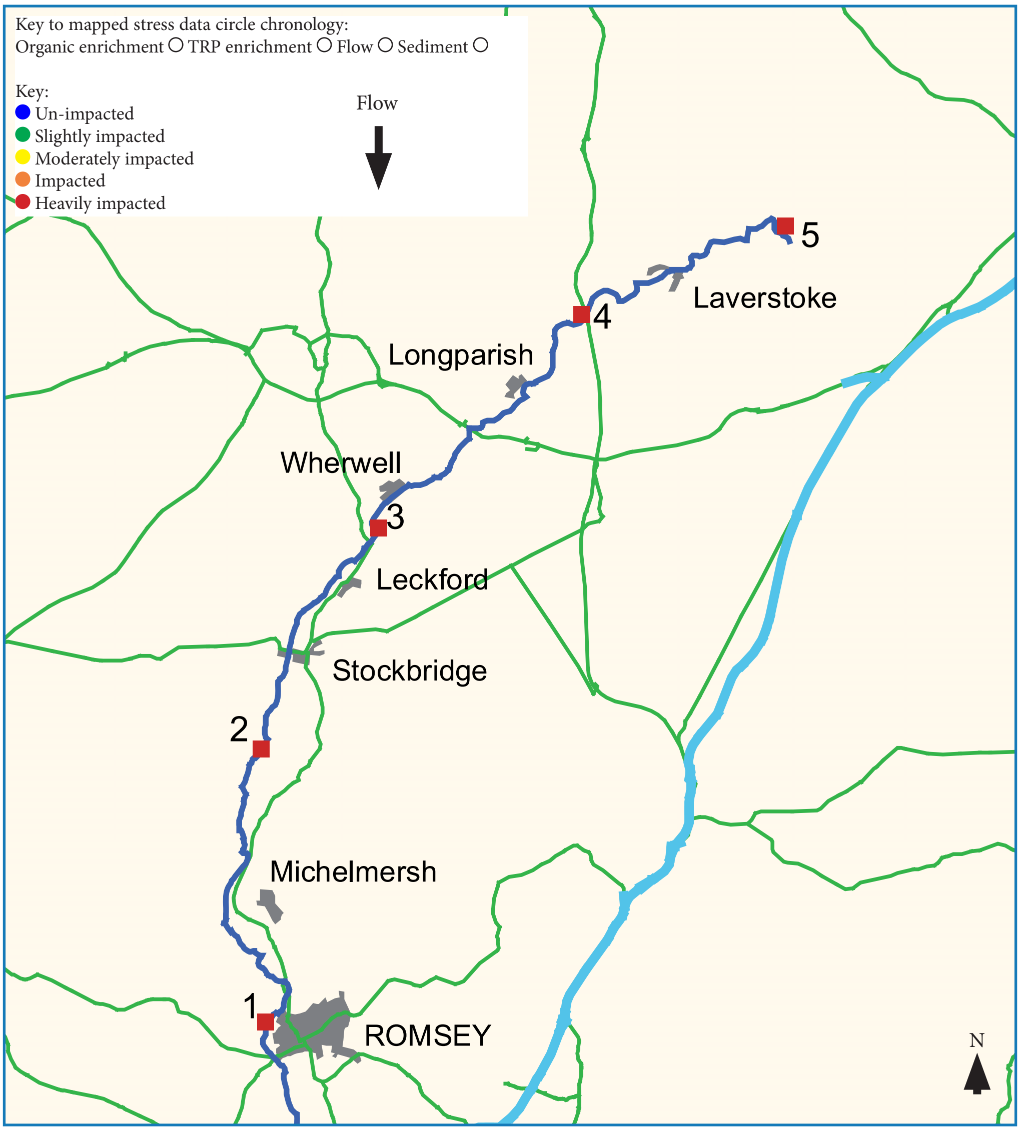




All charts sourced: EA, S&TC UK

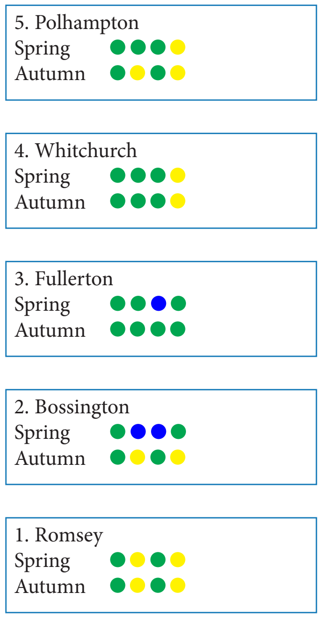
River Test

Our River Test sites exhibit ecological biometrics well below what may be expected from a chalk river. The results show elevated levels of sediment and P at sites 1, 2 and 5, plus sediment at site 4.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress 'traffic lights' in the River Test, 2015



River Test Riverflies and *Gammarus* 2015

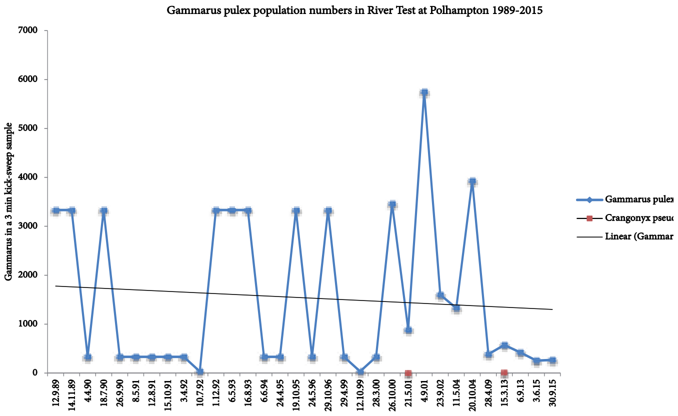
Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	12	21	11	19	12	13	12	11	15	6	15	11
Abundance	183	426	342	409	683	211	171	243	389	83	409	219
Gammarus												
Abundance	209	94	88	79	254	185	144	118	184	269	145	180

Source: S&TC UK 2015

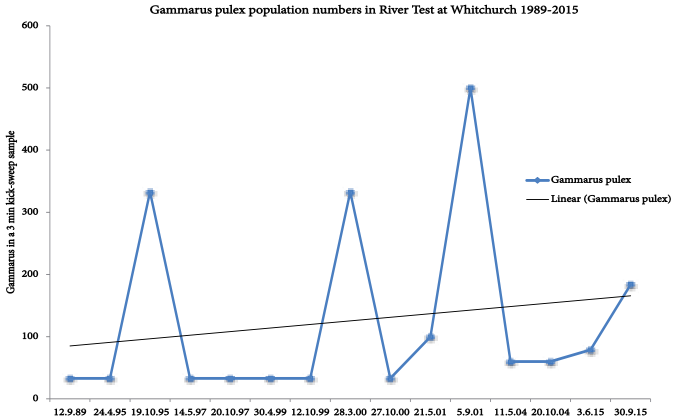
Riverfly richness, abundance and *Gammarus* numbers were all low at each site against expectations for a chalkstream. Richness should exceed 25 and numbers should exceed 1000 in both cases.

Freshwater shrimp down the Test 1972-2015

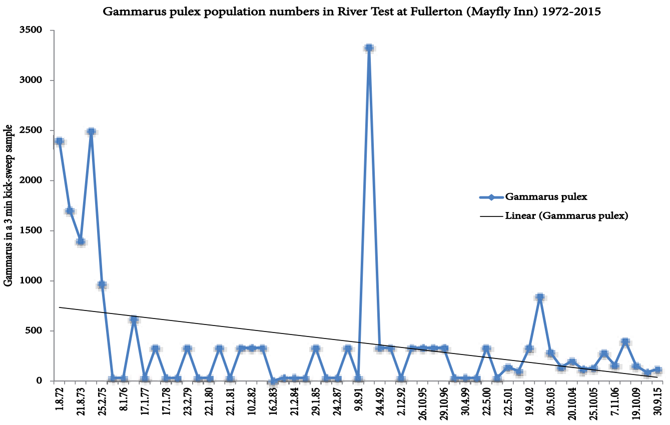
4. Polhampton



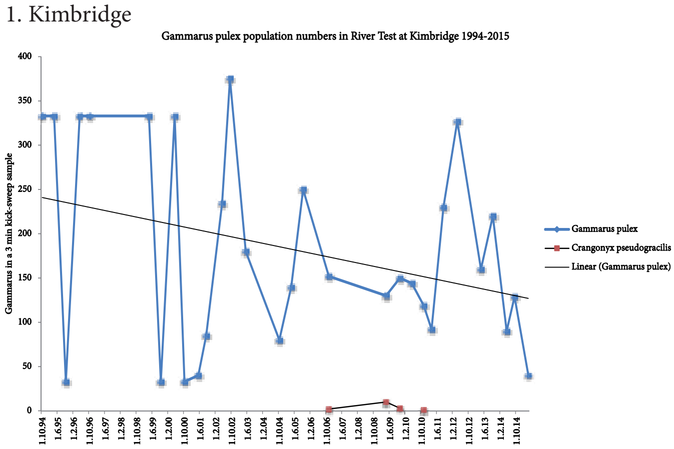
3. Whitchurch



2. Fullerton



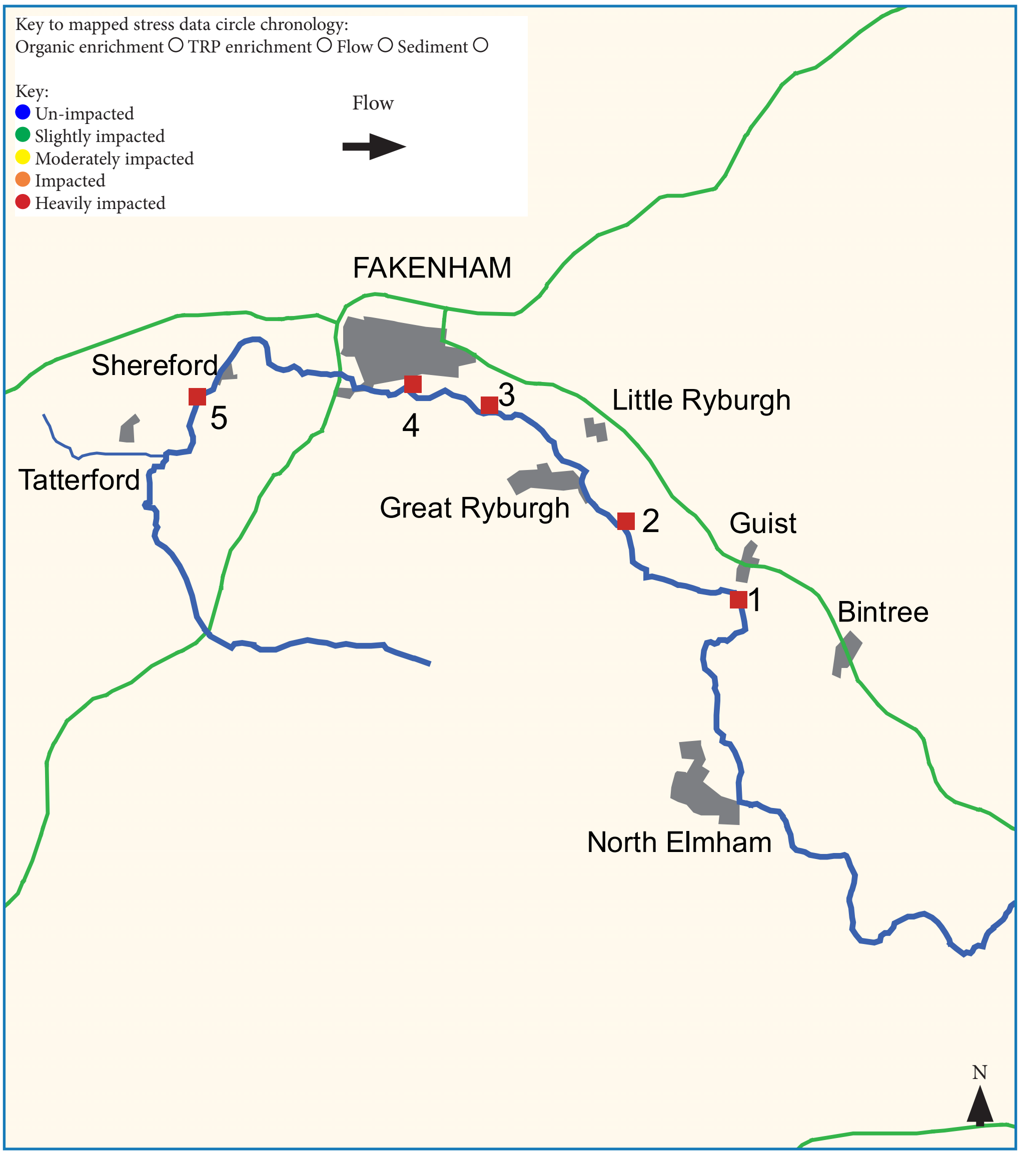
1. Kimbridge



All charts sourced: EA, S&TC UK

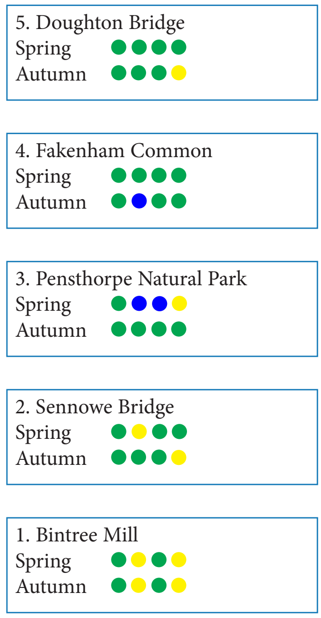
River Wensum

P and sediment impact in the Wensum has had a dramatic negative effect on flylife. The river ranks bottom in our Census, which is an extremely disappointing outcome for one of the UK's four SAC protected chalkstreams. The sediment intolerant riverflies appear particularly disappointing. The *Gammarus*, though often poor in number for a chalkstream, exhibit some mixed trends.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Wensum



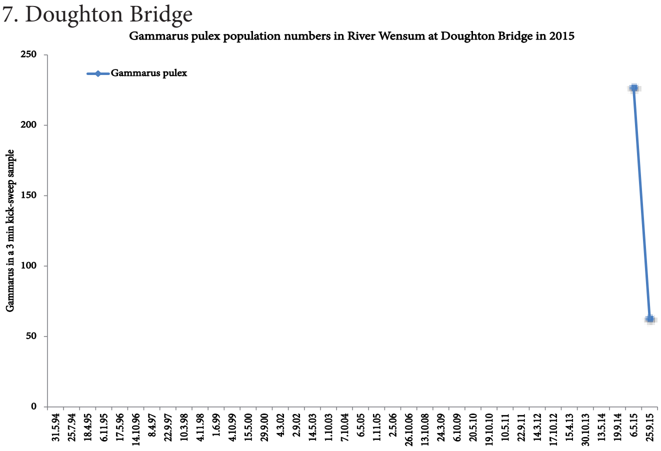
Source: S&TC UK 2015

River Wensum Riverflies and *Gammarus* 2015

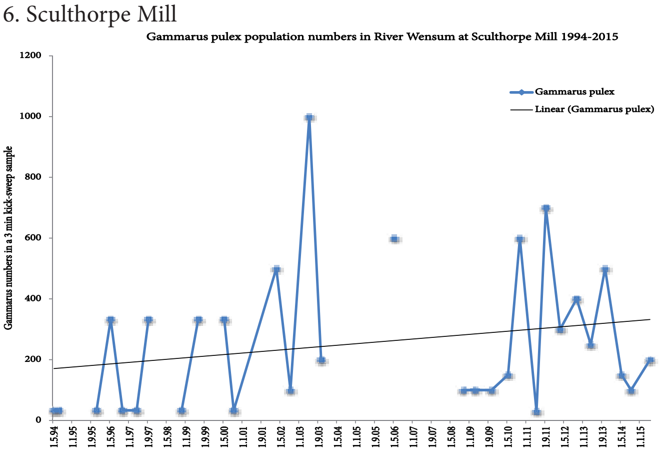
	Spring					Autumn					Spring	Autumn
Site	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**average**	**average**
Riverflies												
Species	15	18	6	10	10	9	12	8	9	8	12	9
Abundance	81	225	65	25	219	122	135	104	222	74	123	131
Gammarus												
Abundance	158	107	589	263	227	126	85	268	164	63	269	141

Freshwater shrimp on the River Wensum 1995-2015

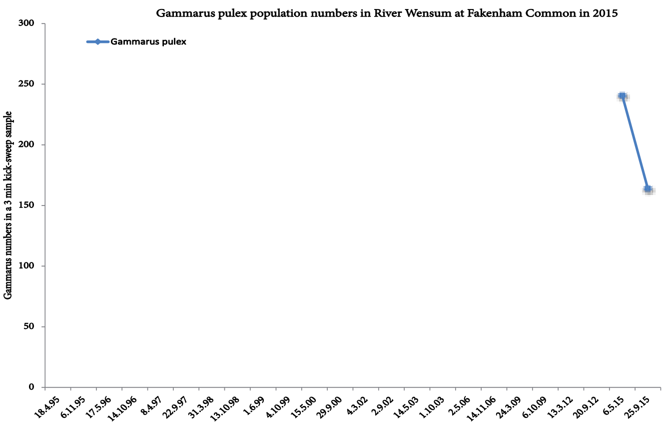
7. Doughton Bridge



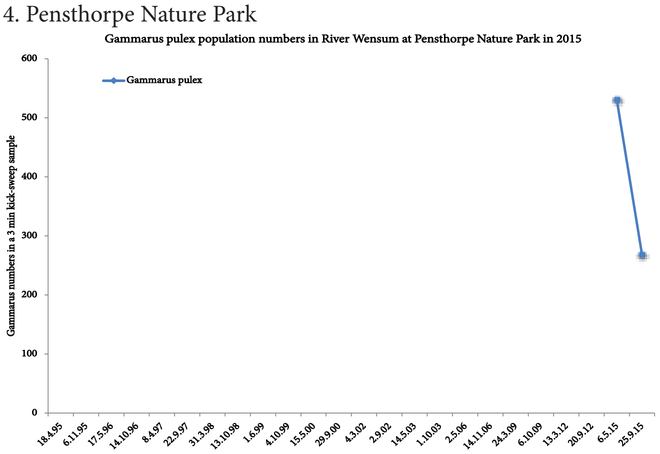
6. Sculthorpe Mill



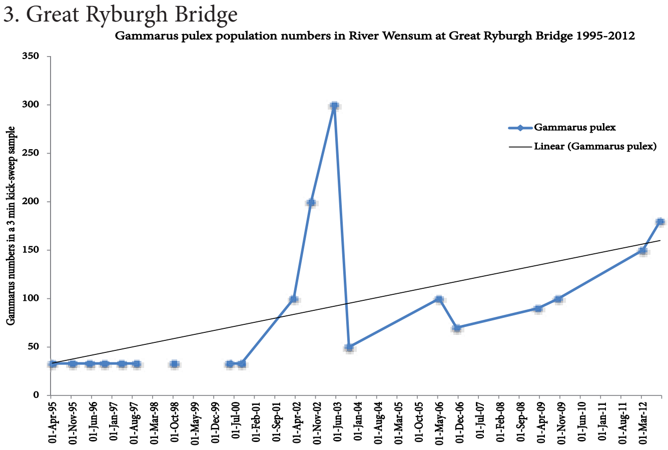
5. Fakenham Common



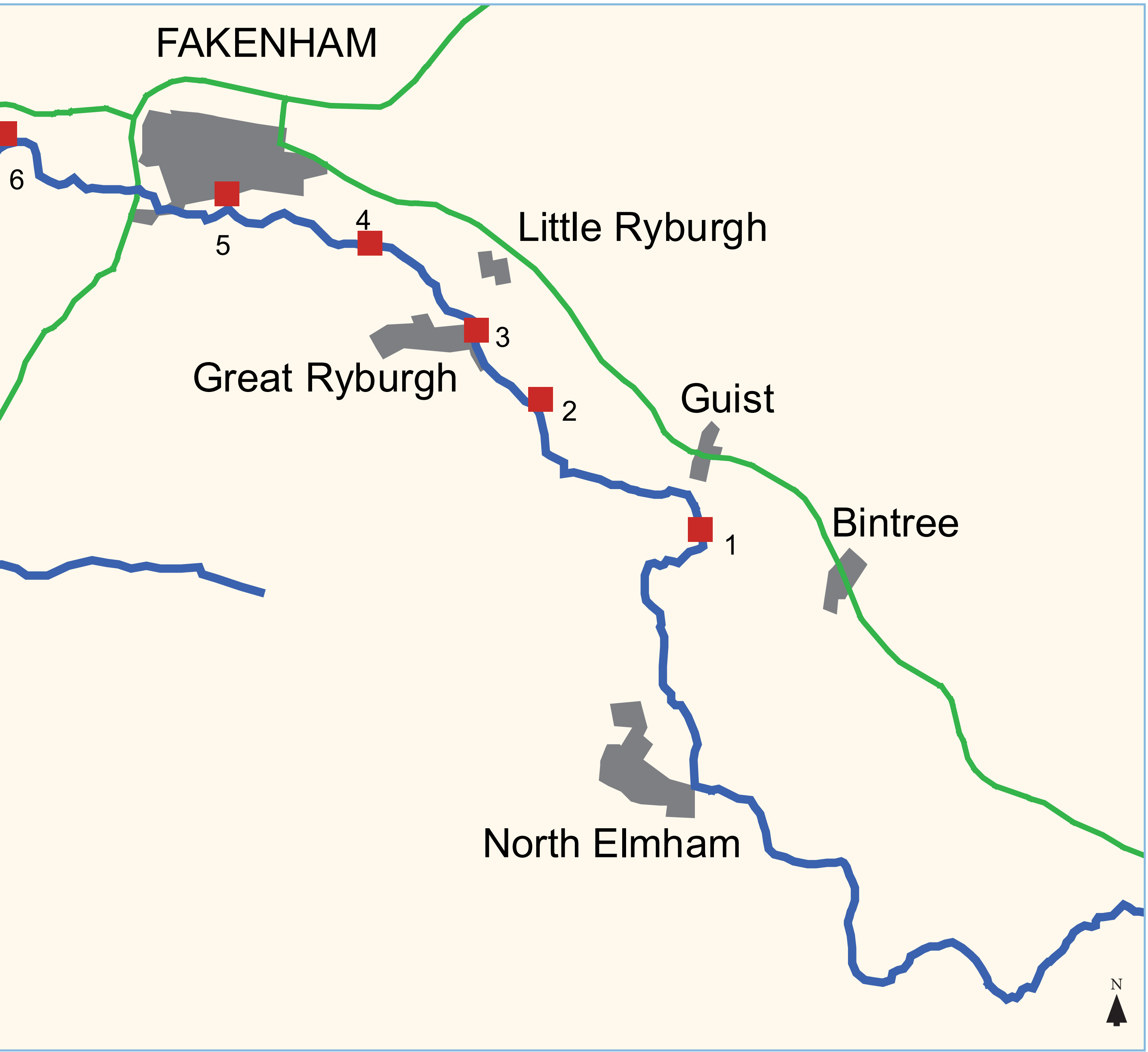
4. Pensthorpe Nature Park



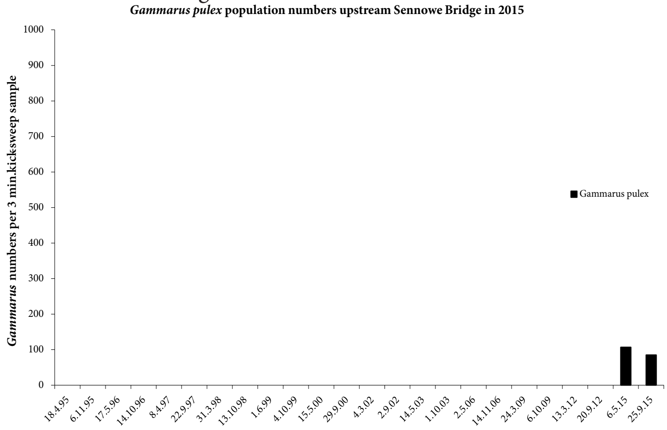
3. Great Ryburgh Bridge



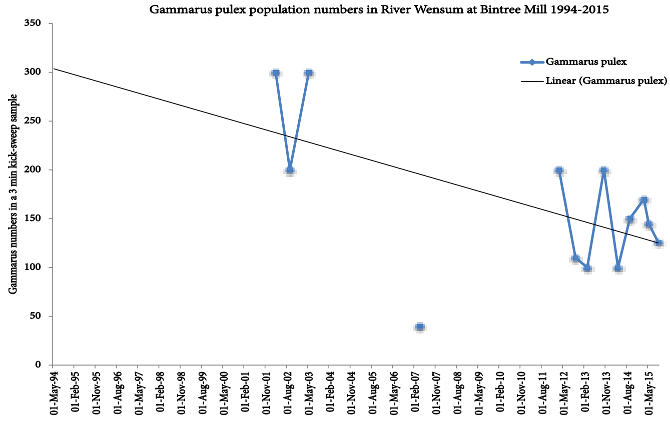
All charts sourced: EA, S&TC UK



2. u/s Sennowe Bridge



1. Bintree Mill

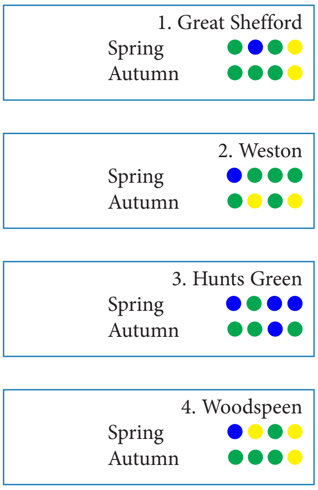


River Lambourn

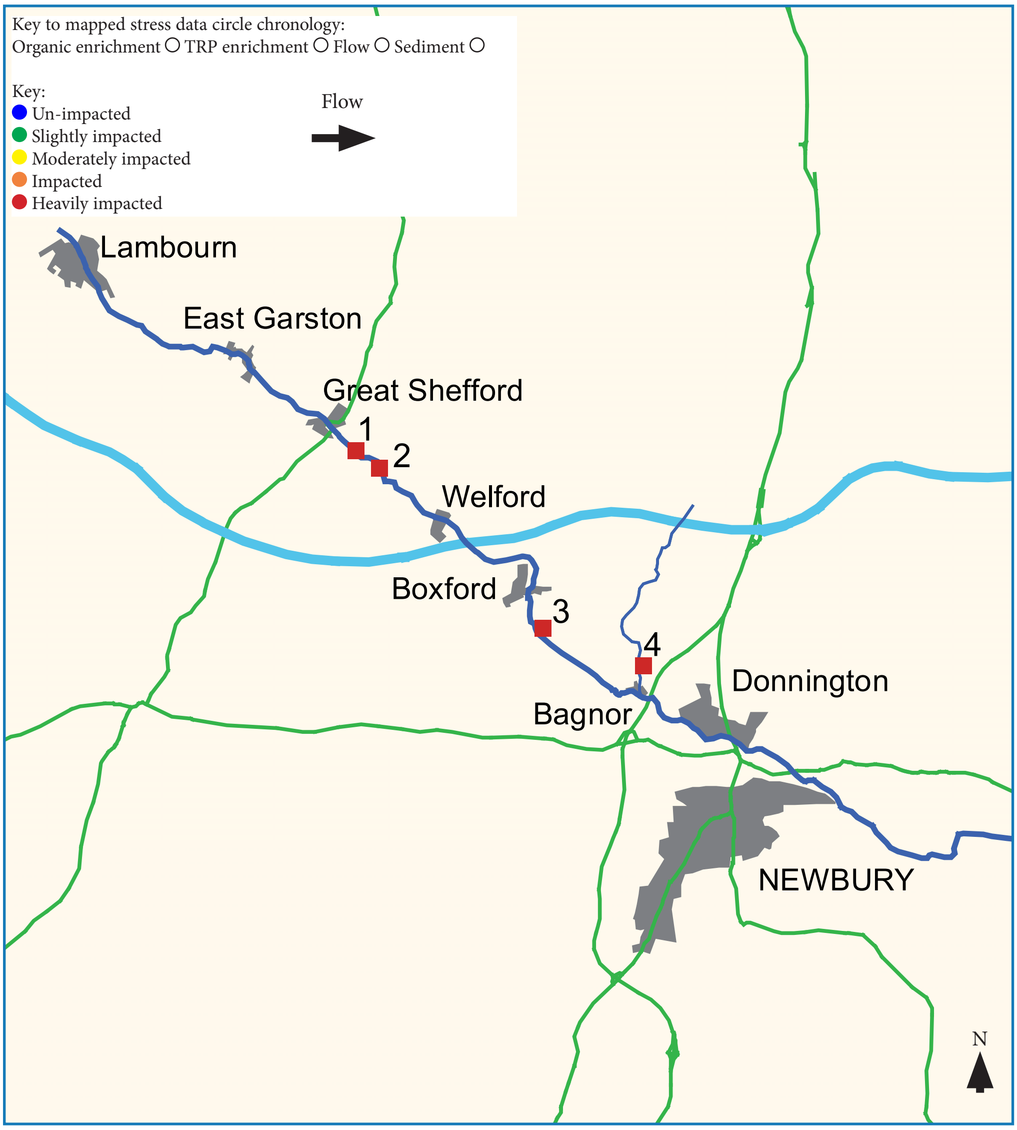
The Lambourn shows some signatures of P and sediment impaction, which has a concomitant effect on riverfly life. The autumn results are especially poor.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Lambourn in 2015



Source: S&TC UK 2015

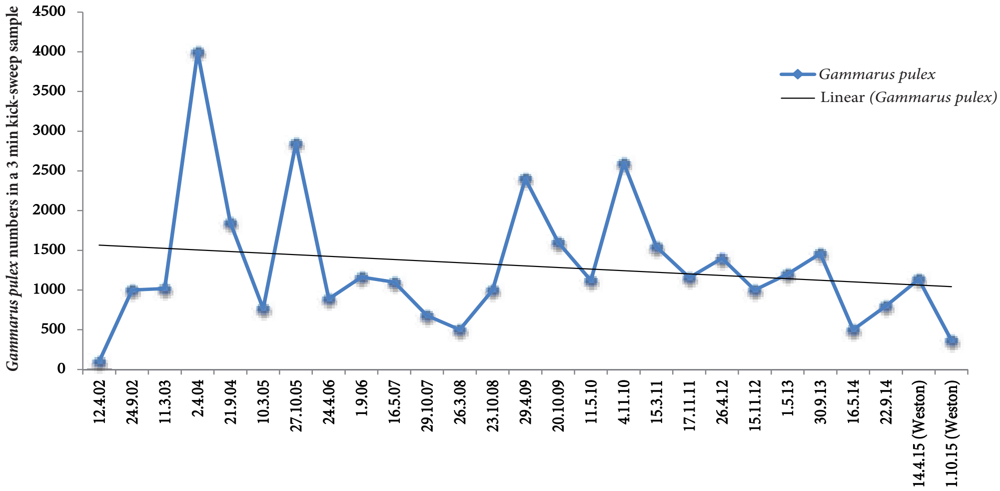


River Lambourn Riverflies and *Gammarus* 2015										
	Spring				Autumn				Spring	Autumn
Site	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**average**	**average**
Riverflies										
Species	16	12	20	10	8	7	14	5	15	9
Abundance	373	320	773	388	71	117	132	12	464	83
Gammarus										
Abundance	395	1136	1437	312	246	367	258	138	820	252

Note the marked decline in richness and abundance at sites 1, 2 and 4 in the autumn with worsening biological signatures of P and sediment.

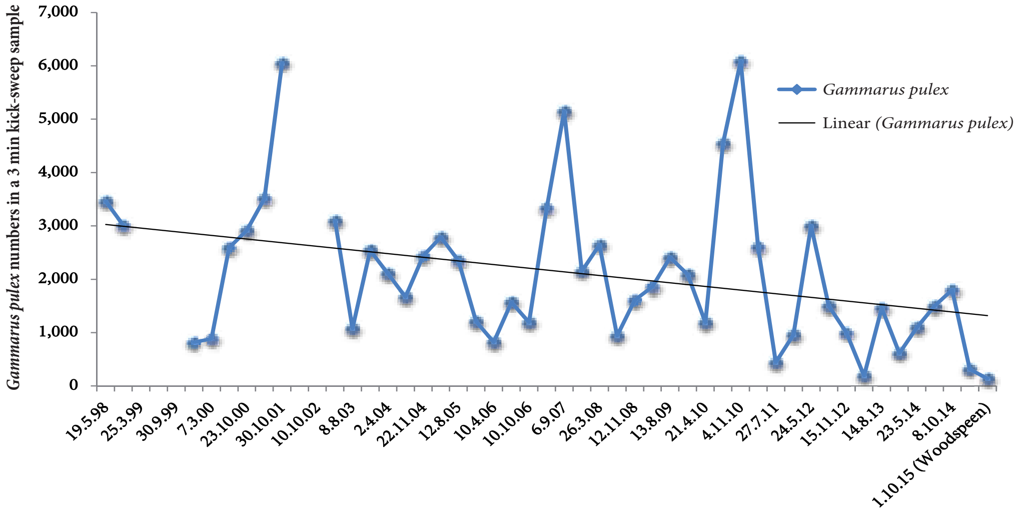
Gammarus trends on the Lambourn 2002-2014

We present *Gammarus* data from EA sampling sites adjacent to our site 1 and site 4 plus our 2015 data. Though the absolute numbers of *Gammarus* in the autumn of 2015 are favourable compared to the Itchen or Test, they have declined markedly over time.



Site 1

Shrimp *(Gammarus pulex)* population in the River Lambourn at East Shefford 2002-2014 and Weston in 2015



Site 2

Shrimp *(Gammarus pulex)* population in the River Lambourn at Bagnor 2002-2014 and Woodspeen in 2015

All charts sourced: EA, S&TC UK

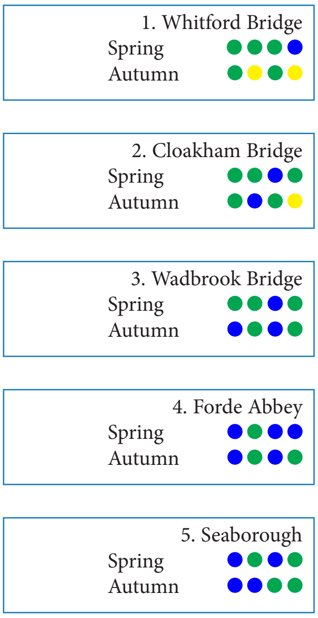
(L-R) Caperer (Halesus radiatus), *Stonefly nymph* (Protonemura praecox). © *Stuart Crofts*

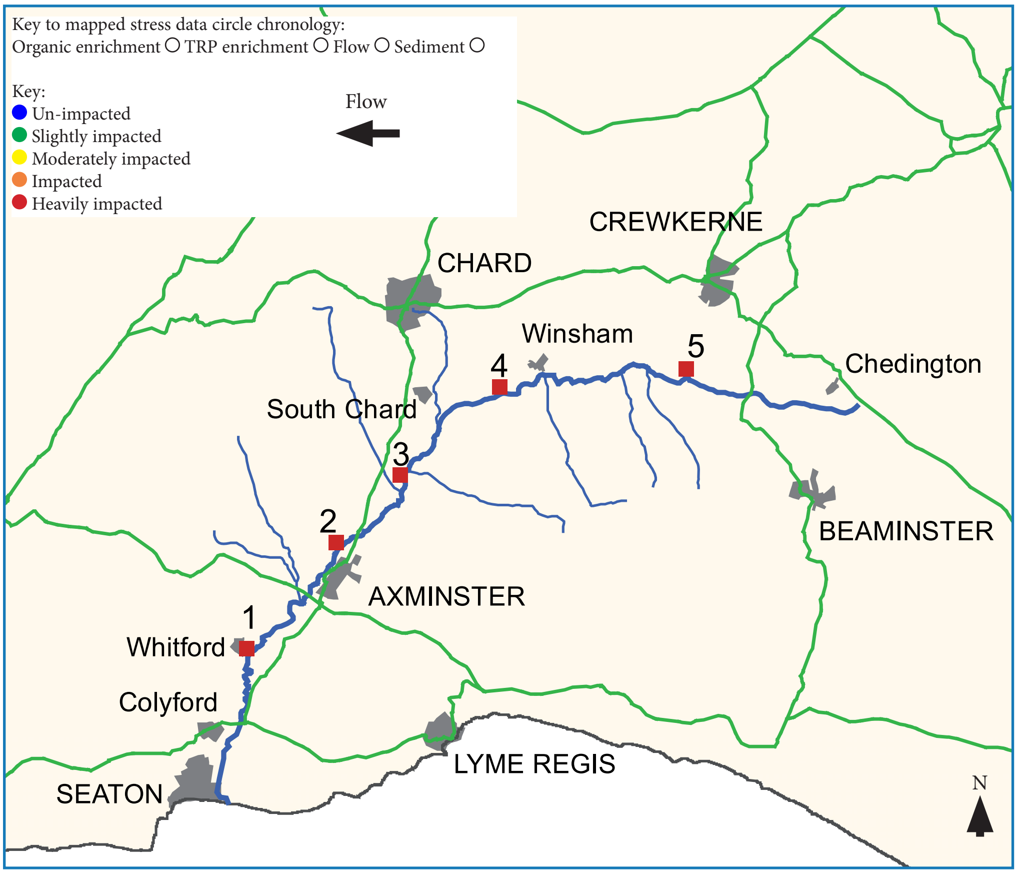
River Axe

The Axe is interesting. It seems to have reasonable signatures for a rain-fed river with moderate riverfly richness and abundance. There is a loss of water quality at the lower end of the catchment in the autumn. We also note relatively low *Gammarus* counts which may possibly be the result of leaching of cattle worming treatments in what is predominantly dairy farming catchment.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Axe in 2015





River Axe Riverflies and *Gammarus* 2015

Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	22	18	20	21	23	8	8	14	14	10	21	11
Abundance	633	628	778	388	528	164	171	263	277	168	591	209
Gammarus												
Abundance	1	0	61	39	31	2	9	1	7	17	26	7

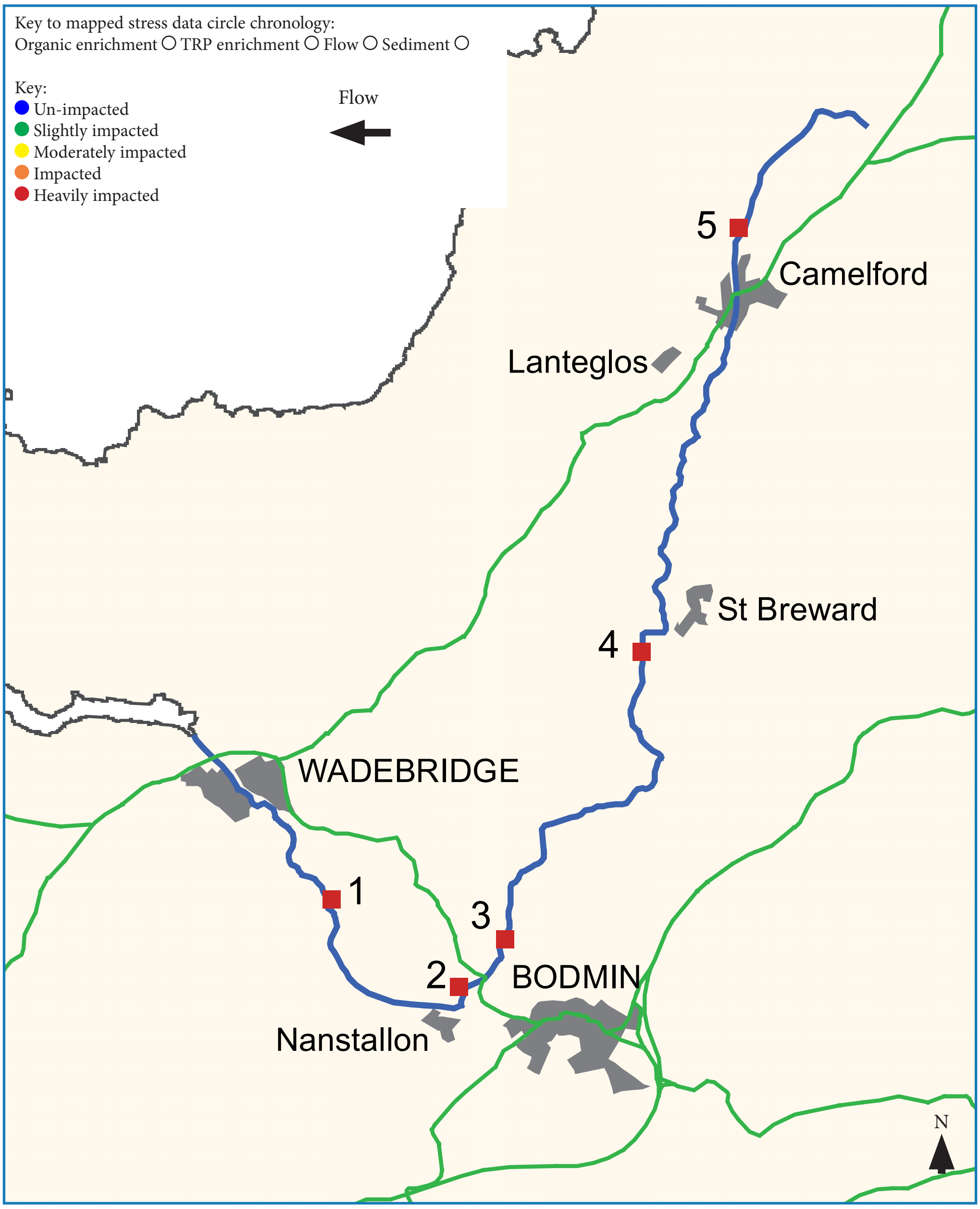
Source: S&TC UK 2015

Note the decline in riverfly richness and abundance at Sites 1 and 2 in the autumn. Also, the autumn *Gammarus* decline is unusual. It is worth noting that the biological signatures for pollutant stresses in 2015 associated well with the chemical signatures for this reach of the river, taken from a 2010-2013 chemical condition assessment report card for the River Axe SAC/SSSI (Natural England, 2014). It was also good to see the presence of numbers of eel elvers in the sample at the lower sites. The elvers were returned to the river unscathed.

Natural England (2014a). *Natural England Pollution Risk Assessment Axe Catchment.* Westcountry Rivers Ltd., Callington, Cornwall, 66pp.

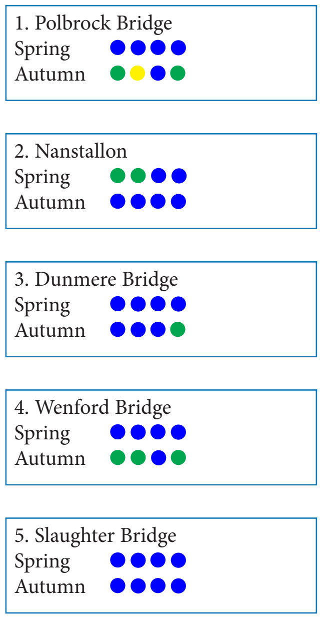
River Camel

On biological signatures alone, the Camel was a good performer in 2015. Only *Gammarus* numbers appeared to decline up the river, which may be related to changing habitat type and/or land management practices.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Camel in 2015



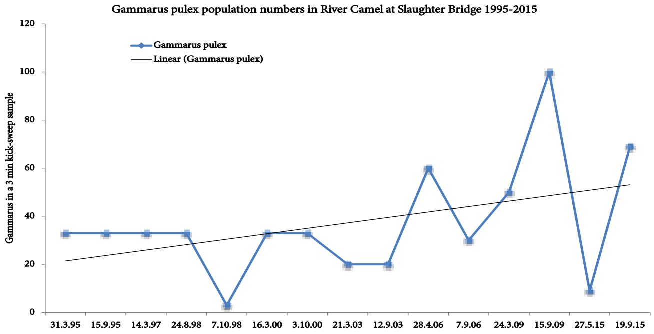
Source: S&TC UK 2015

River Camel Riverflies and *Gammarus* 2015

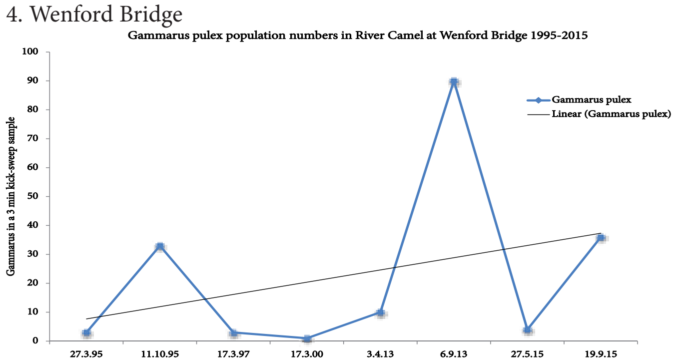
Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	25	18	18	16	21	11	12	10	13	13	20	12
Abundance	550	558	405	419	323	331	185	92	106	105	451	164
Gammarus												
Abundance	1836	128	2	4	9	2493	329	7	36	69	396	587

River Camel Freshwater shrimp levels 1995-2015

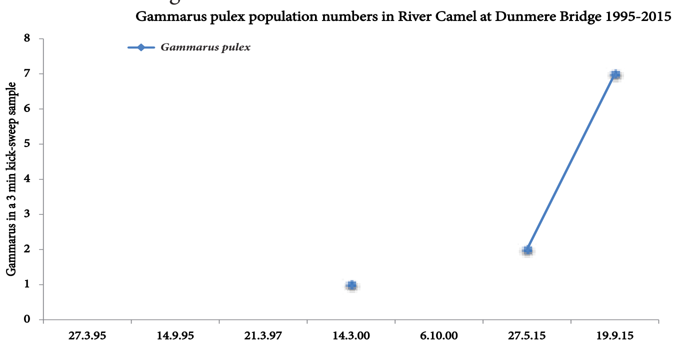
5. Slaughter Bridge

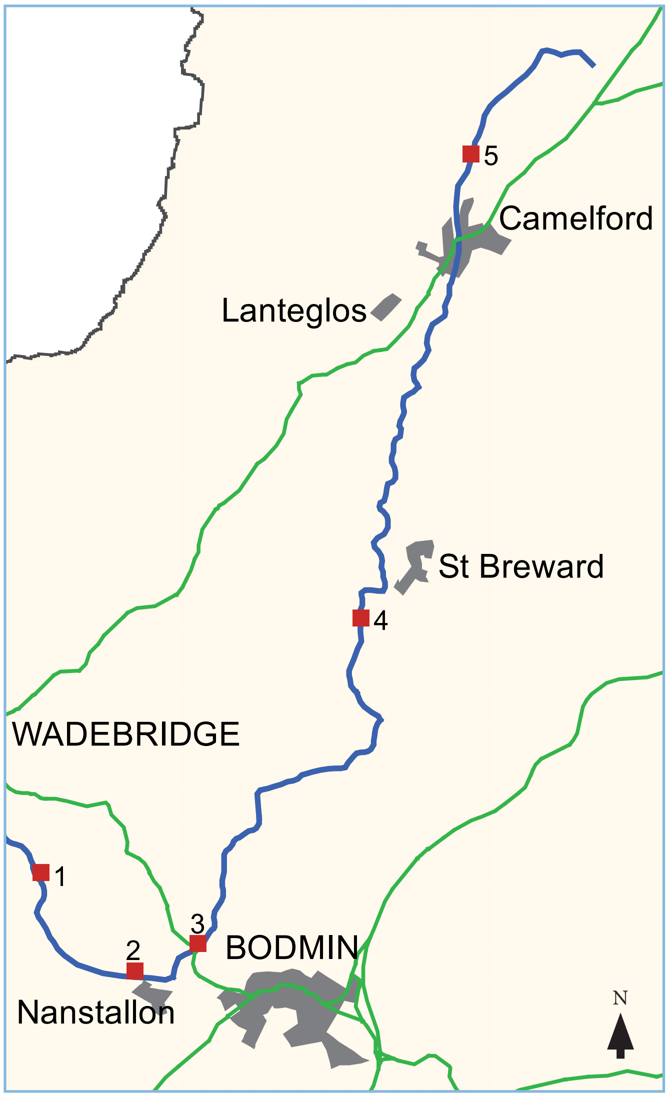


4. Wenford Bridge

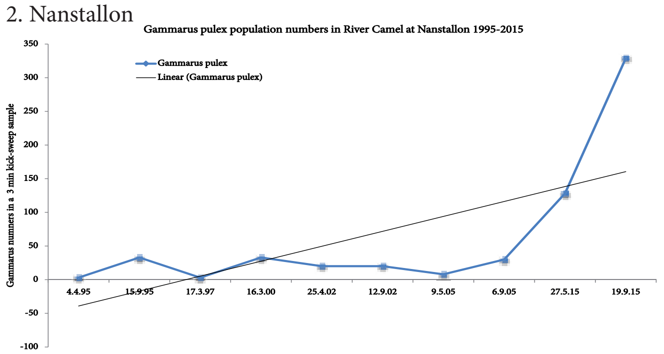


3. Dunmere Bridge

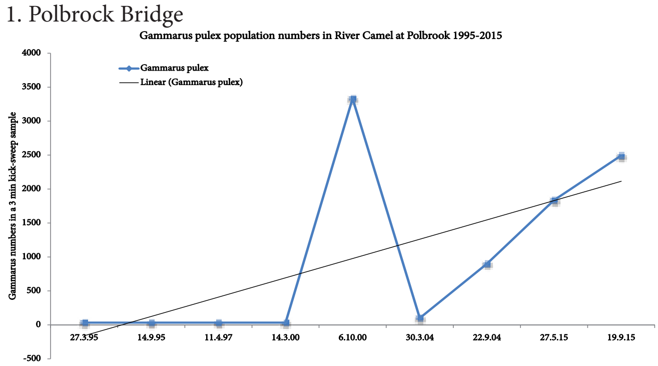




2. Nanstallon



1. Polbrock Bridge



All charts sourced: EA, S&TC UK

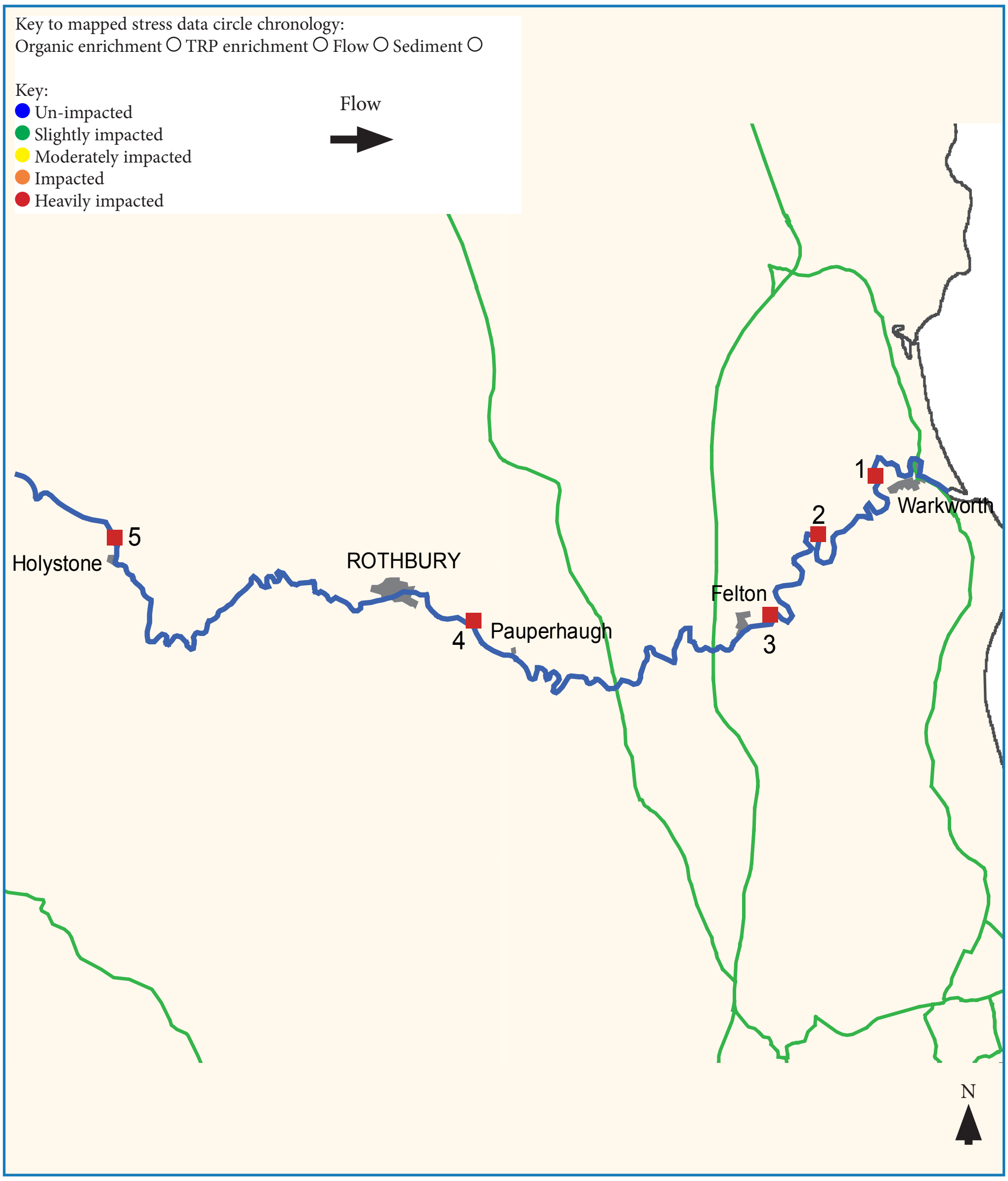
Trends are positive, except for the puzzlingly low *Gammarus* levels further upstream.

It is worth noting that the biological signatures for pollutant stresses in 2015 compared well with chemical signatures for this reach of the River Camel, taken from a 2010-2013 chemical condition assessment report card for the River Camel SAC/SSSI (Natural England, 2014).

Natural England (2014b). *Natural England Pollution Risk Assessment Camel Catchment.* Westcountry Rivers Ltd, Callington, Cornwall, 66pp.

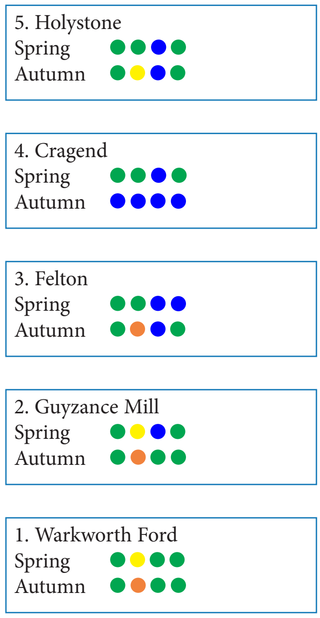
River Coquet

The Coquet had reaches of good biological signatures delivering good species richness and abundance. Site 4 at Cragend in the autumn is one of the best examples in our entire survey. The species level result for this site is available on request but not until the author has fished it! *Gammarus* numbers throughout the catchment are low and this may be due in part to habitat and/or agricultural practices.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Coquet in 2015



Source: S&TC UK 2015

River Coquet Riverflies and *Gammarus* 2015

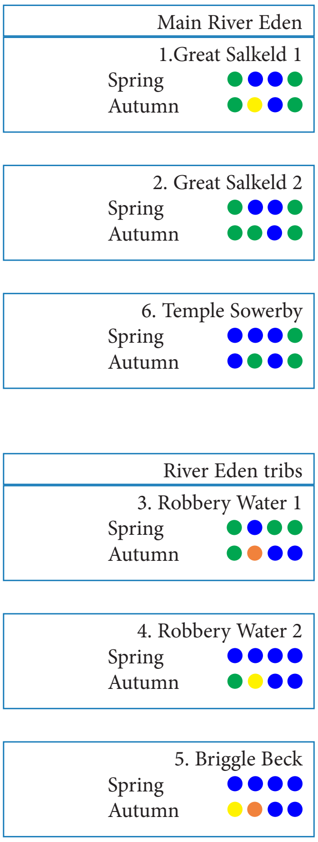
Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	17	17	23	18	20	13	10	16	23	12	19	15
Abundance	301	490	518	596	629	198	234	265	640	608	507	389
Gammarus												
Abundance	0	6	10	8	0	29	33	24	98	0	5	37

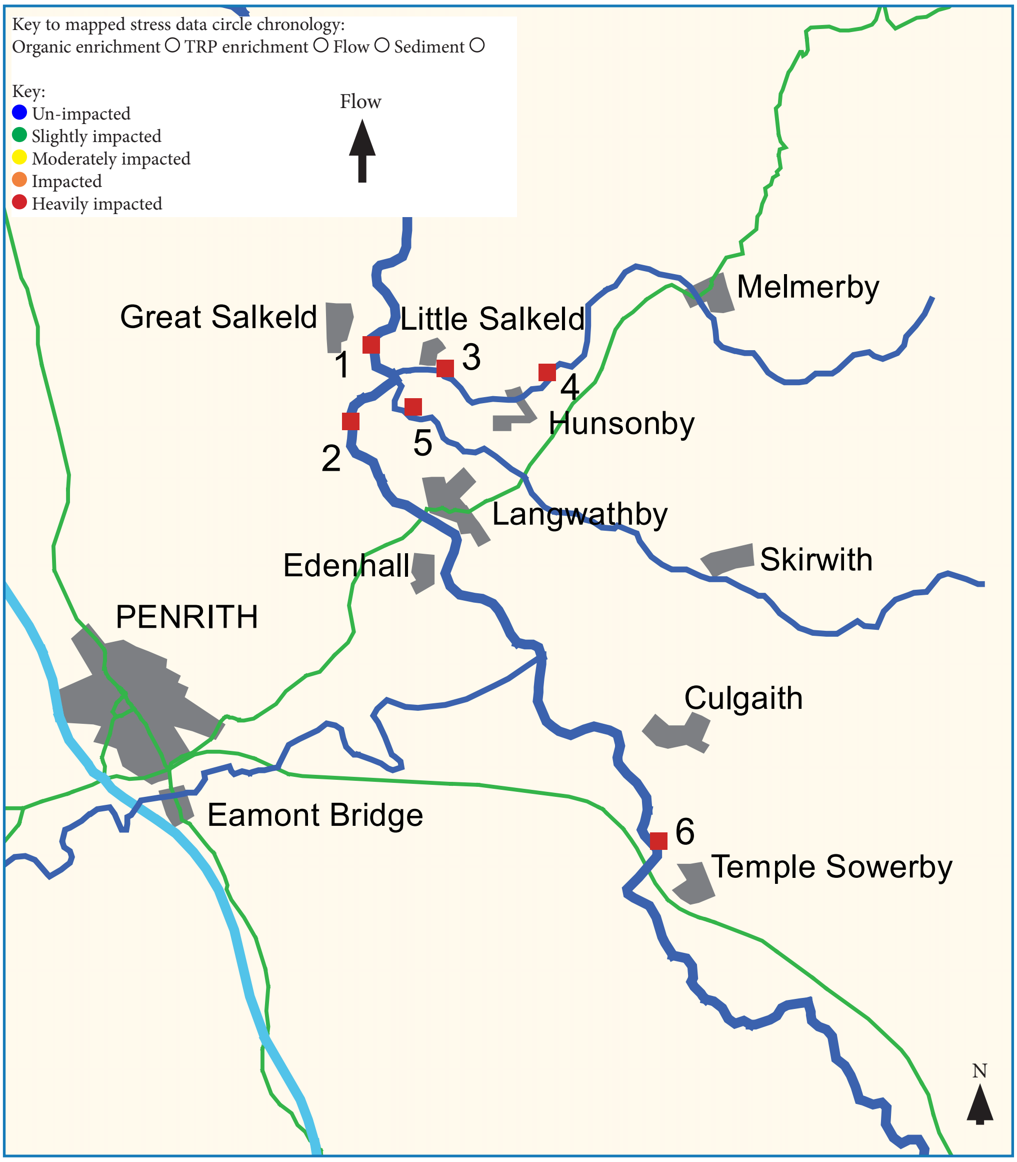
River Eden

The Eden is a mixed bag across the limited range of our study sites. It is mostly unimpacted or slightly impacted in spring conditions and deteriorates in the lower flow conditions of autumn, when P clearly impacts on the tributaries. The *Gammarus* counts and trends are interesting. In some reaches, levels are lower than we would expect. This variability may be due to livestock-related chemicals and run-off such as slurry entering watercourses.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Eden in 2015



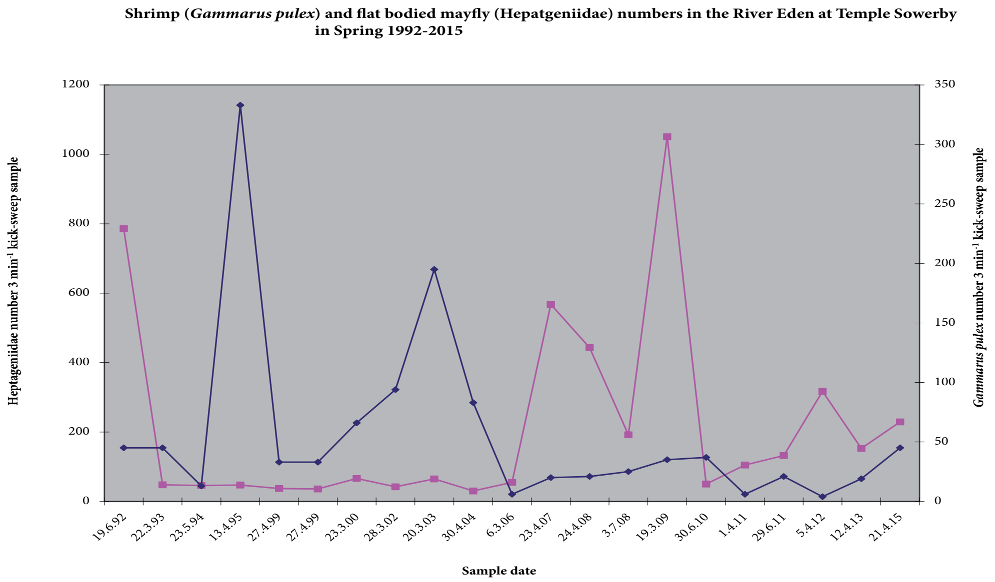


Source: S&TC UK 2015

River Eden Riverflies and *Gammarus* 2015

Site	Spring 1	2	3	4	5	6	Autumn 1	2	3	4	5	6	Spring average	Autumn average
Riverflies														
Species	20	16	21	11	14	22	10	13	12	11	12	15	17	12
Abundance	510	483	333	134	376	757	298	295	137	319	126	256	432	239
Gammarus														
Abundance	1	15	4	3	161	45	0	1	316	148	145	61	38	112

The Eden exhibited moderate to low riverfly abundance across most of the study sites. *Gammarus* was poor in the spring but recovered somewhat in the autumn except for sites 1 and 2. However, long-term data for site 6, Temple Sowerby, shows that both riverflies and *Gammarus* are well below the levels achieved in previous decades.



Shrimp *(Gammarus pulex)* and flat bodied mayfly *(Hepatgeniidae)* numbers in the River Eden at Temple Sowerby in spring 1992-2015

Source: EA, S&TC UK

The longer-term *Gammarus* trends at Temple Sowerby and on the Eamont are negative. The predominant form of farming around our sites is cattle – both dairy and beef. *Gammarus* numbers may well be affected by livestock medications such as Ivermectin (as laboratory experiments have shown at very low dose levels). Further study is required to establish cause but it is clear that something is impacting *Gammarus* populations in this reach of the River Eden.

Iron Blue dun female (Baetis niger). © *Stuart Crofts*

River Dove

The flylife appears somewhat light compared with the general water quality derived from the biometrics. We note site 5 is poorer in spring than other sites. This may be due to agricultural pollution. A particular concern is the presence of the invasive demon shrimp *(Dikerogammarus haemobaphes)* at site 1 and 2. The lower *Gammarus* counts at sites 4 and 5 in the autumn may be habitat related or indicate insecticide or other toxin issues.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Dove in 2015

5. Hollinsclough
Spring ●●●● (green, yellow, green, blue)
Autumn ●●●● (blue, blue, blue, blue)

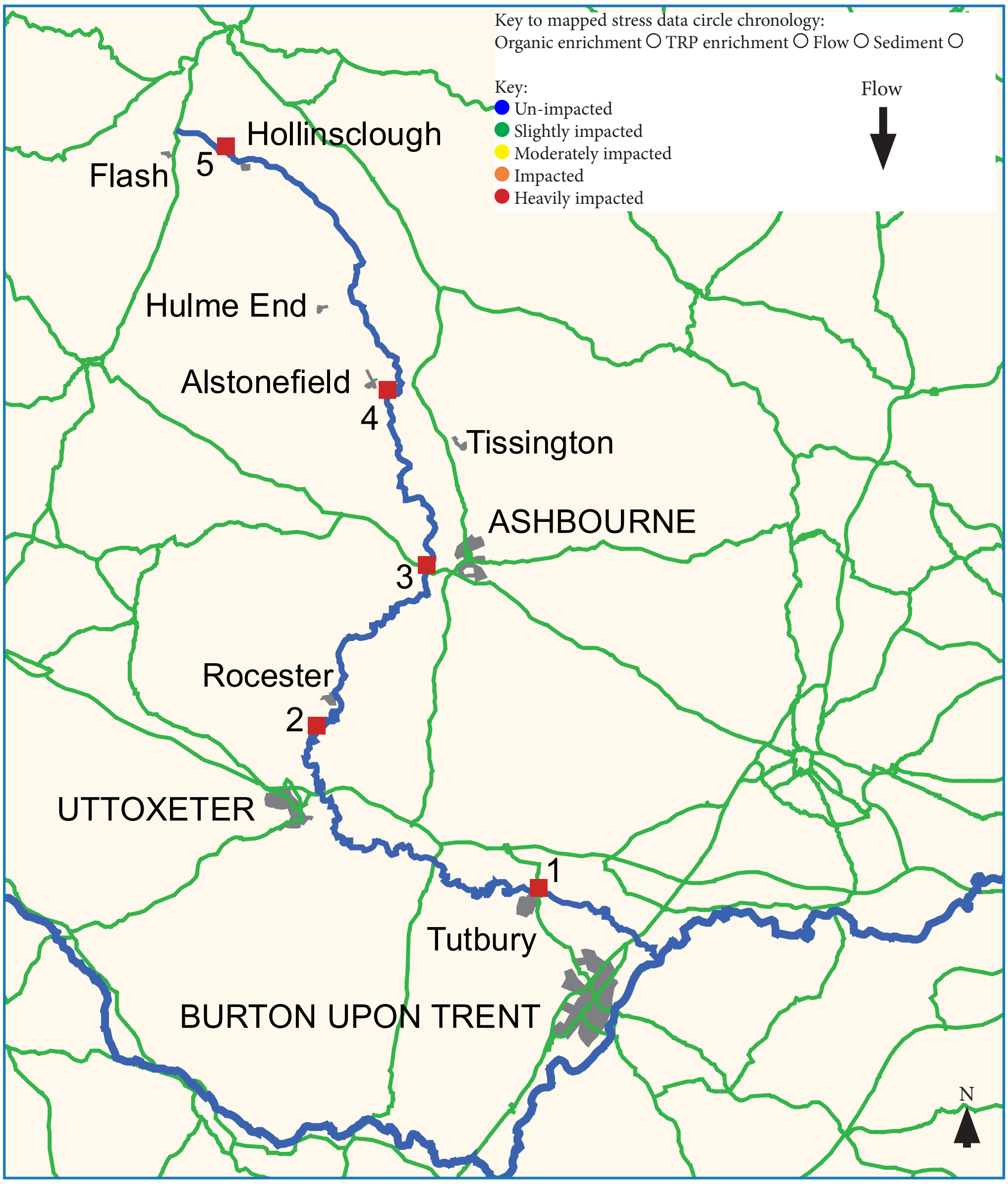
4. Milldale
Spring ●●●● (green, green, blue, blue)
Autumn ●●●● (blue, blue, blue, blue)

3. Mayfield
Spring ●●●● (blue, blue, blue, green)
Autumn ●●●● (blue, blue, blue, green)

2. Rocester
Spring ●●●● (blue, blue, blue, green)
Autumn ●●●● (green, blue, blue, green)

1. Hatton
Spring Not sampled
Autumn ●●●● (green, yellow, green, green)

Source: S&TC UK 2015

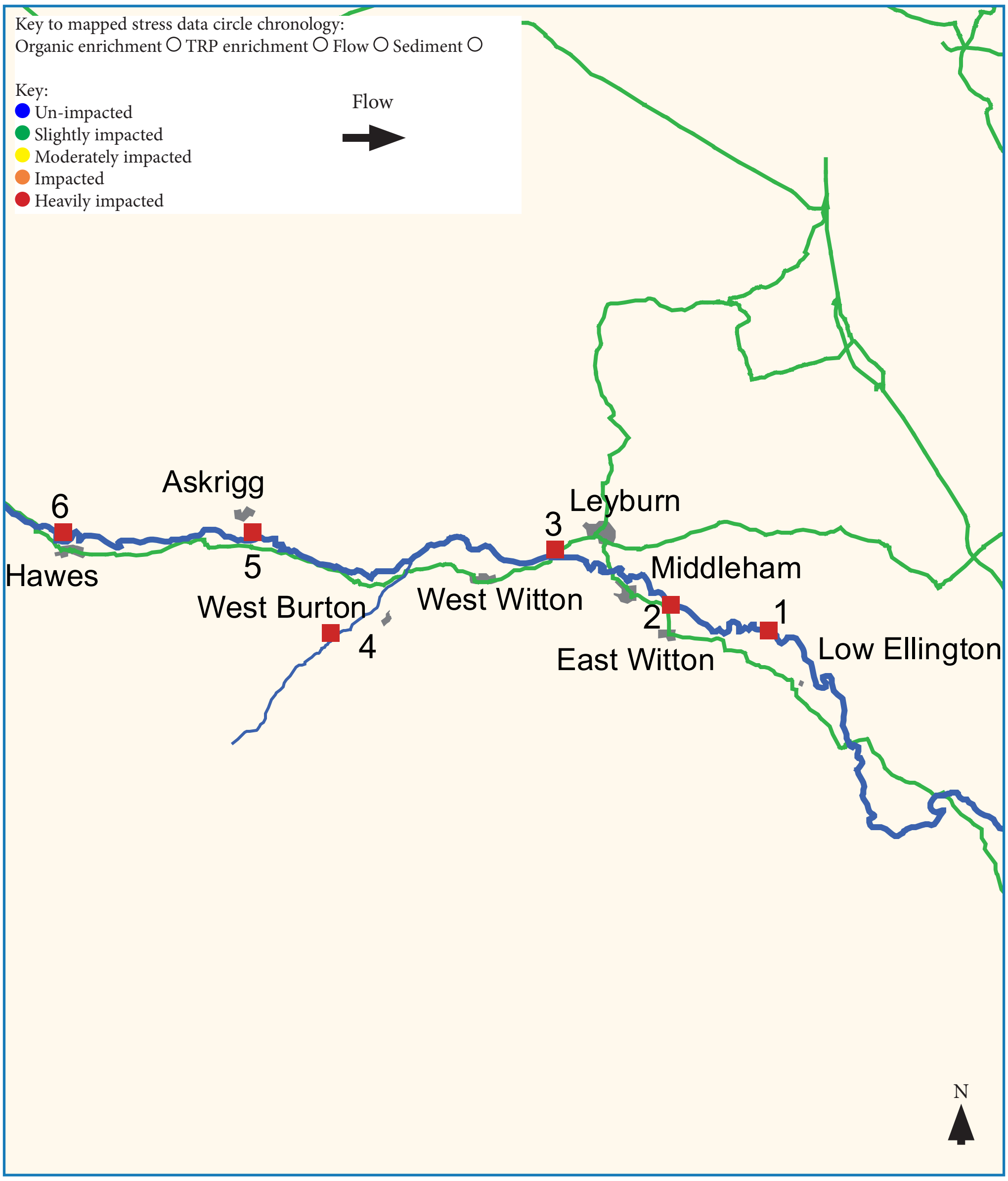


River Dove Riverflies and *Gammarus* 2015

Site	Spring 1	2	3	4	5	Autumn 1	2	3	4	5	Spring average	Autumn average
Riverflies												
Species	n/s	20	25	18	15	9	13	17	15	11	20	13
Abundance		439	745	457	354	229	278	289	229	87	499	222
Gammarus												
Abundance	n/s	109	153	20	1	59	26	123	68	0	71	55

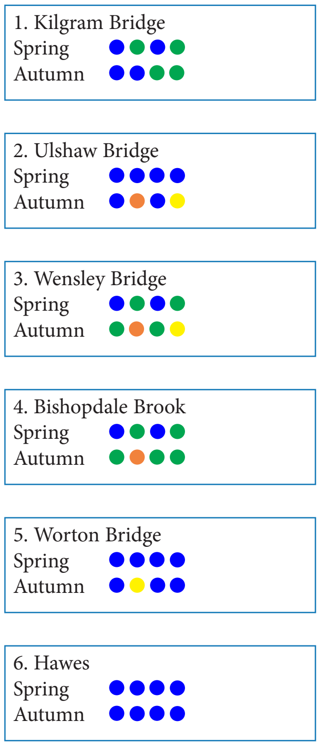
River Ure

Autumn biometrics deteriorated from the spring, possibly due to the impact of a dry summer, with phosphate and sediment signatures the worst. The lack of *Gammarus* in both spring and the peak autumn breeding season suggests a lack of suitable habitat in the rapid flows, the possible presence of low level insecticide pollution or a lack of recovery from widespread historic pollution issues.



Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Ure in 2015



Source: S&TC UK 2015

River Ure Riverflies and *Gammarus* 2015

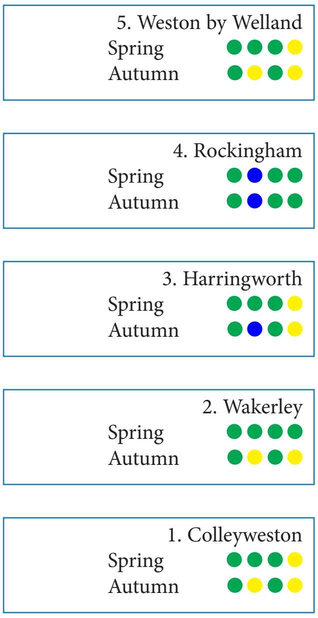
Site	Spring 1	2	3	4	5	6	Autumn 1	2	3	4	5	6	Spring average	Autumn average
Riverflies														
Species	21	23	22	21	20	19	11	8	12	11	9	10	21	10
Abundance	452	418	602	121	407	579	93	78	155	43	180	254	430	134
Gammarus														
Abundance	0	5	2	7	0	0	0	6	3	1	1	0	2	2

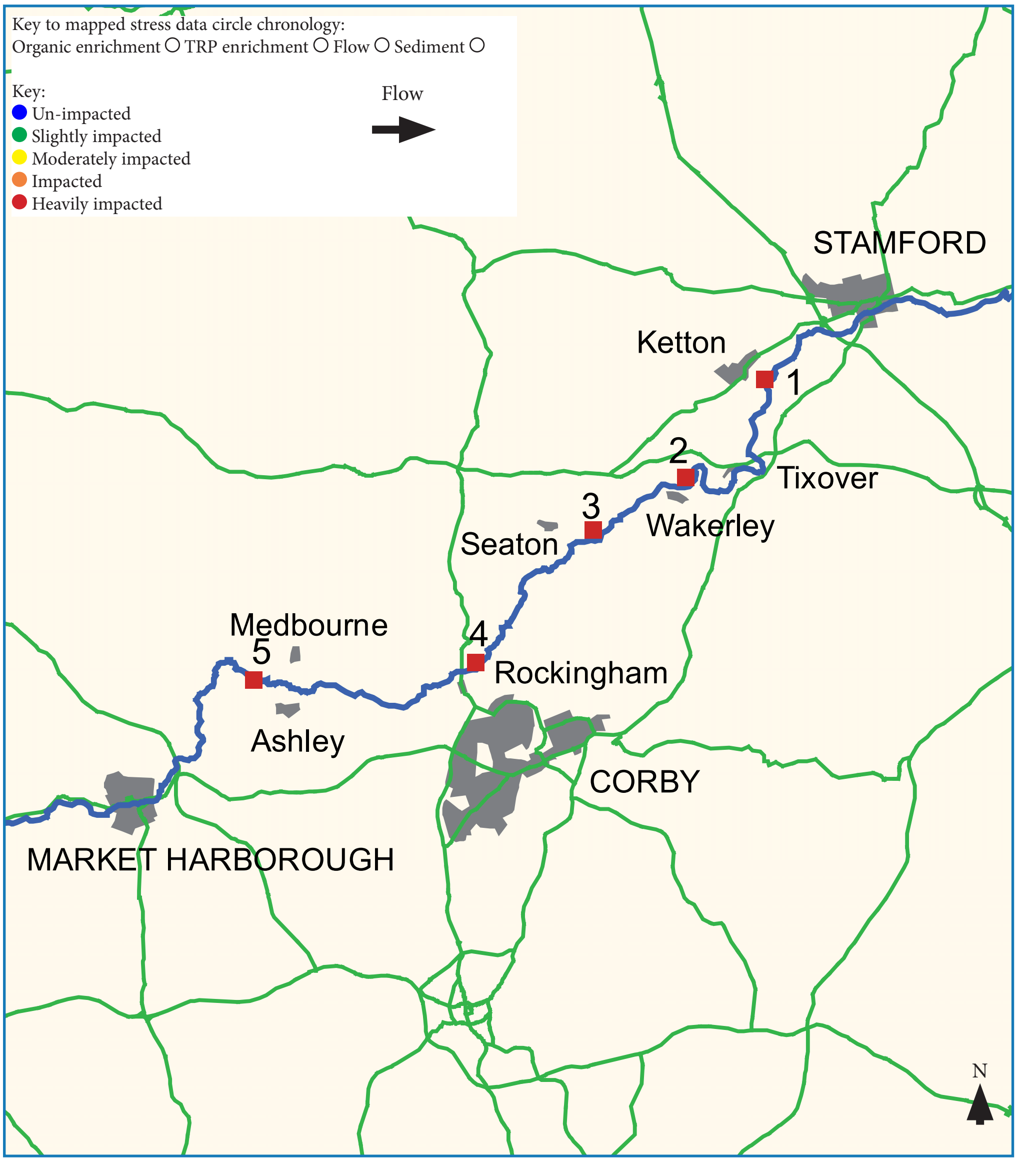
River Welland

Sediment and phosphates appear to be the main sources of pollution at our Census sites, with sediment particularly prevalent. Sediment is long recognised as a major source of impact on the river. *Gammarus* numbers were poor in spring and autumn for a relatively clean lowland river. This suggests the presence or legacy of some form of low-level chemical pollution in the river.

Biometric fingerprints

Organic, nutrient P, flow and sediment biological stress signatures in the River Welland in 2015





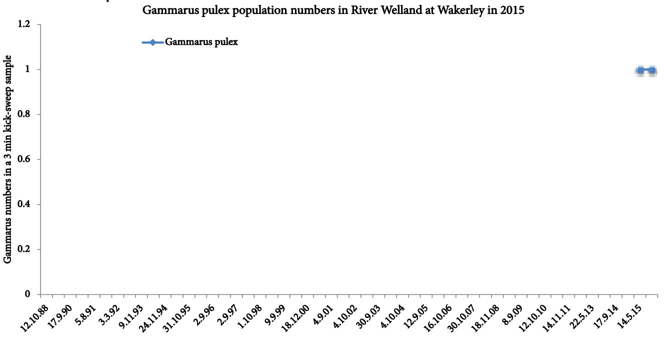
Source: S&TC UK 2015

River Welland Riverflies and *Gammarus* 2015

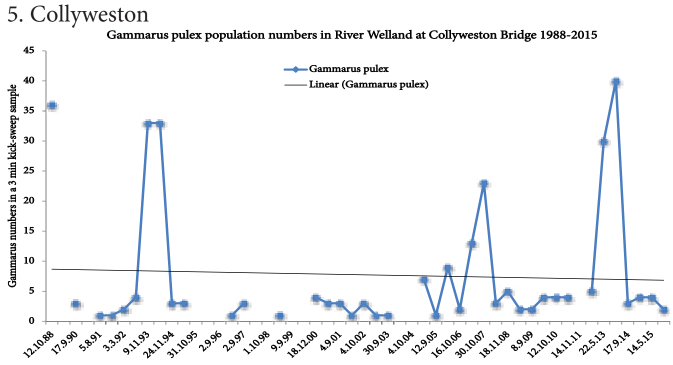
Site	Spring 1	Spring 2	Spring 3	Spring 4	Spring 5	Autumn 1	Autumn 2	Autumn 3	Autumn 4	Autumn 5	Spring average	Autumn average
Riverflies												
Species	11	13	18	13	13	9	9	12	8	12	14	10
Abundance	166	292	515	436	441	244	155	219	129	109	370	171
Gammarus												
Abundance	2	1	1	5	0	4	1	2	23	2	2	6

River Welland freshwater shrimp levels 1988-2015

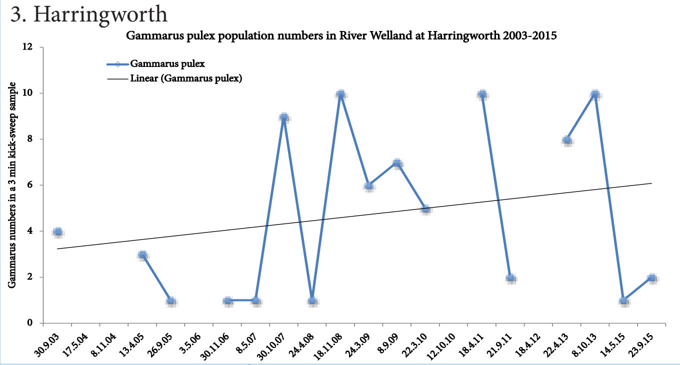
4. Wakerley

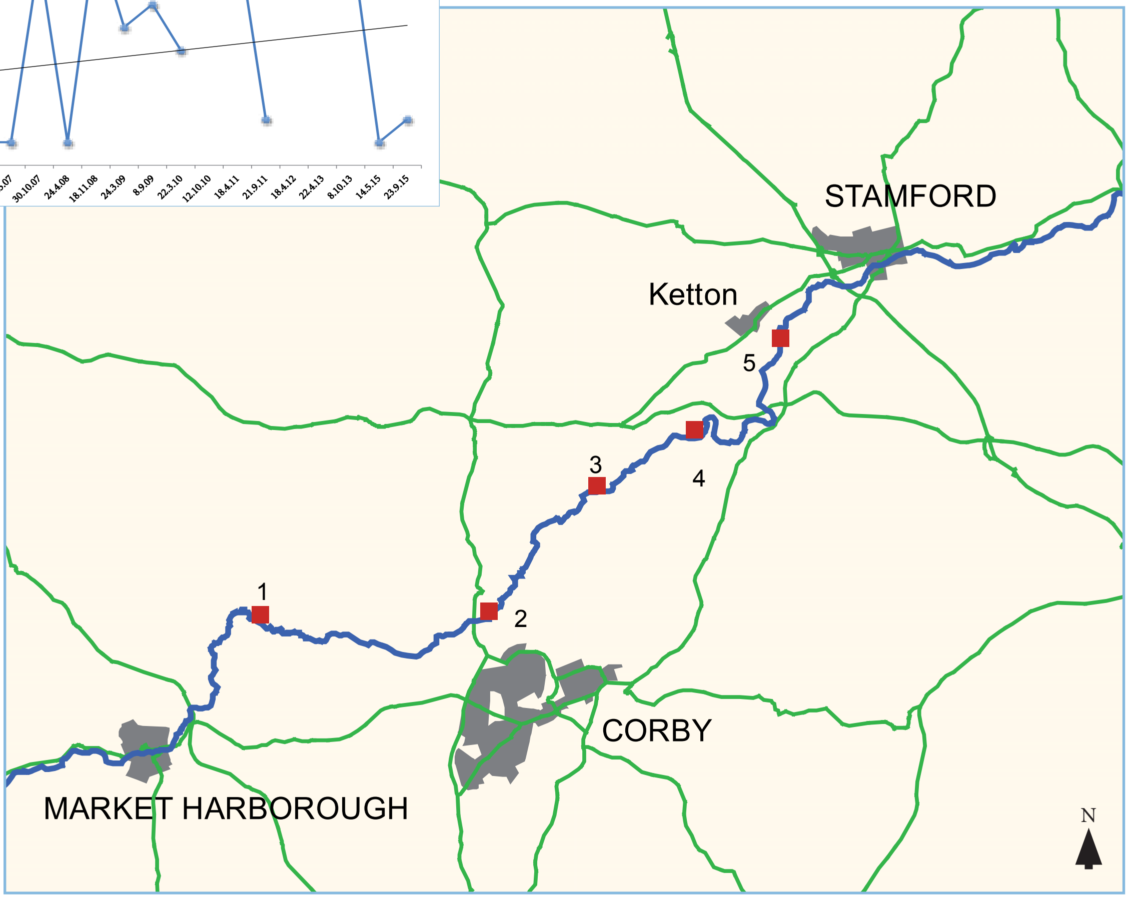


5. Collyweston

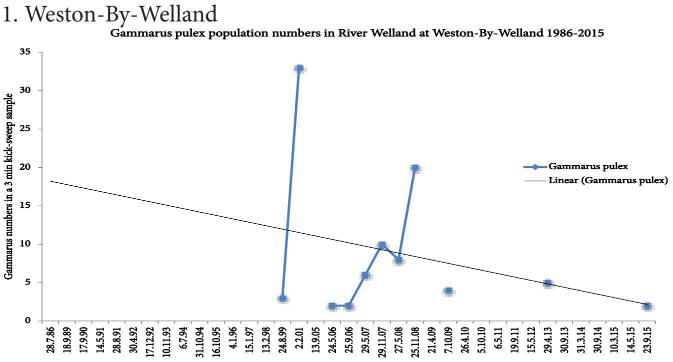


3. Harringworth

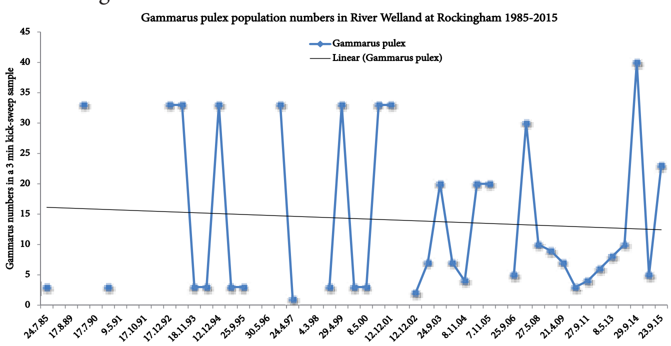




1. Weston-By-Welland



2. Rockingham



All charts sourced: EA, S&TC UK

Appendix 1

Look up table for individual biometric ranking scores (use for a cumulative river site rank)										
Rank	10 Biometrics for ranking ecological condition									
	BMWP	*ASPT	*R (species richness)	*Mayfly-stonefly-caddis EPT(S)	*Total invertebrate abundance in no/ 3 minute kick-sweep	PSI (S)	Saprobic index	Total Reactive Phosphorous (TRPI)	LIFE	CCI
5. V good	>96	>6.5	>45	>30	>5000	81-100	1.0-1.80	81-100	>8	>20
4. Good	71-95	6.0-6.5	35-44	20-29	1000-4999	61-80	1.81-2.29	61-80	7-7.99	15-20
3. Moderate	51-70	5.0-6.0	25-34	10-19	250-999	41-60	2.3-2.69	41-60	6.5-6.99	10-15
2. Poor	36-50	<5	15-24	2-9	100-249	21-40	2.7-3.19	21-40	6-6.49	5-10
1. Bad	0-35	<5	<14	≤1	≤99	0-20	3.2-4	0-20	<6	0-5

Source: Aquascience Consultancy Limited

This table shows the various bands (from 5 very good to 1 bad) for each of the 10 biometrics. There is an element of judgement in establishing the bandings. We hope to bring other quantitative methods into play in due course.

Appendix 2

Source: EA

WFD River Ecological Classifications
Ecological status applies to surface water bodies and is based on the following quality elements: biological quality; general chemical and physico-chemical quality; water quality with respect to specific pollutants (synthetic and non-synthetic); and hydromorphological quality. There are five classes of ecological status (high, good, moderate, poor or bad). Ecological status and chemical status together define the overall surface water status of a water body.

WFD River Ecological Classifications	
Status	**Definition**
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife or fisheries.
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

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