SmartRivers **Case files**

A decade of decline on the River Avon SAC

August 2025

Our evidence

Our invertebrate monitoring data shows a clear decline in the freshwater invertebrate community over the last ten years on the River Avon, a Special Area of Conservation (SAC) that flows through Wiltshire and Hampshire.

Surveys over ten years between 2015 and 2024 show:

- Invertebrate communities have declined - particularly in abundance (the numbers of invertebrates being found in samples).
- Declines in riverflies, sensitive sentinel species, were more significant than that of the wider invertebrate community.
- According to the Water Framework Directive (WFD) assessment all sites scored as 'high' quality for invertebrates in 2015. In 2024, the monitored sites still scored as 'high' or 'good' despite declines in the invertebrate community noted above.

Our asks

The Environment Agency (EA) and Natural England must change how they assess the health of chalk streams by setting more ambitious bespoke environmental targets.

Without this the disconnect between 'healthy' policy classifications and on-the-ground reality of ecological decline will continue, and we risk extinctions of sensitive species. This Avon dataset is a wake-up call that the current system is failing to protect our chalk streams.

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Introduction

The River Avon flows through Wiltshire and Hampshire. It is one of England's important chalk streams - an **internationally rare** habitat that supports a rich diversity of wildlife. Fed by groundwater from the surrounding chalk aquifer, the Avon provides clean, cool, and oxygen-rich water essential for species such as Atlantic salmon, brown trout, and water crowfoot. Designated as a **Site of Special Scientific Interest** (SSSI) and **Special Area of Conservation** (SAC), the river plays a critical role in the conservation of rare and protected species.

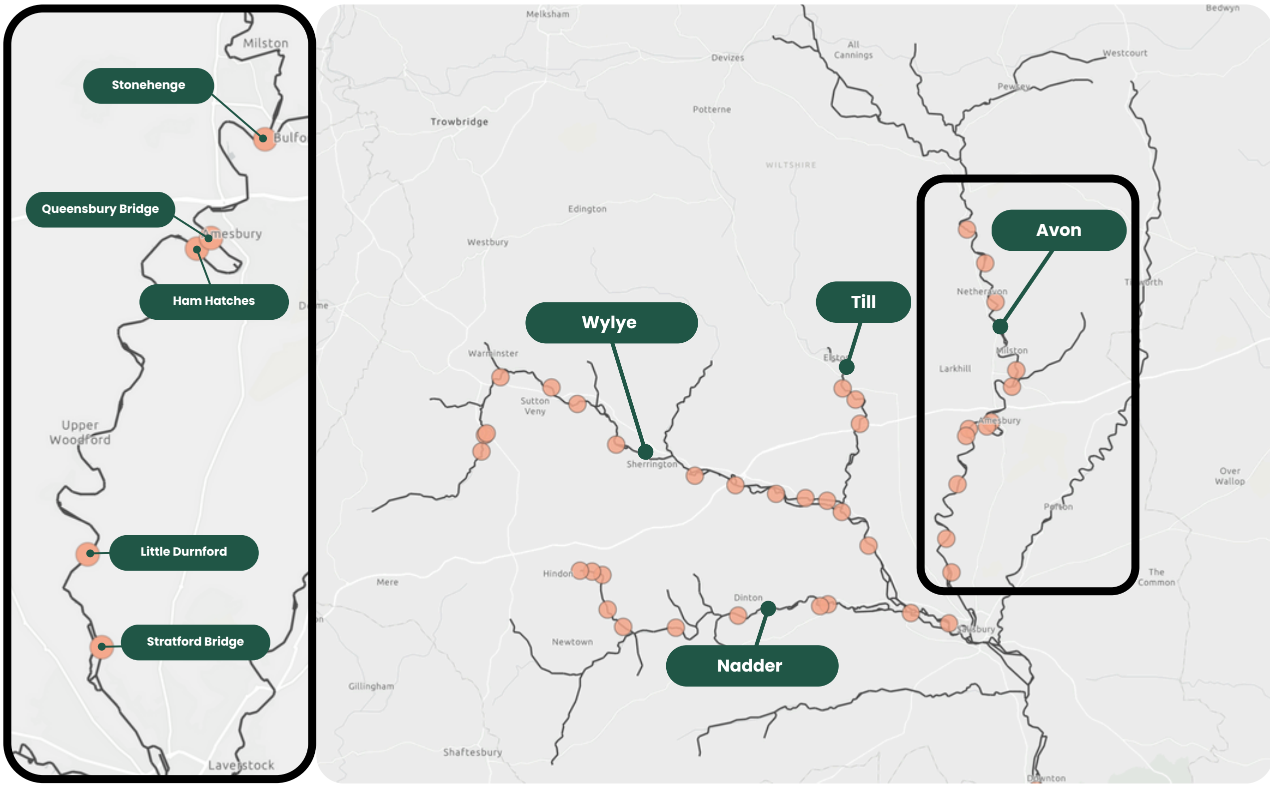

Figure 1: Pink circles show SmartRivers monitoring coverage in the Avon catchment. The five sites with a decade of data available are highlighted on the left.

WildFish holds a considerable amount of invertebrate monitoring data from our Riverfly Census project to more recent citizen science monitoring in our SmartRivers programme partnered with the Wiltshire Fishery Association (WFA). Our partnership now monitors 12 sites along the upper Avon, as well as 23 sites on the Nadder, Till, and Wylye tributaries. However, there were five initial sites on the upper Avon in 2015, and we now hold a **decade's worth of data** on these sites.

Methods/Analysis

Five SmartRivers sites on the River Avon were sampled twice a year (spring/autumn) between 2015 and 2024 using industry standardised three-minute kick sampling methods. This data was then used to create records of invertebrate biodiversity (diversity and abundance) over the years of surveying.

The invertebrates were identified to mixed taxonomic level, with species-level identification wherever possible. Diversity counts were estimated using a conservative approach. i.e., in a survey if there were observations of a species, but also related genus/family observations (e.g. from damaged specimens or early instars) it was assumed that these were likely to be the same species. True abundance counts were recorded.

All invertebrate identification was undertaken by professional entomologists. The kick samples were taken by a combination of professionals and trained SmartRivers volunteers from WFA. One site (Little Durnford) was missing surveys for autumn 2023 and spring 2024 as flow conditions were considered to be too dangerous to sample. A final sample size of 98 surveys taken over 10 years were analysed for this report.

An assessment of the invertebrate community was also calculated using the Whalley, Hawkes, Paisley, and Trigg (WHPT) metric in River Invertebrate Classification Tool (RICT v3.1.8). This method assesses the invertebrate community in a waterway according to the requirements of the WFD. The model 44 input template (and location checker environmental variables) was used for SmartRivers site data, and model 1 input for the EA site data. An NTAXA bias value of 0 was used for the former (based of independent quality controls) and the standard 1.68 for the latter.

Separate analyses were conducted on trends in diversity and abundance for both the total invertebrate community and the riverfly (mayflies, stoneflies, and caddisflies) community. Riverflies in general are considered sensitive to pollution and good indicators for the broader health of river ecology.

For the initial simple comparisons between 2015 and 2024 datasets Wilcoxon signed rank tests were conducted on paired data that did not meet the assumptions of normality (Little Durnford spring 2015 was excluded as it lacked a 2024 pairing). Seasons were combined into one annual dataset to ensure an appropriate sample size.

To assess temporal trends and seasonal differences, linear mixed-effects models were run separately for species richness and abundance, for both the total aquatic invertebrate community and the riverfly community. Year was treated as a continuous fixed effect to capture long-term trends, while season (spring vs autumn) was included as a categorical fixed factor, along with the interaction between year and season. Site was included as a random effect to account for repeated sampling at the same locations over time. Abundance data were log-transformed to improve normality and meet model assumptions.

Results

2015 vs 2024 analysis

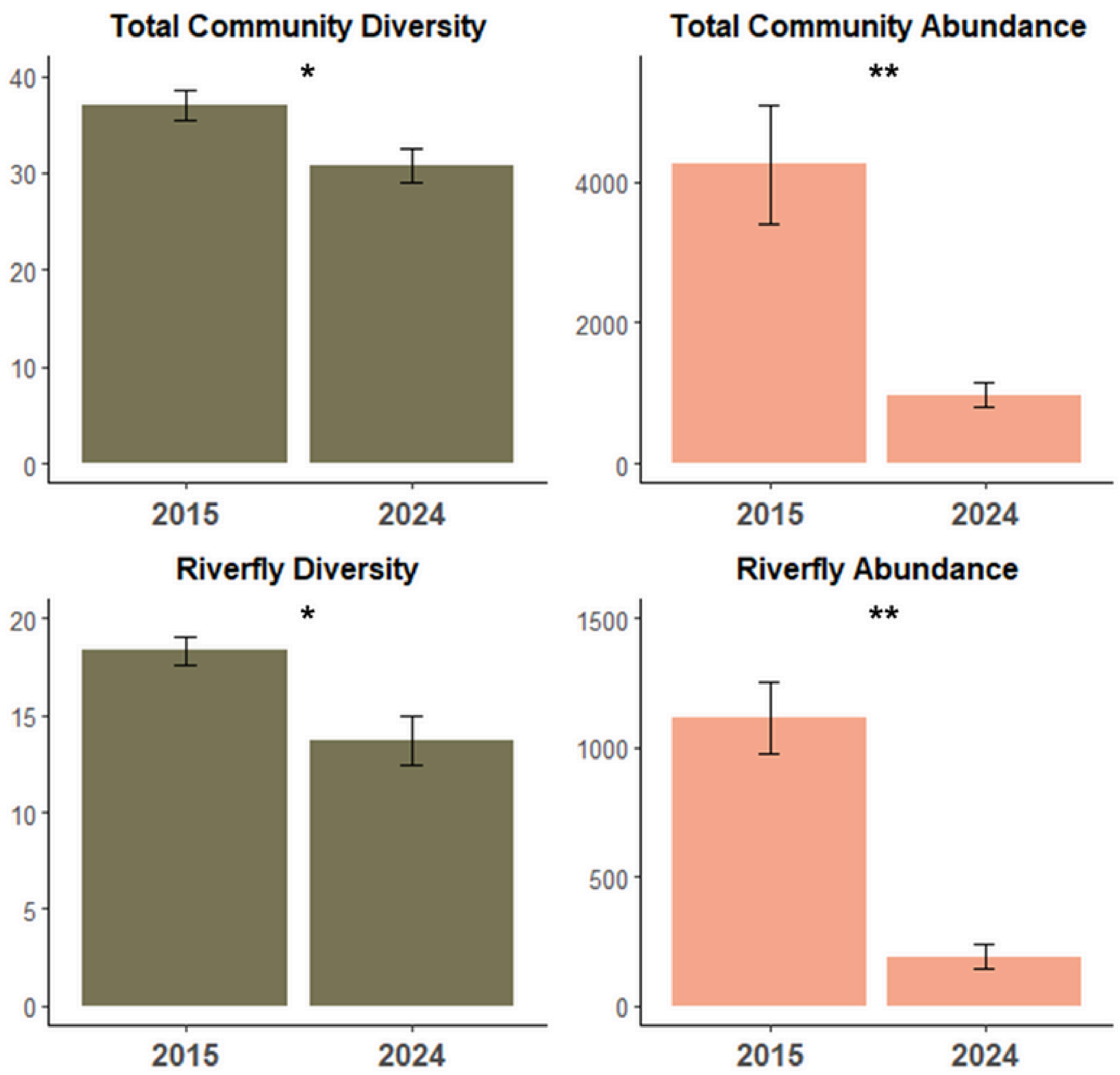

Figure 2: Showing the average annual counts (± standard error) of diversity and abundance for both the total community and riverfly community in 2015 and 2024.

Total invertebrate community analysis between 2015 and 2024 samples showed a significant decline in both diversity (p=0.02) and abundance (p=0.004). These data show a 17% decline in average annual diversity counts and a 77% decline in average annual abundance counts between 2015 and 2024.

Riverfly community analysis between 2015 and 2024 samples showed a significant decline in both diversity (p=0.01) and abundance (p=0.008). These data show a 25% decline in average annual diversity and an 83% decline in average annual abundance between 2015 and 2024.

The analysis above provides a summarised interpretation of our long-term dataset. It shows clearly what we consider to be a highly concerning decline in the invertebrate populations on the Avon. To further support this, a more in-depth analysis examining trends over the complete 10-year period with consideration of season is presented below.

A previous criticism of the SmartRivers dataset by the EA was that the abundance values for our 2015 survey was very high compared to subsequent years of monitoring. While this is undoubtably true (Figure 9), this is simply the dataset we have accumulated over this time. In the same area of the Avon as our SmartRivers sites the EA only has one site (9112) consistently monitored over the last decade in both seasons (WFD site 9110 only had data up to 2023 at time of download: April 2025). Figure 10 shows that the EA surveys in 2015 and 2024 had higher diversity values (conservative count described above) than SmartRivers surveys but the abundance values sit comfortably within the range of SmartRivers sites in 2015. There also appears to be a comparable decline in abundance between 2015 and 2024.

In-depth analysis

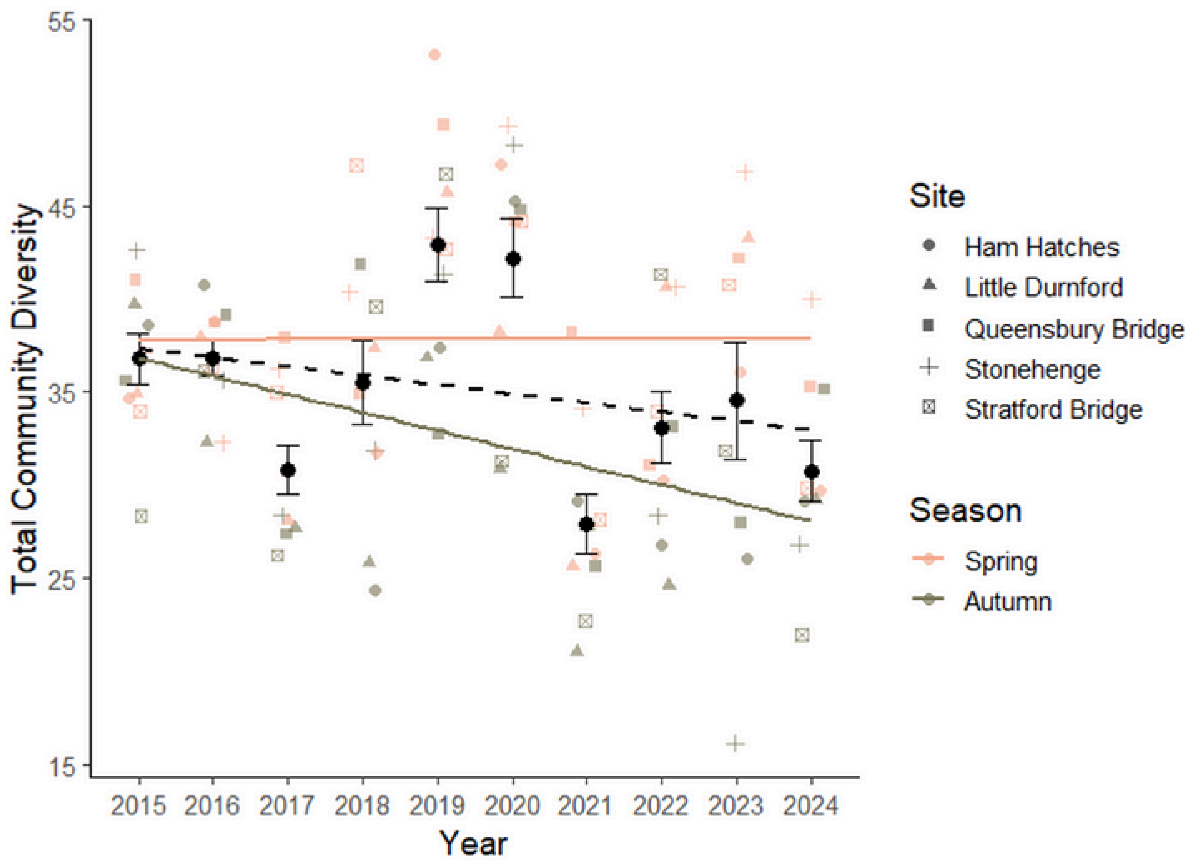

Figure 3: Showing trends in total community diversity between 2015 and 2024. Black points show average (± standard error) annual diversity. Trends displayed for annual average (black dashed), spring (pink), and autumn (grey) diversity. Coloured shapes show individual site data points across seasons.

Analysis of total community diversity showed the interaction between year and season was significant, indicating differing trends between seasons ($F_{1,94} = 4.31$, $p = 0.041$). A post hoc inspection of fixed effects showed a significant negative interaction term ($t_{94} = -2.08$, $p = 0.041$), suggesting a decline in diversity in autumn samples over time, but not in spring. As their interaction was significant, the effects of year ($F_{1,94} = 4.12$, $p = 0.045$) and season ($F_{1,94} = 0.15$, $p > 0.7$) were not significant individually, although year did show a marginal effect. Therefore, this analysis suggests that while there is no overall decline in total community diversity over time, the invertebrate diversity is declining in the autumn surveys.

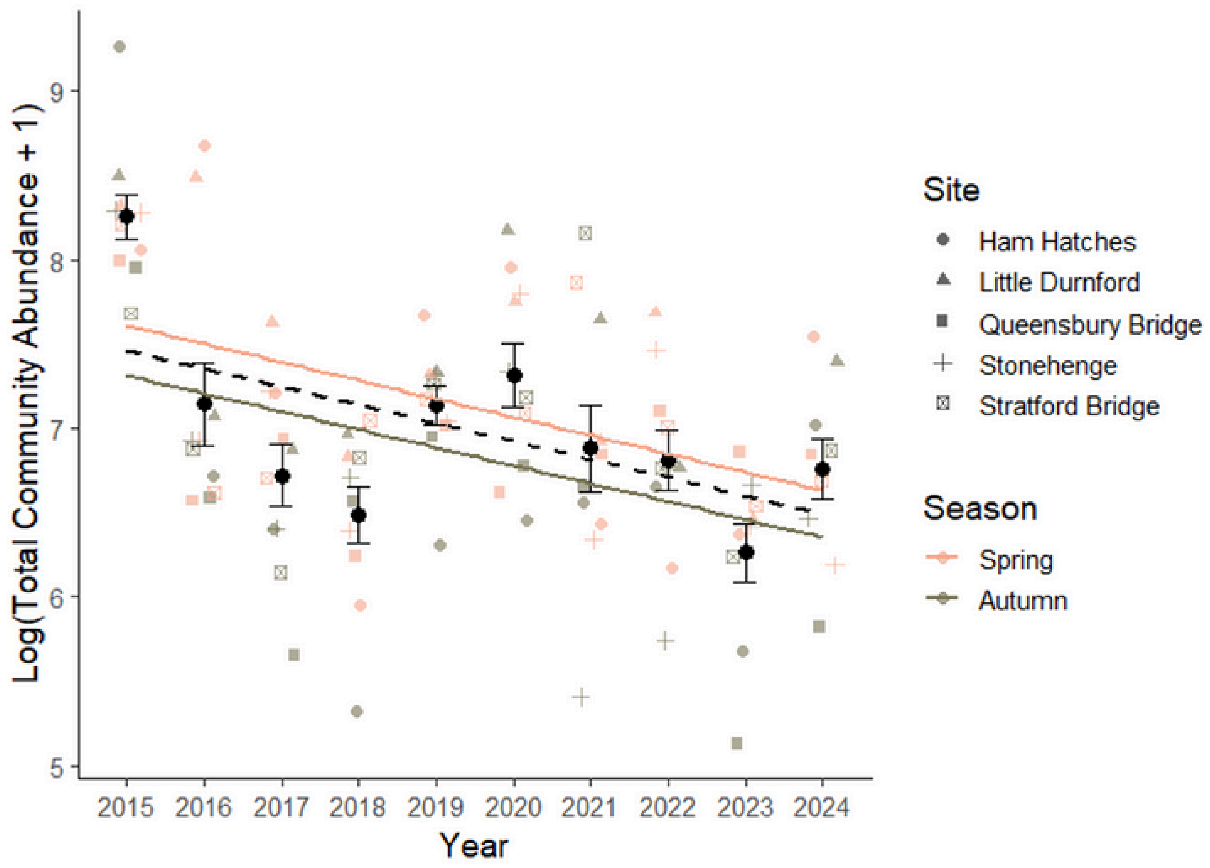

Figure 4: Showing trends in total community abundance between 2015 and 2024. Black points show average (± standard error) annual abundance. Trends displayed for annual average (black dashed), spring (pink), and autumn (grey) abundance. Coloured shapes show individual site data points across seasons.

Analysis of log transformed total community abundance data showed a significant result for year ($F_{1,90} = 19.27$, $p < 0.001$), where total abundance declined over the surveying period ($t_{90} = -3.11$, $p = 0.003$). There was no significant effect of season ($F_{1,90} = 1.38$, $p > 0.1$) or the interaction between year and season ($F_{1,90} = 0.001$, $p > 0.9$). This analysis shows a clear decline in abundance across both seasons over time.

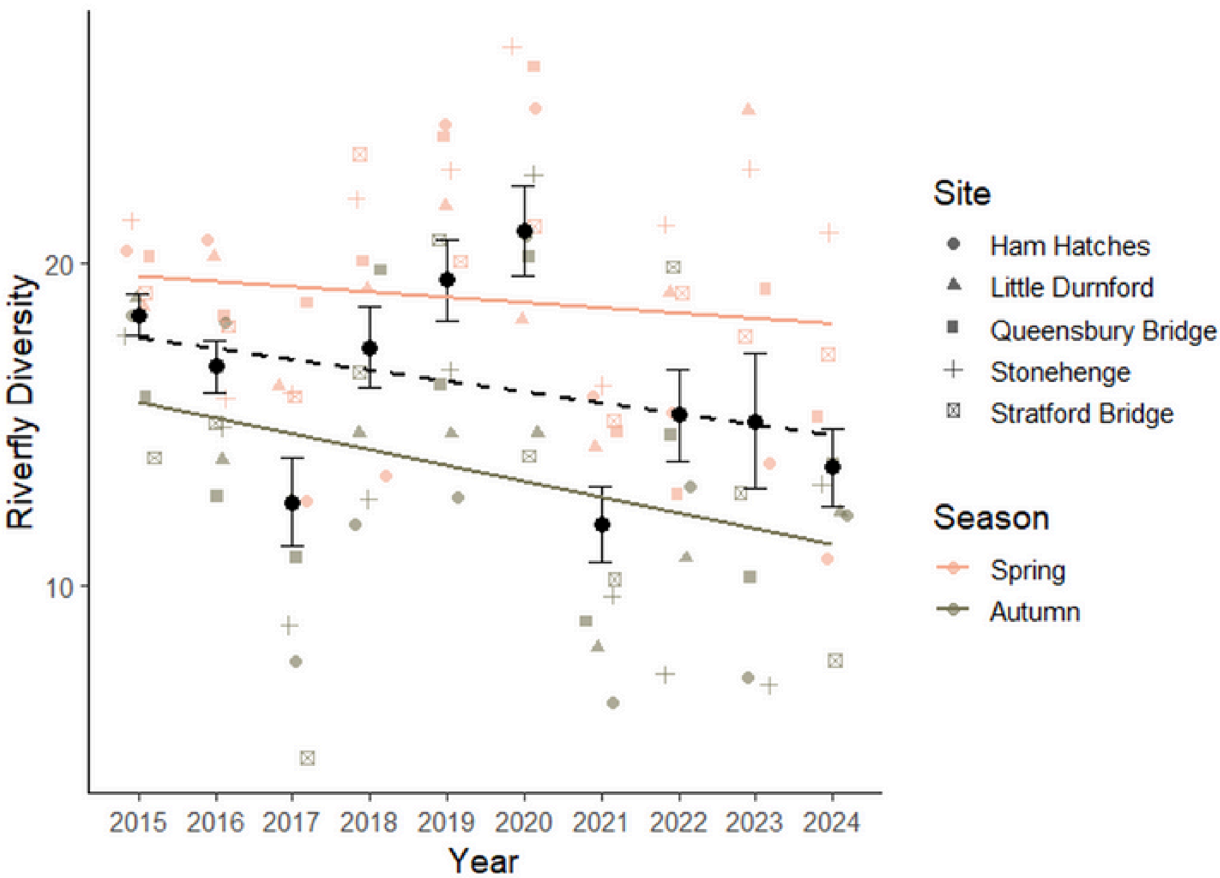

Figure 5: Showing trends in riverfly diversity between 2015 and 2024. Black points show average (± standard error) annual diversity. Trends displayed for annual average (black dashed), spring (pink), and autumn (grey) diversity. Coloured shapes show individual site data points across seasons.

Analysis of riverfly diversity showed significant results for both year ($F_{1,94}$ = 5.43, p = 0.022) and season ($F_{1,94}$ = 6.81, p = 0.011). This suggests a decline in riverfly diversity over the sampling period, with diversity ~4 observations lower on average in the autumn surveys (t_{94} = −2.61, p = 0.011). The interaction between year and season was not significant ($F_{1,94}$ = 1.39, p = 0.241). These results suggest that riverfly diversity is decreasing across both seasons, with autumn consistently showing lower diversity. The latter result is not unexpected due to riverfly lifecycles, as species such as the blue-winged olive mayfly (*Serratella ignita*) for example are expected to be in the egg stage.

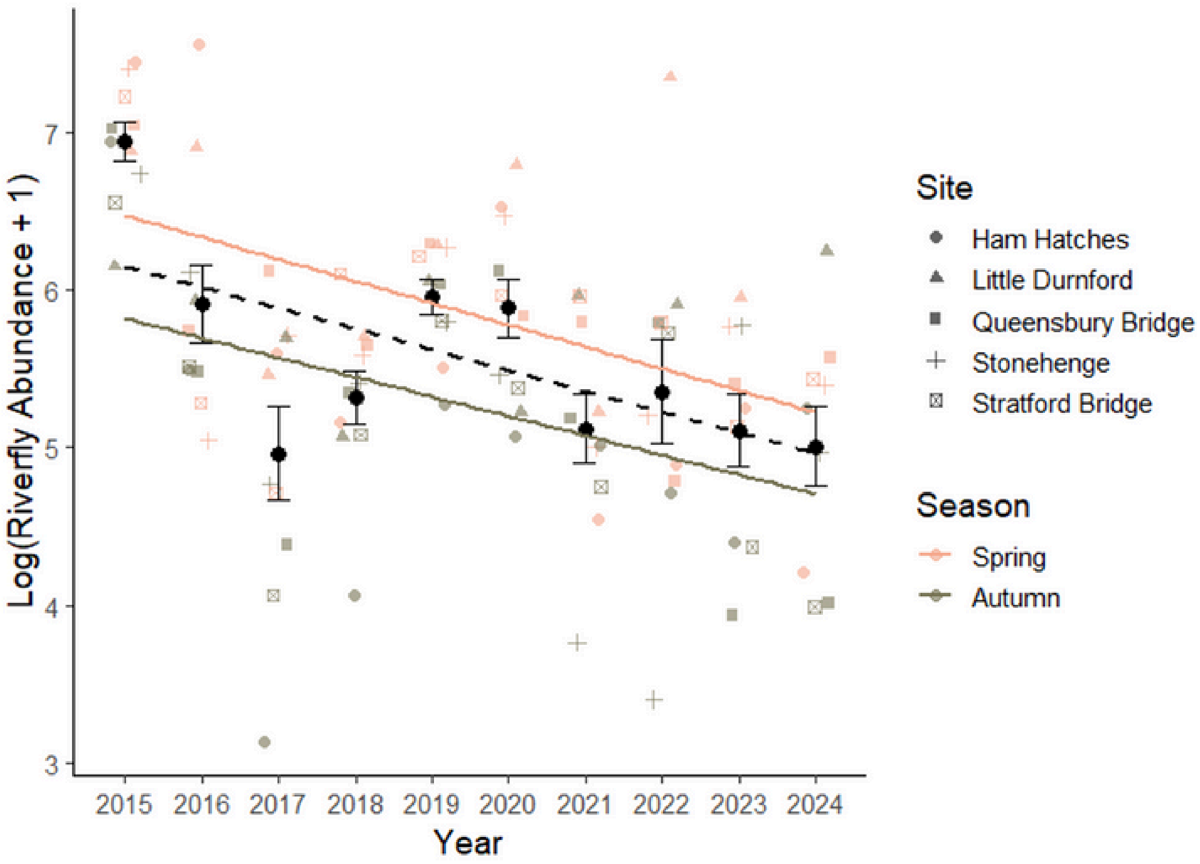

Figure 6: Showing trends in riverfly abundance between 2015 and 2024. Black points show average annual abundance (± standard error). Trends displayed for annual average (black dashed), spring (pink), and autumn (grey) abundance. Coloured shapes show individual site data points across seasons.

Analysis of log transformed abundance data for the riverfly community showed a significant effect of year ($F_{1,90}$ = 23.19, p < 0.001), where abundance declined over the surveying period (t_{90} = −3.58, p = 0.001). Season also had a significant effect ($F_{1,90}$ = 5.36, p = 0.023), with autumn riverfly abundance on average 48% lower than in spring (t_{90} = -2.14, p = 0.023). There was no significant effect of the interaction between year and season ($F_{1,90}$ = 0.074, p = 0.786). Overall, these results suggest that there is a consistent declining trend in riverfly numbers over the surveying period, with fewer riverflies found in the autumn samples. Again, the latter result is not unexpected as riverflies are generally expected to be in higher numbers in spring surveys due to their ecology[1].

Note: In this analysis year was treated a continuous (numerical) fixed factor as we are primarily focused on the trends in invertebrate populations over the monitoring period. However, if year is treated as a categorical factor (to focus on year-to-year non-linear changes), the interaction between year and season is highly significant, indicating greater declines in spring compared to autumn (p < 0.001). This is highly concerning given that we know spring surveys are key to monitoring riverfly populations.

[1] For example, species, or subsets of the population. that have overwintered as eggs will have emerged as larvae.

Spring Data

Year	Invertebrates	Sites Present (max 4)	Average Abundance (±SE)
2015	*Gammarus pulex/fossarum*	4	1432 (±236)
	Baetis sp.	4	908 (±140)
	Simuliidae *sp.*	3	396 (±88)
	Caenis rivulorum	4	140 (±53)
	Elmis aenea	3	140 (±25)
	Serratella ignita	4	89 (±66)
	Sericostoma personatum	4	57 (±13)
	Ephemera danica	4	51 (±15)
	Hydroptila sp.	4	50 (±33)
	Lepidostoma hirtum	4	36 (±19)
2024	Simuliidae *sp.*	4	560 (±351)
	Gammarus pulex/fossarum	4	141 (±18)
	Limnius volckmari	4	46 (±25)
	Baetis sp.	4	45 (±15)
	Sericostoma personatum	4	39 (±13)
	Ephemera danica	4	30 (±16)
	Serratella ignita	3	26 (±18)
	Chironomidae *sp.*	4	20 (±9)
	Hydroptila	2	20 (±17)
	Aphelocheirus aestivalis	1	18 (NA)

Autumn Data

Year	Invertebrates	Sites Present (max 5)	Average Abundance (±SE)
2015	*Gammarus pulex/fossarum*	5	3177 (±1355)
	Baetis sp.	5	541 (±90)
	Elmis aenea	4	454 (±127)
	Simuliidae *sp.*	3	190 (±93)
	Limnius volckmari	4	142 (±18)
	Hydropsychidae *sp.*	5	97 (±33)
	Potamopyrgus antipodarum	2	84 (±55)
	Chironomidae *sp.*	5	68 (±17)
	Pisidium sp.	5	53 (±12)
	Ephemera danica	5	45 (±17)
2024	*Gammarus pulex/fossarum*	5	470 (±124)
	Simuliidae *sp.*	5	86 (±33)
	Limnius volckmari	5	77 (±32)
	Agapetus fuscipes	4	76 (±62)
	Elmis aenea	5	44 (±12)
	Chironomidae *sp.*	4	30 (±16)
	Hydropsychidae *sp.*	5	27 (±19)
	Ephemera danica	5	20 (±10)
	Sericostoma personatum	5	19 (±10)
	Brachycentrus subnubilis	5	17 (±7)

Figure 7: Showing the 10 invertebrate species (or higher taxonomic classification) with the highest average abundance (± standard error) in spring and autumn for both 2015 and 2024 surveys. Where taxa are found in both years of surveys, green shows and increase and orange a decline in abundance. Where invertebrates were identified at multiple taxonomic levels abundance counts were summed at the highest recorded level. E.g. family level for true flies (Diptera) and caseless caddis (Hydropsychidae), or genus for Baetid mayflies (Baetis). Invertebrate groups featuring in both years' worth of surveys are underlined.

The above table is an overview of the most abundant invertebrate taxa across the five monitored sites in the 2015 and 2024- spring and autumn surveys. This is only a small component of diversity in the invertebrate community but the dominant groups in terms of the numbers of invertebrates being found in the river, so it is unsurprising that the story it tells follows from the conclusions of the statistical analysis presented above.

Seven out of ten of the most abundant invertebrates in both seasons were found in both the 2015 and 2024 surveys. Of these only one observation, blackfly larvae (Simuliidae *sp.*) in spring, increased between 2015 and 2016 surveys. This is a family that, if found to dominate samples relative to other taxa, can be indicative of water quality issues (Everall pers. comm.). The rest of the invertebrates found in both years of surveys all declined in abundance.

We know that spring is an important season for riverfly numbers, particularly mayflies, and we see substantial average declines in these species. Particularly olives (*Baetis sp.*, -95%), but also blue-winged olives (*Serratella ignita*, -71%), and green drakes (*Ephemera danica*, -42%). Also, we know that autumn is a key season for freshwater shrimp numbers (*Gammarus pulex/fossarum*) and between the 2015 and 2024 surveys there was an average 85% decline in this species. These invertebrates are key components of the wider freshwater ecological community, and these declining numbers are highly concerning.

UKTAG River Assessment Method – WHPT in RICT

Dataset	RICT Analysis	Year	Site	Spring Sample	Autumn Sample	EQR ASPT	ASPT Class (Probability)	EQR NTAXA	NTAXA Class (Probability)	MINTA Overall Class
SmartRivers	Model 44	2015	Stonehenge	01-May	01-Sep	1.16	High (99.98)	1.14	High (100)	High
			Queensbury Bridge	01-May	01-Sep	1.10	High (99.39)	1.07	High (99.95)	High
			Ham Hatches	01-May	01-Sep	1.12	High (99.88)	1.02	High (99.71)	High
			Little Durnford	01-May	01-Sep	1.12	High (99.94)	1.00	High (99.51)	High
			Stratford Bridge	01-May	01-Sep	1.12	High (99.91)	0.90	High (89.96)	High
		2024	Stonehenge	10-May	26-Oct	1.13	High (99.93)	0.87	High (82.63)	High
			Queensbury Bridge	08-May	26-Oct	1.04	High (90.72)	0.99	High (98.86)	High
			Ham Hatches	08-May	26-Oct	1.06	High (96.70)	0.78	Good (53.42)	Good
			Little Durnford	NA	26-Oct	NA	NA	NA	NA	NA
			Stratford Bridge	08-May	26-Oct	1.19	High (100)	0.71	Good (54.94)	Good
EA	Model 1	2015	9112	24-Apr	22-Oct	1.17	High (100)	1.39	High (100)	High
		2024	9112	09-May	31-Oct	1.17	High (99.99)	1.35	High (100)	High

Figure 8: The condition of the invertebrate community on the Avon according to the WHPT metric in RICT showing both SmartRivers and EA data for sites monitored in both 2015 and 2024 (highlighted grey). No classification could be calculated for Little Durnford in 2024 as only one season of monitoring data. All rows of data generated a suitability code of 1.

The table above summarises the key outputs from WHPT in RICT where the ecological quality ratio (EQR) of two family-level metrics, average score per taxon (ASPT) and NTAXA (number of scoring taxa) are used to calculate an overall classification for WFD (MINTA overall class). The results for both SmartRivers and EA datasets show that all six sites scored as 'high' quality in 2015. In 2024, three out of five (no Little Durnford) remained classified as 'high' with two sites dropping to 'good'.

WildFish is concerned as to the appropriateness of WFD classifications for chalk streams given their expected ecological quality compared to other rivers types. Our key concern is that if a chalk stream was to decline it may still be scoring as ‘good’ or ‘high’ due to naturally having a more diverse and abundant invertebrate community relative to other river types.

In this analysis we can see EQR values greater than 1 which may be suggestive of the generally higher quality of chalk streams relative to the reference databases. However, leaving that aside, our broader analysis above has shown clear declines in biodiversity (particularly for abundance). This decline is not reflected in the WFD classifications calculated for 2024. This is highly concerning as WFD is the metric by which waterbodies are assessed. The numbers of invertebrates in the Avon appear to have catastrophically declined, yet our regulatory monitoring system reports that all is well.

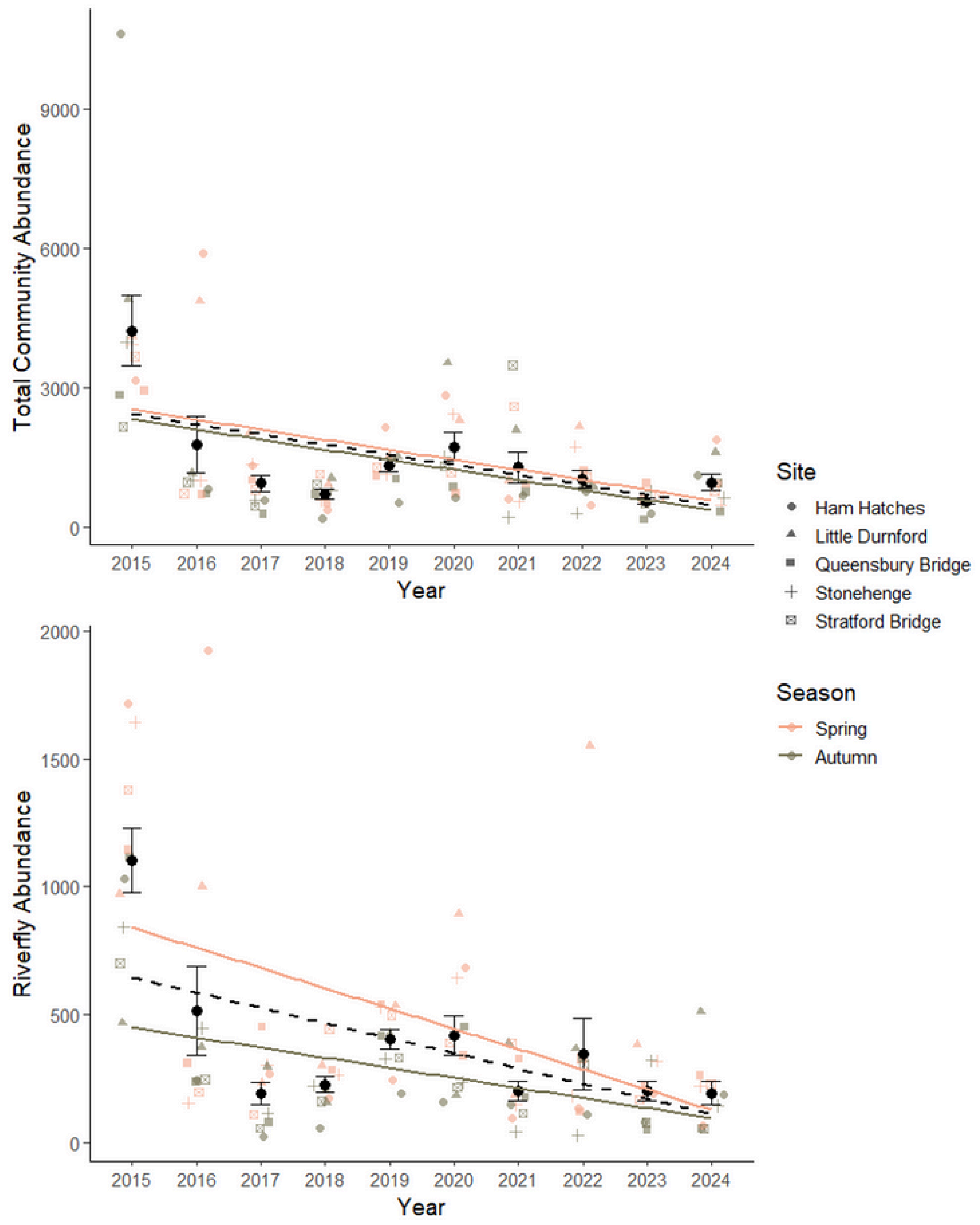

Figure 9: Showing trends in true counts of total community and riverfly abundance between 2015 and 2024. Black points show average (± standard error) annual diversity. Trends displayed for annual average (black dashed), spring (pink), and autumn (grey) diversity. Coloured shapes show individual site data points across seasons.

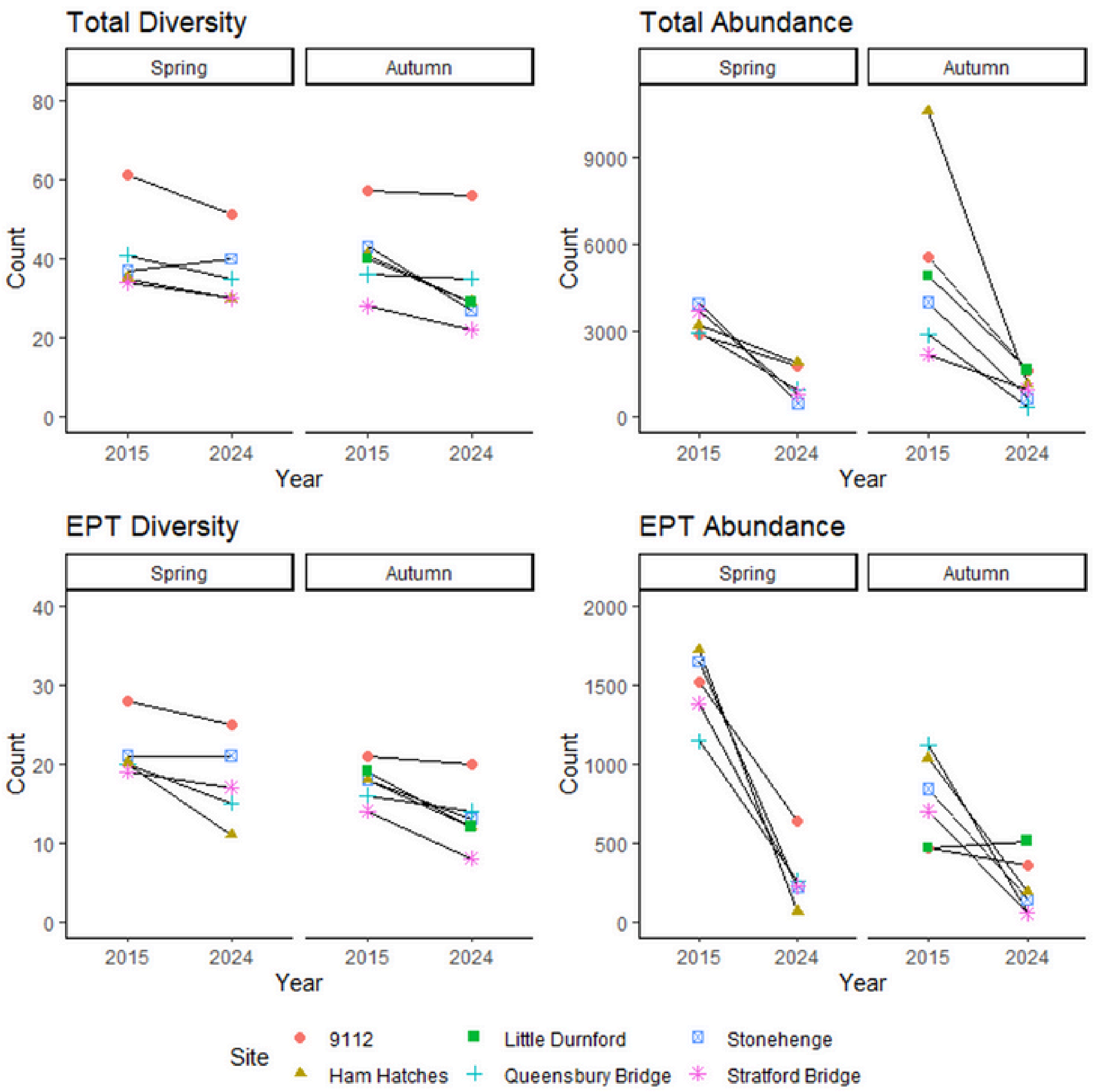

Figure 10: Showing diversity and abundance counts for the total and riverfly invertebrate community in 2015 and 2024 spring and autumn surveys. EA site 9112 is presented alongside the SmartRivers sites analysed in this report. Coloured shapes show individual site data points across seasons.

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