RIVERFLY CENSUS CONCLUSIONS

Test & Itchen

Salmon & Trout Conservation

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OUTCOMES & NEXT STEPS

The Salmon & Trout Conservation (S&TC) Riverfly Census has revealed that phosphorus and sediment pollution are impacting both the Test & Itchen. The data also indicates pressure from chemical pollution on the invertebrate communities in these rivers. The sources of phosphorus and sediment are slightly different in the two catchments, but ecological impact is similar. S&TC have been acting with stakeholders in the area to improve water quality in the Test & Itchen. So far this research has triggered many positive outcomes, including but not limited to the following:

- Phosphorus discharge limits have been tightened on watercress farms
- For the first time unique invertebrate targets, based on current and historical data have been agreed for Mayflies and Gammarus. Biological targets for sediment impact have also been agreed using the Proportion of Sediment-sensitive Invertebrates (PSI).
- A close partnership with Vitacress was developed to independently measure the phosphorus impact of bringing Pinglestone farm back into production. The lessons and knowledge from this work will be used to reduce environmental impact on all their farms

At Salmon & Trout Conservation, we see a world where wild fish have pollution-free places to live, with plenty to eat.

However, there is still much work to be done.

Further quantification and and reduction of phosphate and sediment inputs from point and diffuse sources such as septic tanks, agriculture, sewage treatment works and industry is essential. The impact of phosphorus and sediment spike events on river invertebrates is also yet to be determined. Understanding the ecological impacts of continuous versus pulse exposures to phosphorus and sediment is crucial to ensure healthy, sustainable river communities. Finally, identifying and reducing potential chemical inputs such as from salad washing are key to improving water quality in these rivers.

REPORT OUTLINE

EXECUTIVE SUMMARY

WHAT WE'VE DONE

A summary of the Riverfly Census process and objectives

WHAT WE'VE FOUND

A site-by-site presentation of the S&TC Riverfly Census results on the Test and Itchen

WHAT ARE THE ISSUES?

We compare our data with Environment Agency & historical values where possible to discuss the potential key issues on these rivers

ACKNOWLEDGEMENTS & CONTACT

Many thanks to the Test & Itchen Association for their kind donation towards the Riverfly Census work on the Test & Itchen.

Work commissioned from Aquascience Consultancy Ltd. We thank them for their professionalism, rigour and assistance throughout the Riverfly Census.

Report composed by Lauren Mattingley.

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Our key points

There are fewer riverfly species in the River Test and the River Itchen than would be expected in a healthy chalkstream. Overall, the Test appears to be fairing worse than the Itchen (three year mean mayfly species richness 7.17 ± 1.11 CI and 8.6 ± 0.64 CI respectively).

There are significantly fewer mayfly species in the Itchen now compared to 1978/82. This is also true for the Test compared to 1987,1989 and 1992 data, but the difference was not statistically significant. Both rivers have four less mayfly species on average than their historical mayfly species richness means.

RIVER TEST

Current total phosphorus final effluent targets are not strict enough to accommodate the additive effect of multiple discharges around the Fullerton area on the Test.

The invertebrate community indicated high stress from sediment pressure in the Test. The development and trial of a standard and monitoring protocol for sedimentation on chalkstreams, incorporating deposited sediment on riverbeds, should be prioritised.

RIVER ITCHEN

Arguably the 0.05 mg/l CSMG in-river orthophosphate target is still too high for a chalkstream (JNCC, 2014). Especially when taking into consideration that the discharge consents of watercress farms on the Itchen are 0.06 mg/l.

Continuous versus pulse exposure to phosphorus and sediment is an area that warrants research to quantify the exact impacts of nutrients and sediment on the system. Currently we do not know if exposure to peaks causes the same level of ecological damage as continuous releases.

WHAT WE'VE DONE

The Riverfly Census was created to collect much needed 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.

> "Without data you're just another person with an opinion"
>
> W. Edwards Deming

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 spot chemical samples. Every invertebrate is unique, and each requires a specific set of conditions to thrive.

The Riverfly Census utilises the invertebrate assemblage: presence, absence and abundance of certain invertebrates, to indicate the types of stress our rivers are experiencing. The composition of the invertebrate community in the sample allows a biometric score to be calculated, which provides a surrogate, or direct scale, of physical chemical impact. Below are the biometrics used and the type of stress they indicate.

BIOMETRIC GLOSSARY

PSI

Proportion of Sediment-sensitive Invertebrates

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

TRPI

Total Reactive Phosphorus Index

A relatively new metric developed to indicate pressure from phosphorus pollution

SPEAR

SPEcies At Risk

A measure to assess the impact of exposure to pesticides, herbicides and complex chemical toxicants on the invertebrate community

LIFE

Lotic-invertebrate Index for Flow Evaluation

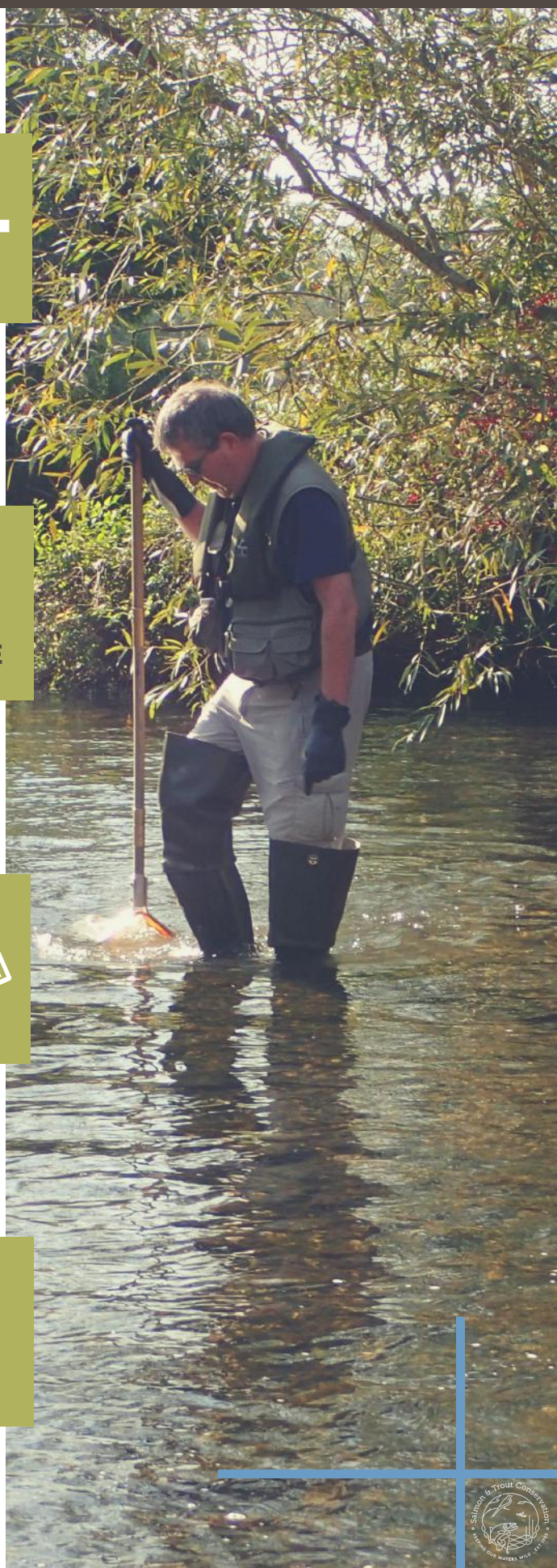
A metric to assess the impact of flow-related stress on lotic communities

SI

Saprobic Index

A measure to indicate stress on the invertebrate community caused by organic pollution

CENSUS METHOD



SCOPE

The Riverfly Census has spanned three years. It began in 2015, with 12 rivers across England. Multiple sample sites were carefully selected on each river.

SAMPLE

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

STUDY

Species presence/absence data was inputted into Aquascience's biometric calculator to obtain scores against key stress types. The data was then evaluated in a whole catchment context to pinpoint likely suspects contributing to river deterioration.

MAKE A STAND

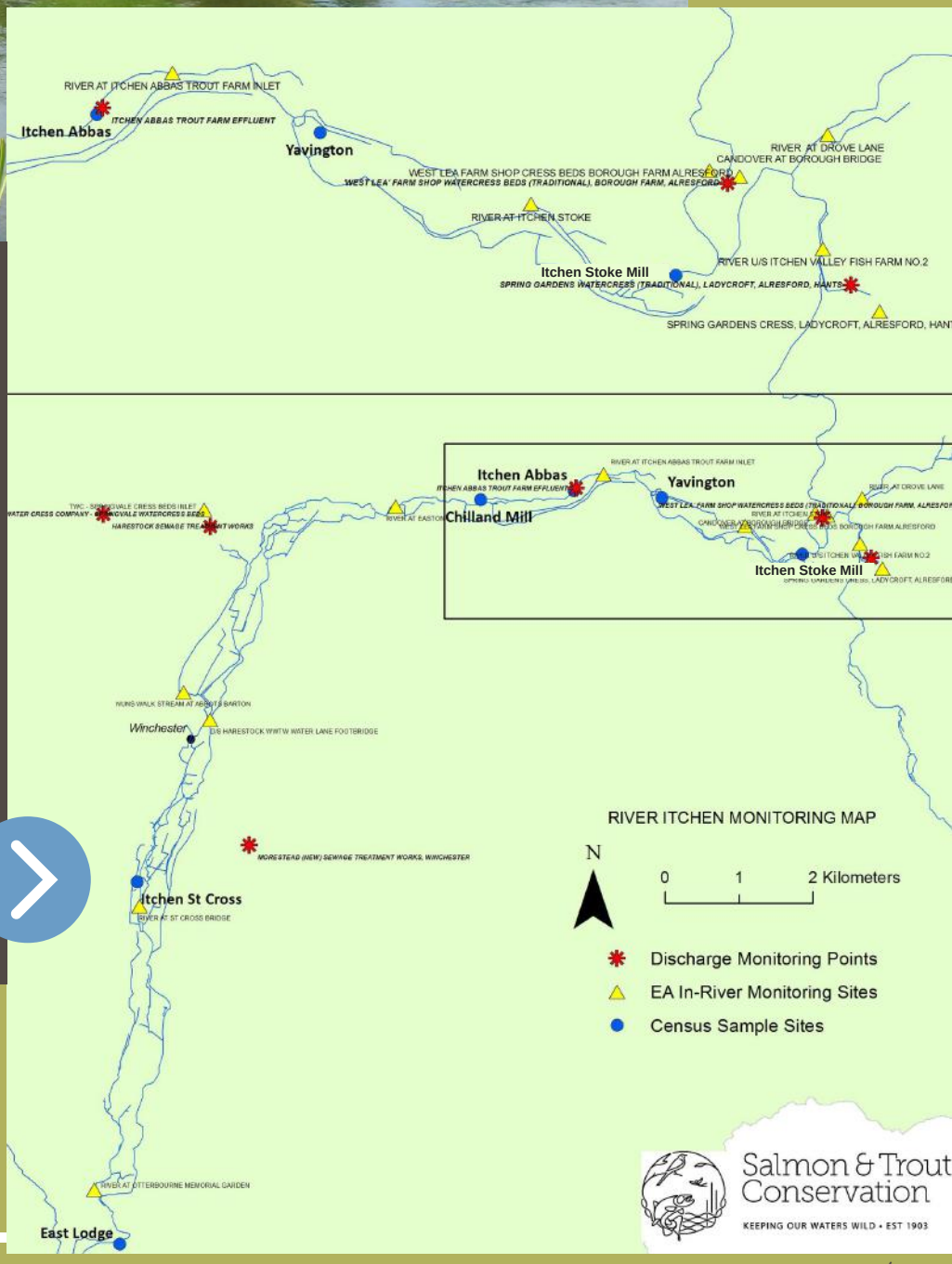
The data was compiled, and is being reported to stakeholders and policy makers, to improve management and conservation of our rivers.

Results: Itchen

Riverfly Census sampling on the Itchen began in 2015 with four sites on the upper river: Itchen Stoke Mill, Yavington, Itchen Abbas and Chilland Mill.

Itchen St Cross and East Lodge were added in 2016 to increase the range of the survey.

The locations of our sample sites are shown on the map, represented by blue circles.

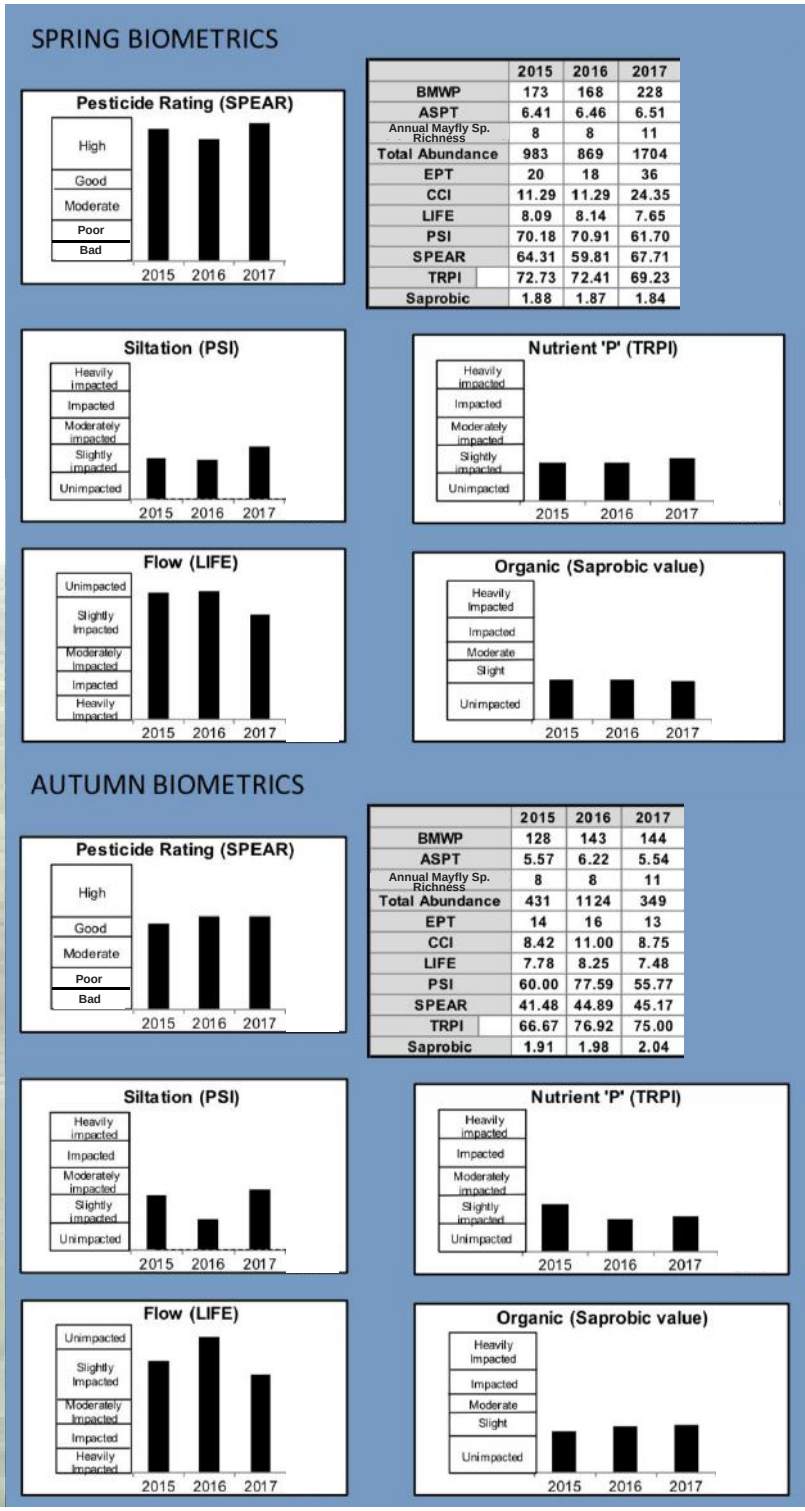


1 WHAT WE'VE FOUND
Itchen Stoke Mill

Sediment (PSI) and nutrient (TRPI) stress signatures were highest in 2015 and 2017. Note that in 2016, the invertebrate community was unimpacted by flow stress in spring and autumn. When there is sufficient flow, stress from sediment and phosphorus is buffered, as there is greater dilution and increased velocity to carry excess fine sediment downstream.

Moderate stress impact from increased sedimentation was exhibited in autumn 2015 and autumn 2017. Due to natural variability some increase in autumn is expected, as during winter periods rainfall is greater and soil erosion is commonly at its maximum (Walling and Amos, 1999). However, the moderate spring score is concerning.

Chemical impact (SPEAR) was not notable at Itchen Stoke Mill during the three years surveyed.



	2015	2016	2017
BMWP	173	168	228
ASPT	6.41	6.46	6.51
Annual Mayfly Sp. Richness	8	8	11
Total Abundance	983	869	1704
EPT	20	18	36
CCI	11.29	11.29	24.35
LIFE	8.09	8.14	7.65
PSI	70.18	70.91	61.70
SPEAR	64.31	59.81	67.71
TRPI	72.73	72.41	69.23
Saprobic	1.88	1.87	1.84

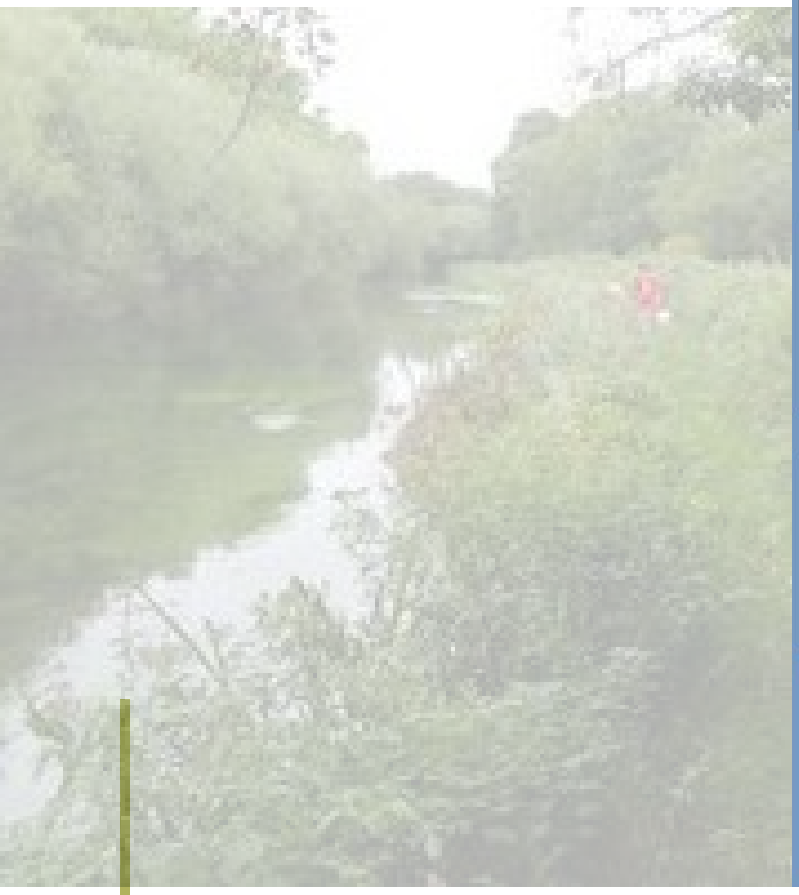
	2015	2016	2017
BMWP	128	143	144
ASPT	5.57	6.22	5.54
Annual Mayfly Sp. Richness	8	8	11
Total Abundance	431	1124	349
EPT	14	16	13
CCI	8.42	11.00	8.75
LIFE	7.78	8.25	7.48
PSI	60.00	77.59	55.77
SPEAR	41.48	44.89	45.17
TRPI	66.67	76.92	75.00
Saprobic	1.91	1.98	2.04

2 WHAT WE'VE FOUND
Yavington

Stress from elevated sediment on the invertebrate community increased during the three years sampled, peaking in 2017 during both spring and autumn. The autumn 2017 PSI score almost fell into the impacted category, which is unacceptable for any river, especially a Special Area of Conservation (SAC). Flow stress was also indicated at this time, which suggests flow wasn't sufficient to move excess sediment off river gravels.

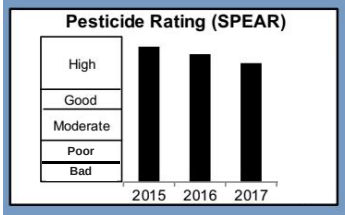
Yavington was unimpacted by nutrient stress in spring 2015, spring 2016 and autumn 2017.

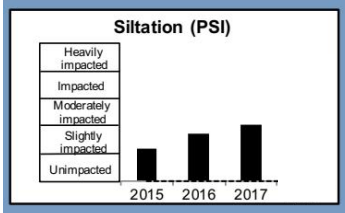
The complex chemical biometric, SPEAR, shows a dip in Autumn, most markedly in 2016, but this does not drop below the threshold and recovers to be well above the high boundary in Spring 2017.

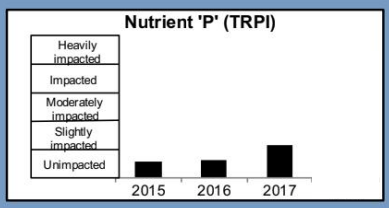


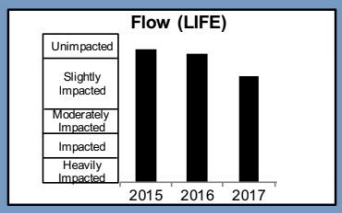
SPRING BIOMETRICS

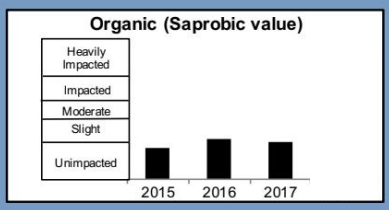
	2015	2016	2017
BMWP	154	143	214
ASPT	7.30	6.50	6.48
Annual Mayfly Sp. Richness	9	7	10
Total Abundance	291	1039	866
EPT	19	22	31
CCI	12.00	10.54	23.50
LIFE	8.20	8.10	7.65
PSI	76.60	65.57	59.30
SPEAR	65.71	61.63	57.54
TRPI	88.89	87.50	77.27
Saprobic	1.66	1.88	1.79





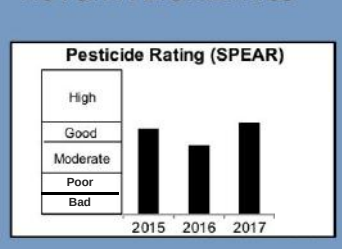


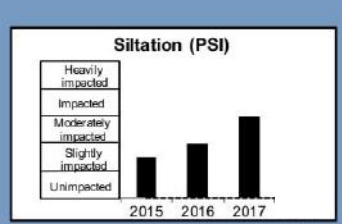


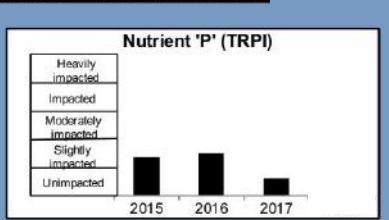


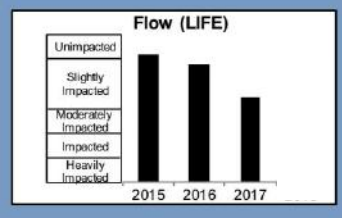
AUTUMN BIOMETRICS

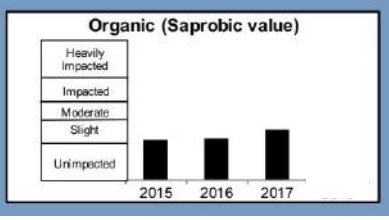
	2015	2016	2017
BMWP	100	144	142
ASPT	5.50	5.54	5.68
Annual Mayfly Sp. Richness	9	7	10
Total Abundance	468	827	507
EPT	11	12	13
CCI	9.41	13.75	8.86
LIFE	8.11	7.90	7.21
PSI	70.27	60.00	40.35
SPEAR	41.49	33.74	44.43
TRPI	72.73	69.23	87.50
Saprobic	1.86	1.89	2.09









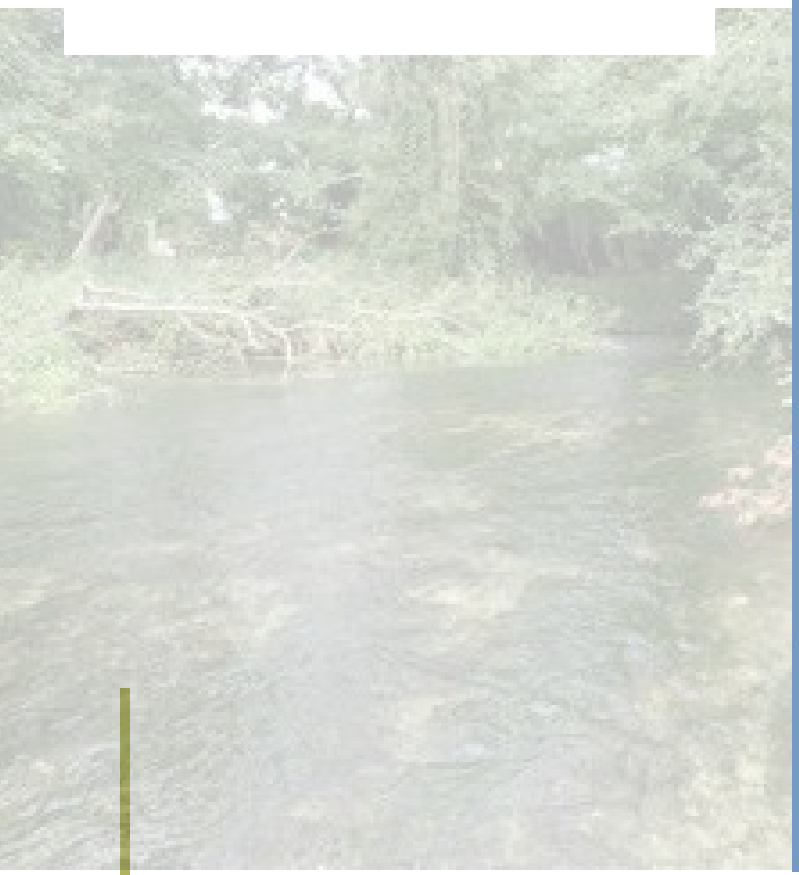


3 WHAT WE'VE FOUND
Itchen Abbas

Nutrient stress on the invertebrate community was most notable at Itchen Abbas in 2015 out of the three years surveyed. However, thick mats of filamentous algae were consistently present on the river bed at the site, indicating pressure on the system from excess phosphate.

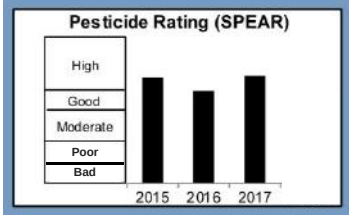
Stress from excess sediment peaked in 2015 but decreased in subsequent years during spring. The opposite occurred in autumn, with a moderate sediment signature peak in 2017, which may have been due to a lack of dilution from summer flows.

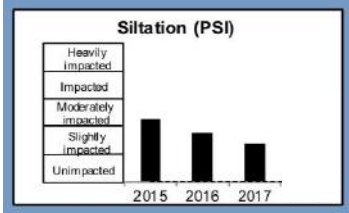
SPEAR failed in autumn 2016 and 2017 but recovered to the high range each spring, suggesting seasonal impact.

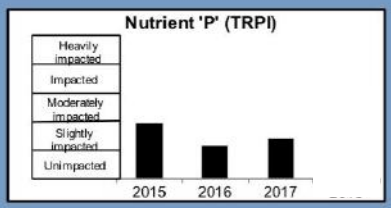


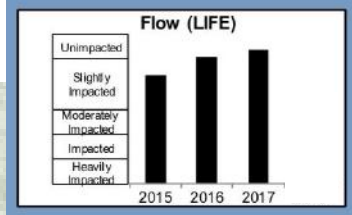
SPRING BIOMETRICS

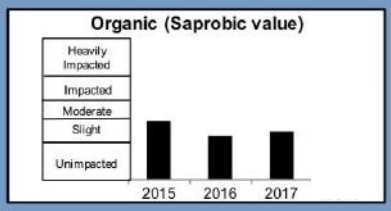
	2015	2016	2017
BMWP	121	158	185
ASPT	5.50	6.08	6.61
Annual Mayfly Sp. Richness	8	7	8
Total Abundance	1007	872	2548
EPT	17	16	27
CCI	11.20	26.88	16.12
LIFE	7.67	8.04	8.19
PSI	54.55	64.81	72.00
SPEAR	50.85	44.11	51.56
TRPI	60.59	76.92	71.43
Saprobic	2.26	1.93	2.02





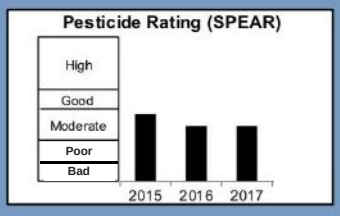


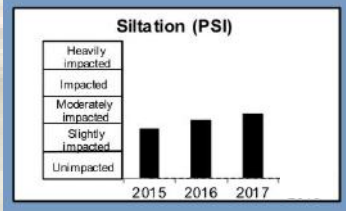


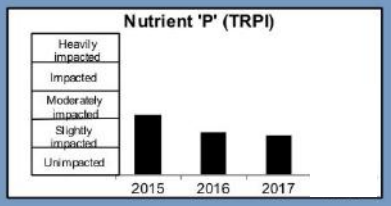


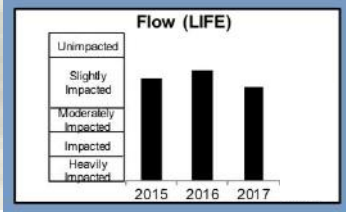
AUTUMN BIOMETRICS

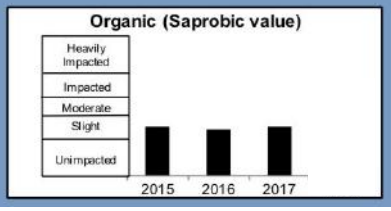
	2015	2016	2017
BMWP	168	171	127
ASPT	6.20	5.34	5.52
Annual Mayfly Sp. Richness	8	7	8
Total Abundance	1144	1791	894
EPT	17	15	10
CCI	14.21	21.53	8.53
LIFE	7.59	7.74	7.39
PSI	62.90	57.30	52.27
SPEAR	33.05	27.35	27.39
TRPI	57.14	69.23	71.43
Saprobic	2.06	1.98	2.05











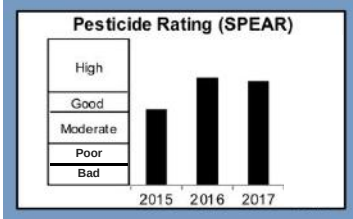
4 WHAT WE'VE FOUND
Chilland Mill

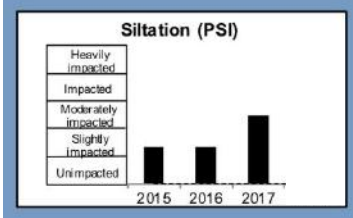
The invertebrate community experienced the greatest stress from flow in 2017, where both seasons demonstrated an impact. Sediment stress was greatest in 2017 during spring, but peaked in 2016 during autumn, with a moderate impact score that warrants further investigation.

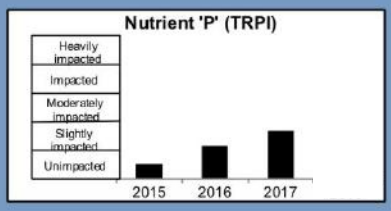
Nutrient stress signatures peaked in autumn 2016 and spring 2017, but the invertebrates were unimpacted in autumn 2017. The greatest chemical stress signatures occurred in 2015 and autumn 2016. Autumn 2016 was below the proposed WFD standard, but had improved by 2017.

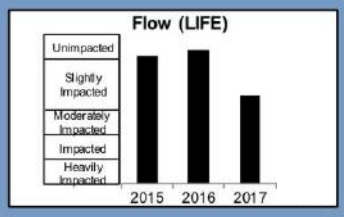
SPRING BIOMETRICS

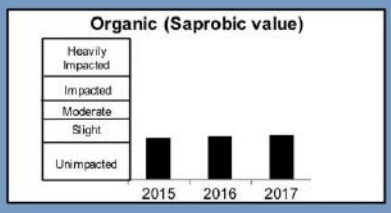
	2015	2016	2017
BMWP	174	170	205
ASPT	6.40	6.54	5.86
Annual Mayfly Sp. Richness	8	8	9
Total Abundance	569	1091	792
EPT	21	22	28
CCI	10.40	15.21	22.38
LIFE	8.07	8.18	7.27
PSI	73.58	73.58	50.57
SPEAR	36.38	51.67	49.87
TRPI	89.47	76.67	66.67
Saprobic	1.91	1.93	1.97





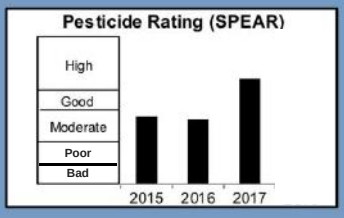


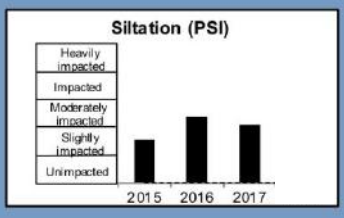


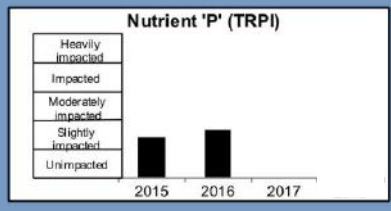


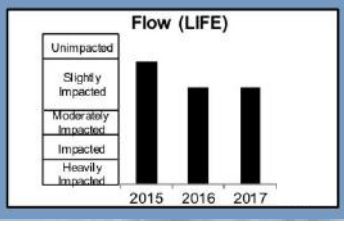
AUTUMN BIOMETRICS

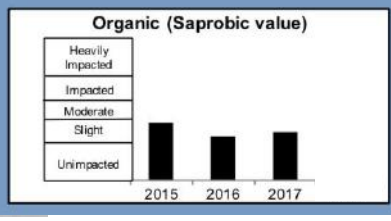
	2015	2016	2017
BMWP	119	154	110
ASPT	5.95	5.31	6.11
Annual Mayfly Sp. Richness	8	8	9
Total Abundance	767	766	214
EPT	13	14	14
CCI	8.42	24.35	8.67
LIFE	7.95	7.43	7.43
PSI	68.89	52.94	57.89
SPEAR	32.06	30.72	50.35
TRPI	71.43	66.67	100.00
Saprobic	2.22	1.94	2.01











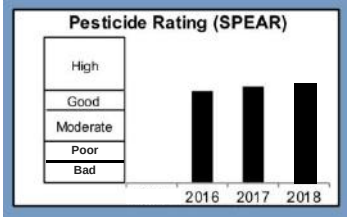
5 WHAT WE'VE FOUND
Itchen St Cross

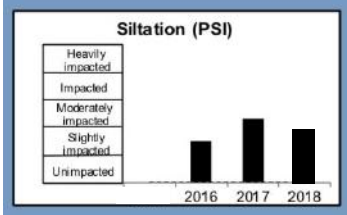
Sediment stress on the invertebrate community was greatest in 2017, where a moderate impact score was exhibited in both spring and autumn. Pressure from flow occurred all years in autumn and in spring 2017. Nutrient signatures were elevated in spring 2017, but slightly lower in autumn 2017.

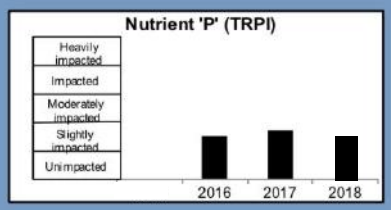
A notable chemical signature occurred in autumn 2016 (SPEAR 22.65), which is substantially below the proposed WFD pass threshold. However, this improves by 2017 and into spring 2018.

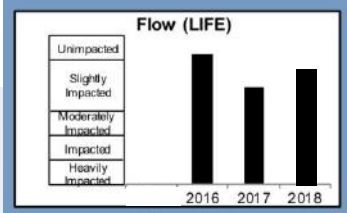
SPRING BIOMETRICS

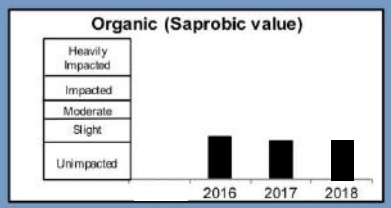
	2015	2016	2017	2018
BMWP	-	138	177	146
ASPT	-	6.00	5.71	5.84
Annual Mayfly Sp. Richness	-	10	6	8
Total Abundance	-	947	524	-
EPT	-	16	22	21
CCI	-	8.75	15.79	14.64
LIFE	-	8.12	7.47	7.72
PSI	-	70.21	54.17	60.56
SPEAR	-	44.08	46.39	50.63
TRPI	-	69.23	65.00	68.42
Saprobic	-	1.93	1.82	1.83





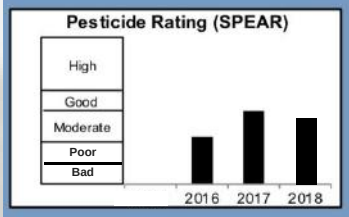


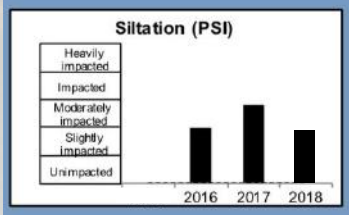


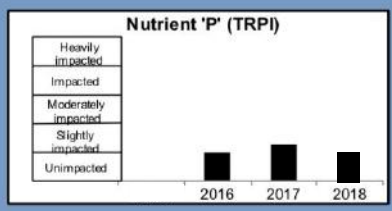


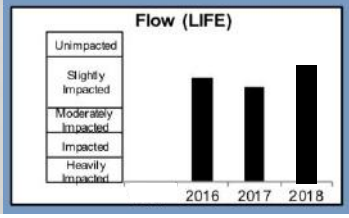
AUTUMN BIOMETRICS

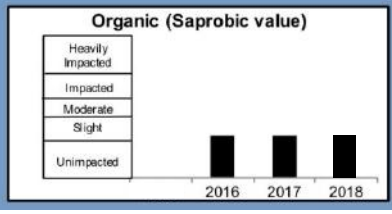
	2015	2016	2017	2018
BMWP	-	144	154	129
ASPT	-	1.54	5.31	5.61
Annual Mayfly Sp. Richness	-	10	6	8
Total Abundance	-	1144	524	-
EPT	-	14	13	12
CCI	-	24.00	12.12	13.72
LIFE	-	7.59	7.41	7.85
PSI	-	60.32	44.26	63.64
SPEAR	-	22.65	35.18	33.27
TRPI	-	80.00	75.00	80.00
Saprobic	-	1.91	1.91	1.91











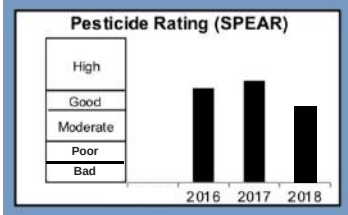
6 WHAT WE'VE FOUND
East Lodge

East Lodge was the furthest downstream site we sampled on the Itchen and therefore the site was potentially subjected to the greatest additive pressure from upstream activities. The biometrics were quite consistent over the three years evaluated, with relatively good biosignatures of water quality.

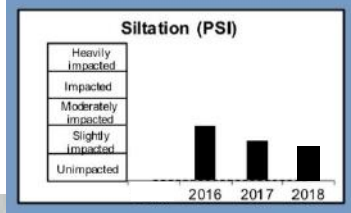
The most noteworthy findings were the borderline moderate sediment impact signatures that occurred in 2016 and autumn 2017.

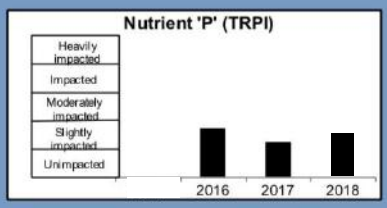
Complex chemical impact went below the WFD threshold with a SPEAR score of 30.53 in autumn 2017. This indicates an event in summer 2017 with some recovery by 2018 and may warrant further investigation.

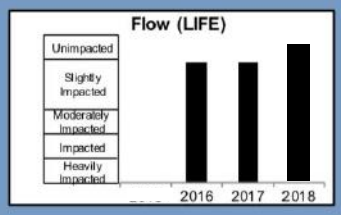
SPRING BIOMETRICS

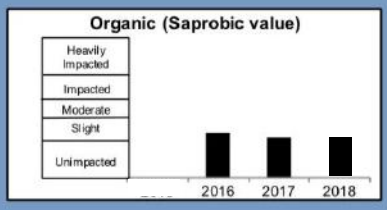


	2015	2016	2017	2018
BMWP	-	169	202	159
ASPT	-	6.04	6.31	6.12
Annual Mayfly Sp. Richness	-	9	10	10
Total Abundance	-	1261	2725	-
EPT	-	19	31	20
CCI	-	18.40	31.53	17.14
LIFE	-	7.94	7.94	8.39
PSI	-	60.61	71.43	78.13
SPEAR	-	46.12	49.24	38.30
TRPI	-	65.38	75.00	70.83
Saprobic	-	1.96	1.88	1.87

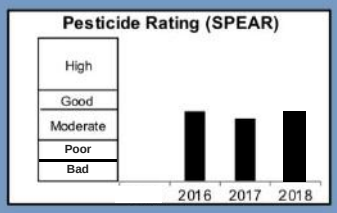




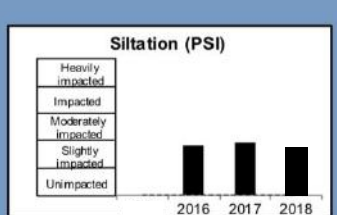


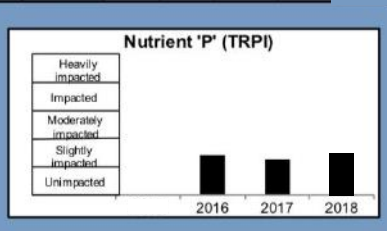


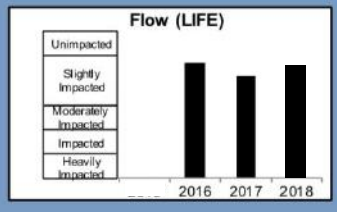
AUTUMN BIOMETRICS

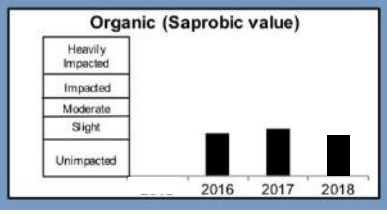


	2015	2016	2017	2018
BMWP	-	189	169	178
ASPT	-	5.91	6.04	5.93
Annual Mayfly Sp. Richness	-	9	10	10
Total Abundance	-	1705	687	-
EPT	-	18	14	18
CCI	-	13.63	13.78	13.30
LIFE	-	7.86	7.59	7.79
PSI	-	63.41	61.19	67.74
SPEAR	-	34.40	30.53	33.85
TRPI	-	71.43	75.00	69.23
Saprobic	-	1.94	2.02	1.86

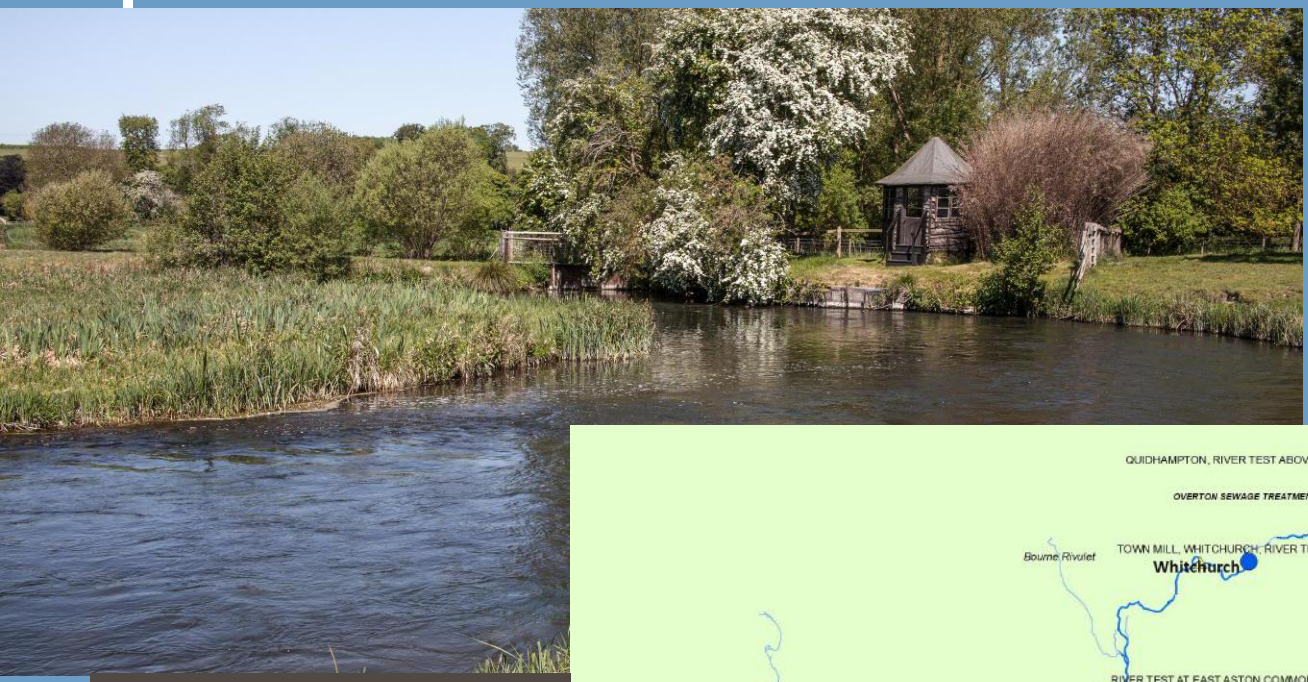






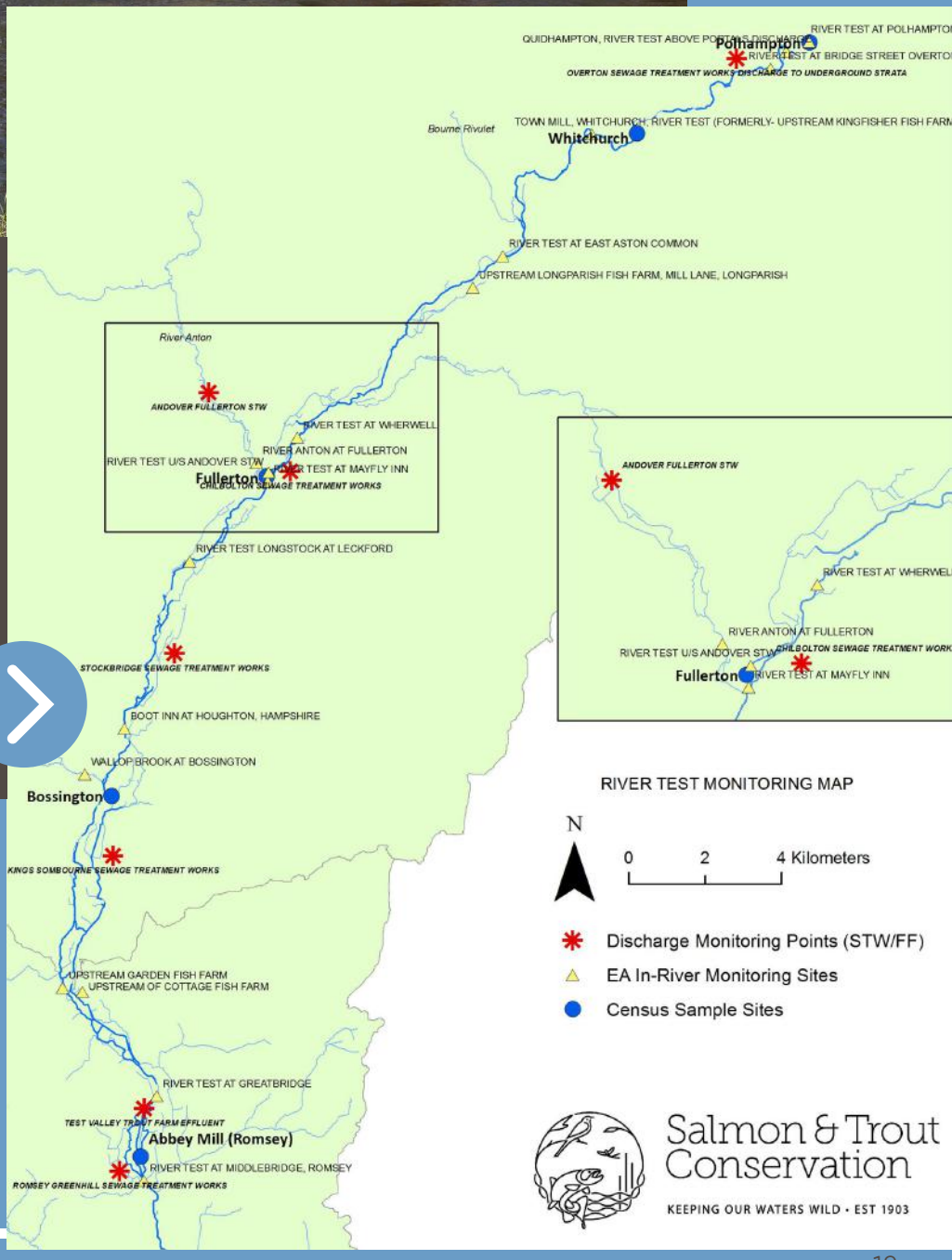


Results: Test



Riverfly Census sampling on the Test began in 2015 with five sites: Abbey Mill (Romsey), Bossington, Fullerton, Whitchurch and Polhampton.

The locations of our sample sites are shown on the map, represented by blue circles.



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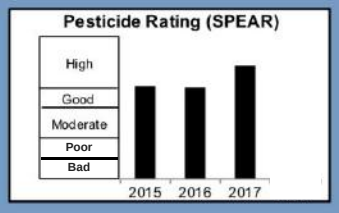
WHAT WE'VE FOUND
Polhampton

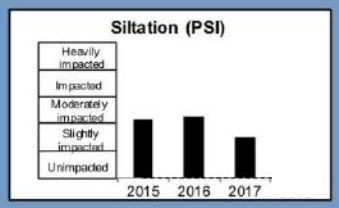
1

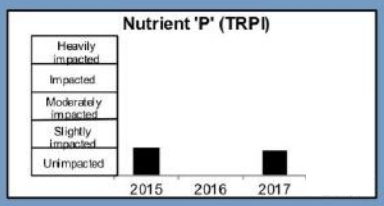
Polhampton was the most upstream site on the Test and is technically classified as a headwater. Flow stress on the invertebrates declined over the three-year period in both seasons, which may partly have been due to instream habitat work. Improvement in sedimentation and chemical signatures also occurred, potentially due to better flow and increased dilution.

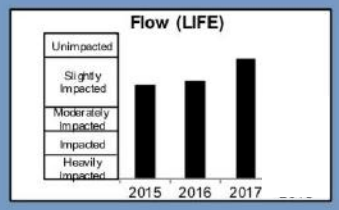
SPRING BIOMETRICS

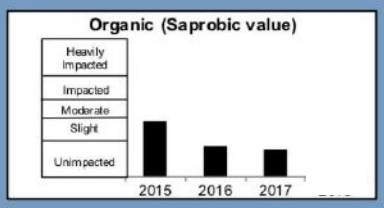


	2015	2016	2017
BMWP	89	69	156
ASPT	5.93	5.31	6.50
Annual Mayfly Sp. Richness	3	4	7
Total Abundance	1598	899	914
EPT	12	8	20
CCI	8.00	8.33	15.04
LIFE	7.42	7.53	7.97
PSI	56.41	54.84	69.84
SPEAR	45.75	44.99	55.97
TRPI	80.00	100.00	81.82
Saprobic	2.22	1.67	1.61

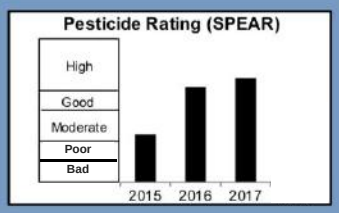




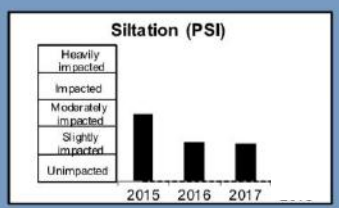


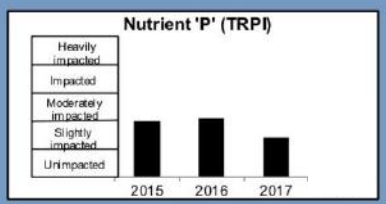


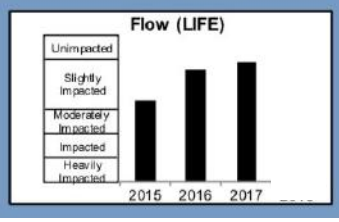
AUTUMN BIOMETRICS

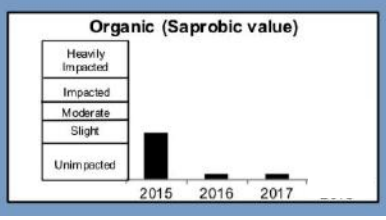


	2015	2016	2017
BMWP	107	164	97
ASPT	5.10	6.31	5.71
Annual Mayfly Sp. Richness	3	4	7
Total Abundance	646	1310	5212
EPT	6	18	10
CCI	7.81	14.45	7.00
LIFE	7.16	7.81	7.95
PSI	50.00	71.19	72.09
SPEAR	23.65	46.37	50.97
TRPI	60.00	58.33	71.43
Saprobic	2.02	1.14	1.14









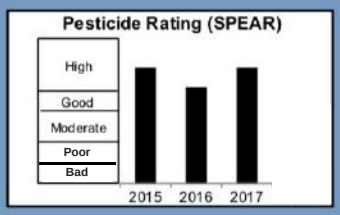
This site achieved an unimpacted score for nutrient stress in spring 2016, but borderline slight impact was exhibited in spring 2015 and spring 2017, which is concerning given that Polhampton is at the very top of the river and should be experiencing minimal nutrient pressure.

WHAT WE'VE FOUND
Whitchurch

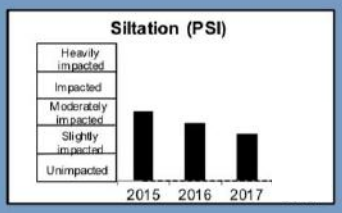
2

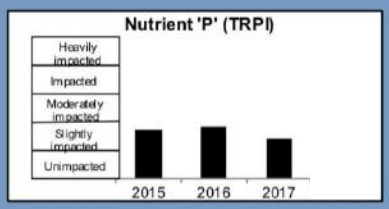
There was a slight decrease in flow velocity at the site over the three years. Slight increases in flow stress at these times could associate with the stronger siltation signatures in autumn 2016 and 2017. Nutrient impact was consistent throughout the three years in both seasons, remaining in the slight impact category.

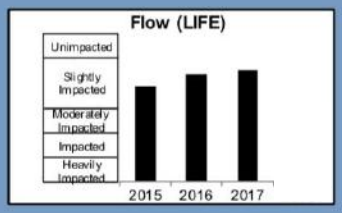
SPRING BIOMETRICS

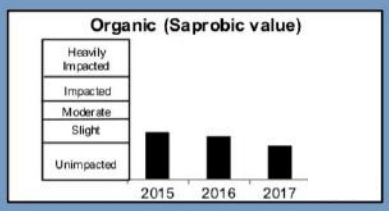


	2015	2016	2017
BMWP	123	181	176
ASPT	5.86	6.03	6.52
Annual Mayfly Sp. Richness	10	7	6
Total Abundance	602	703	1499
EPT	19	22	24
CCI	11.25	13.78	12.91
LIFE	7.43	7.67	7.78
PSI	48.94	58.21	65.75
SPEAR	56.20	46.67	56.05
TRPI	65.00	63.67	72.00
Saprobic	2.01	1.93	1.74

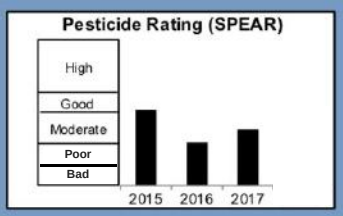




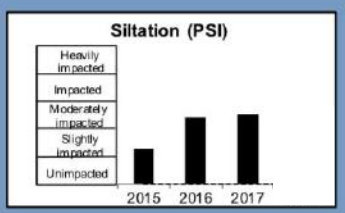


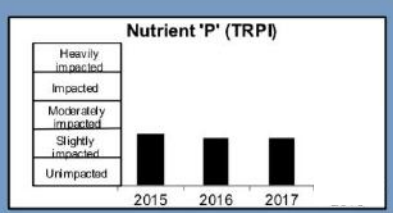


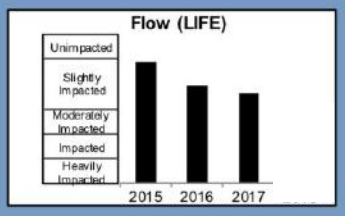
AUTUMN BIOMETRICS

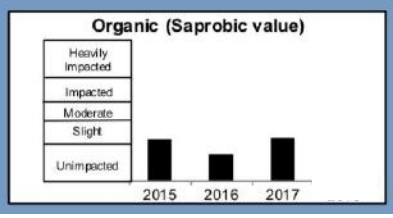


	2015	2016	2017
BMWP	129	115	115
ASPT	5.86	5.23	5.00
Annual Mayfly Sp. Richness	10	7	6
Total Abundance	808	753	254
EPT	15	9	8
CCI	10.42	10.00	7.75
LIFE	7.96	7.46	7.30
PSI	74.55	50.98	48.98
SPEAR	36.70	20.58	27.00
TRPI	63.64	66.67	66.67
Saprobic	1.91	1.56	1.92









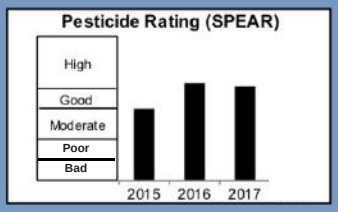
The lowest SPEAR score (20.58) and therefore the greatest chemical stress out of all the Test samples occurred at Whitchurch, in autumn 2016, but returned to the high category in spring 2017. There did however continue to be a seasonal impact in autumn 2017.

WHAT WE'VE FOUND
Fullerton

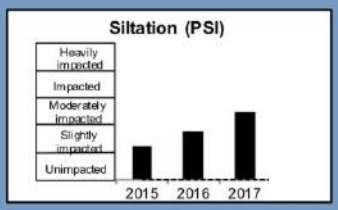
3

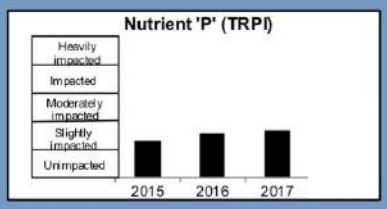
At Fullerton there appeared to be a combination of flow and sediment stress on the invertebrate community, across the study period. There were also notable stress signatures for both LIFE and PSI in spring 2017, with sediment having a moderate impact. Nutrient signatures were raised in autumn 2016 and spring 2017.

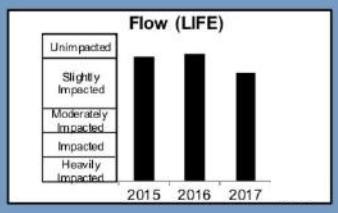
SPRING BIOMETRICS

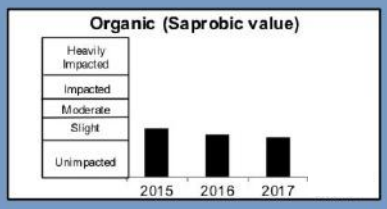


	2015	2016	2017
BMWP	120	151	189
ASPT	6.00	6.04	5.91
Annual Mayfly Sp. Richness	6	10	8
Total Abundance	670	1193	1244
EPT	11	21	21
CCI	9.77	15.17	14.00
LIFE	8.05	8.09	7.70
PSI	75.56	64.47	50.57
SPEAR	34.78	47.65	45.62
TRPI	73.33	68.57	66.67
Saprobic	2.05	1.93	1.85

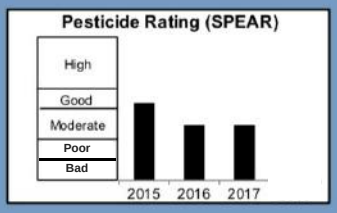




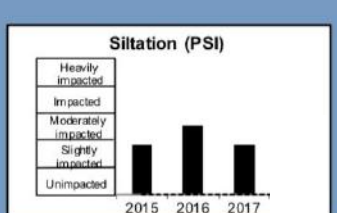


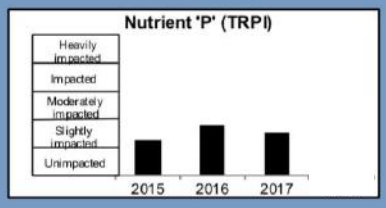


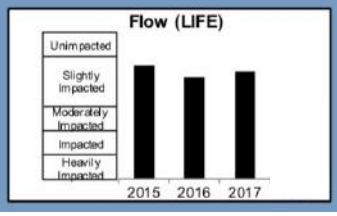
AUTUMN BIOMETRICS

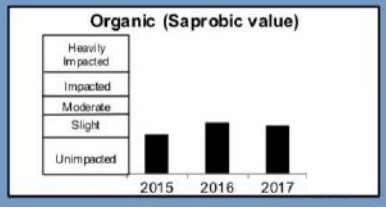


	2015	2016	2017
BMWP	121	142	112
ASPT	5.76	5.46	5.33
Annual Mayfly Sp. Richness	6	10	8
Total Abundance	726	1176	1746
EPT	11	12	9
CCI	10.00	7.50	6.76
LIFE	7.82	7.58	7.70
PSI	63.04	49.09	63.64
SPEAR	37.91	26.93	26.87
TRPI	75.00	64.29	69.23
Saprobic	1.85	2.11	2.07









Complex chemical stress signatures were below the proposed WFD pass threshold in autumn 2016 and autumn 2017, but were high in the spring, suggesting a seasonal impact.

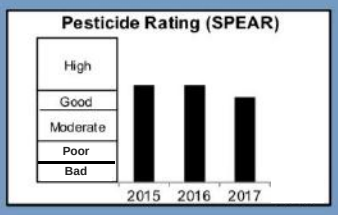
WHAT WE'VE FOUND
Bossington

4

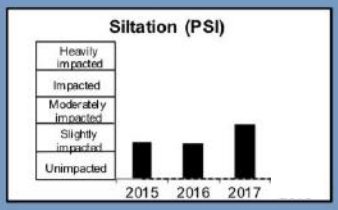
A moderate impact of phosphorus on the invertebrate community was highlighted during autumn 2015. There was an increase of nutrient, sediment and flow stresses in spring 2017. During autumn, sediment stress was consistently borderline moderate impact.

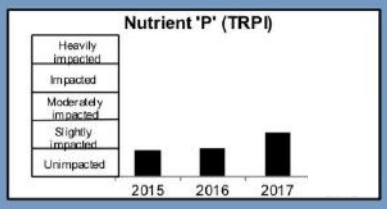
Complex chemical signatures showed a seasonal dip, most pronounced in autumn 2015 and autumn 2017 (24.98 and 29.94 respectively). The autumn 2017 result followed a slight dip in spring 2017. This may be considered for further investigation.

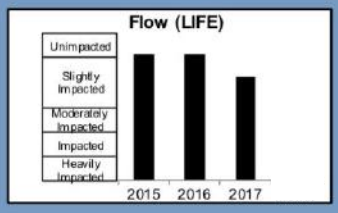
SPRING BIOMETRICS

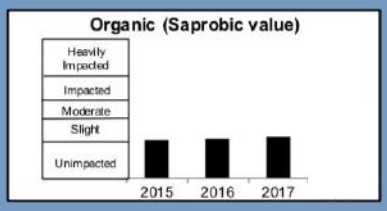


	2015	2016	2017
BMWP	189	180	188
ASPT	6.75	6.67	6.27
Annual Mayfly Sp. Richness	7	9	6
Total Abundance	690	772	1214
EPT	21	22	21
CCI	17.60	32.67	15.80
LIFE	8.08	8.08	7.61
PSI	73.08	74.65	59.70
SPEAR	47.29	47.07	41.35
TRPI	80.77	79.99	68.42
Saprobic	1.84	1.88	1.90

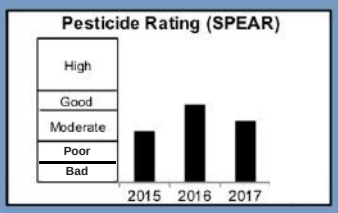




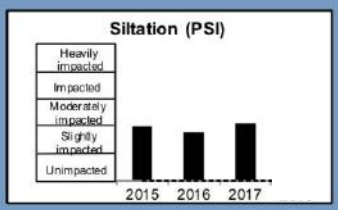


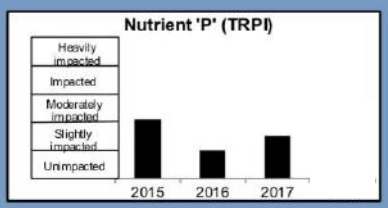


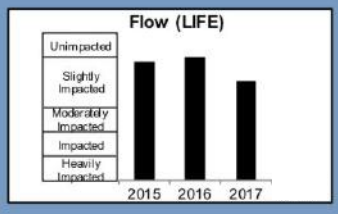
AUTUMN BIOMETRICS

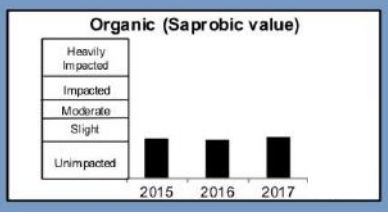


	2015	2016	2017
BMWP	144	196	155
ASPT	5.54	6.13	5.54
Annual Mayfly Sp. Richness	7	9	6
Total Abundance	568	1320	528
EPT	12	18	13
CCI	10.21	14.41	13.77
LIFE	7.93	8.00	7.53
PSI	59.65	64.71	57.81
SPEAR	24.98	37.72	29.94
TRPI	58.33	80.00	70.00
Saprobic	1.85	1.84	1.89









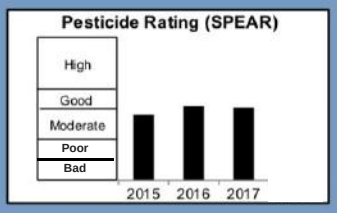
WHAT WE'VE FOUND
Abbey Mill (Romsey)

5

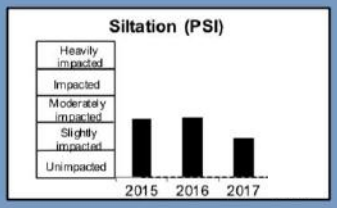
Abbey Mill was the furthest downstream site we sampled on the Test. Nutrient and sediment impacts were apparent in 2015 and spring 2016, but then showed some signs of improvement. The biometrics TRPI and LIFE indicated a biological impact. Every year and season indicated flow stress with the exception of spring 2017. For the phosphorus biometric TRPI, 2015 was the most impacted year, with a moderate spike in autumn.

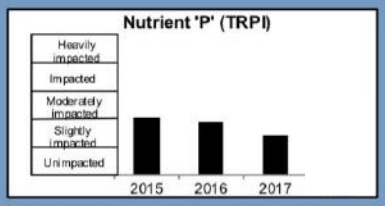
Abbey Mill had scores at or above the WFD threshold during spring 2015-2017, however, there was a seasonal dip each year, with the score going below the threshold and into the moderate range.

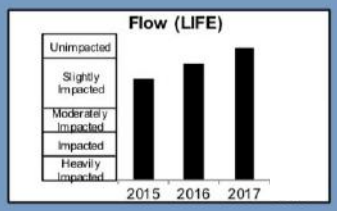
SPRING BIOMETRICS

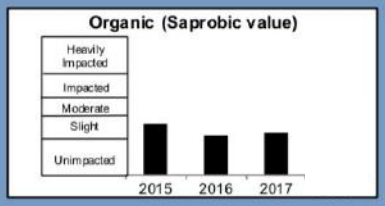


	2015	2016	2017
BMWP	139	161	203
ASPT	5.79	5.96	6.55
Annual Mayfly Sp. Richness	5	5	7
Total Abundance	774	912	1498
EPT	12	13	22
CCI	10.38	14.64	25.83
LIFE	7.57	7.89	8.22
PSI	57.14	55.74	70.67
SPEAR	32.47	36.75	35.65
TRPI	59.11	62.07	71.43
Saprobic	2.12	1.88	1.93

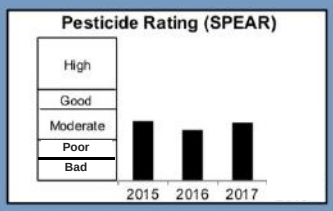




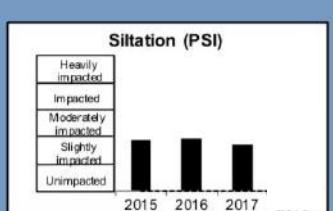


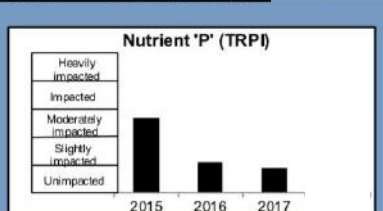


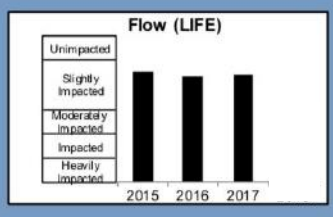
AUTUMN BIOMETRICS

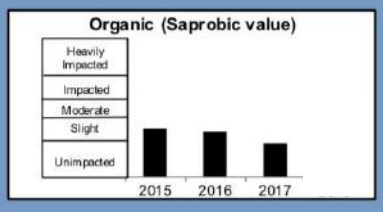


	2015	2016	2017
BMWP	148	175	159
ASPT	5.48	5.83	6.12
Annual Mayfly Sp. Richness	5	5	7
Total Abundance	948	896	602
EPT	13	14	14
CCI	16.33	15.50	14.00
LIFE	7.77	7.69	7.72
PSI	62.12	61.76	66.15
SPEAR	29.11	25.02	28.59
TRPI	46.47	77.78	81.82
Saprobic	2.07	1.99	1.75

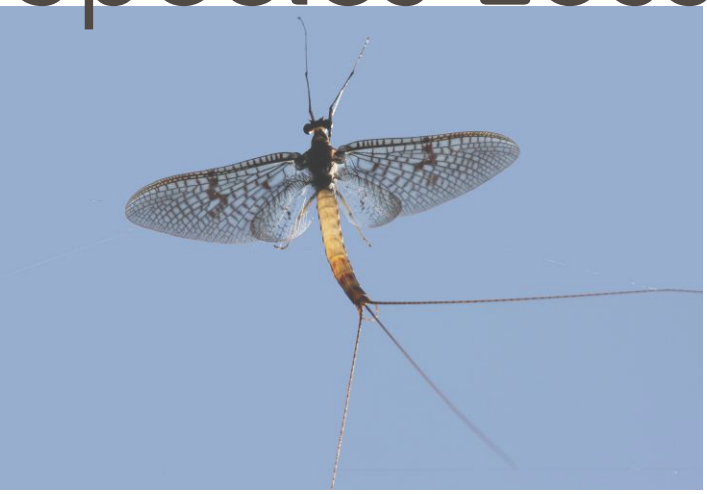








Species Loss



MAYFLY SPECIES RICHNESS

Species loss in any environment is an indication of ecosystem distress. In rivers like the Test and Itchen, mayfly (family Ephemeroptera) diversity tells us a lot about their ecological condition. In 2017 we agreed a bespoke minimum target of 10 mayfly species for the Test and Itchen with the local Environment Agency, for the middle to lower reaches.

Polhampton was excluded from the target and therefore the following calculations due to it being a headwater - diversity naturally increases in mid-reaches as more microhabitats become available.

On the Test, the target was only achieved twice during the three-year survey, at Whitchurch in 2015 and Fullerton in 2016. The number of mayfly species found annually during the survey did not follow a consistent pattern at the five sites sampled. Abbey Mill had the lowest mayfly species richness recorded in 2015 and 2016 (just 5 species). In the final survey year, Bossington and Whitchurch had the lowest mayfly species richness (both 6 species). The overall 3 year average for the river was also below this target (7.17 ± 1.11 CI species) (Fig. 1).

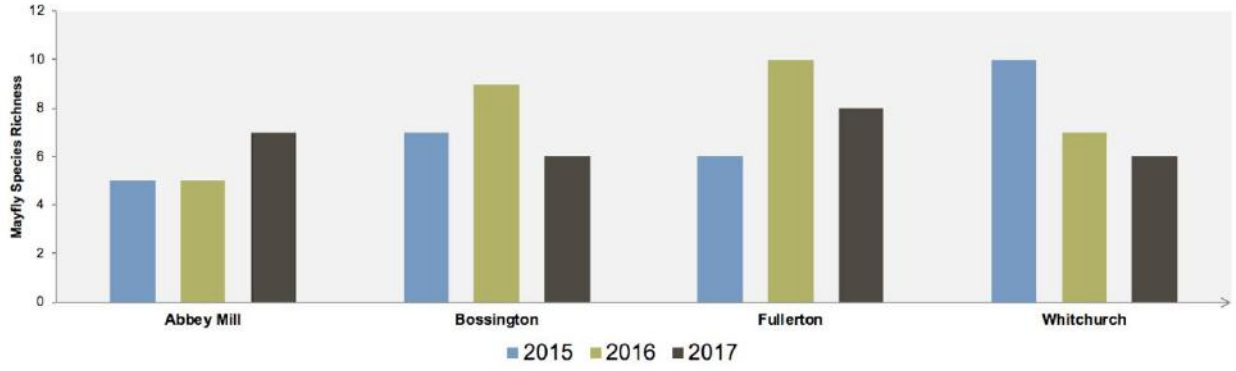


Fig. 1 - Test Annual Mayfly Species Richness 2015-2017, S&TC Riverfly Census.

On the Itchen, East Lodge (the furthest downstream site) was the most consistent for mayfly species richness, achieving the target of 10 species for 2017 and 2018 and only missing the target by one species in 2016. The greatest number of species was found at Itchen Stoke Mill in 2017 (11 species). However, generally the upper river had lower mayfly diversity than downstream sites. Itchen Abbas and Chilland Mill did not achieve the target at all during the 3 years monitored (Fig. 2).

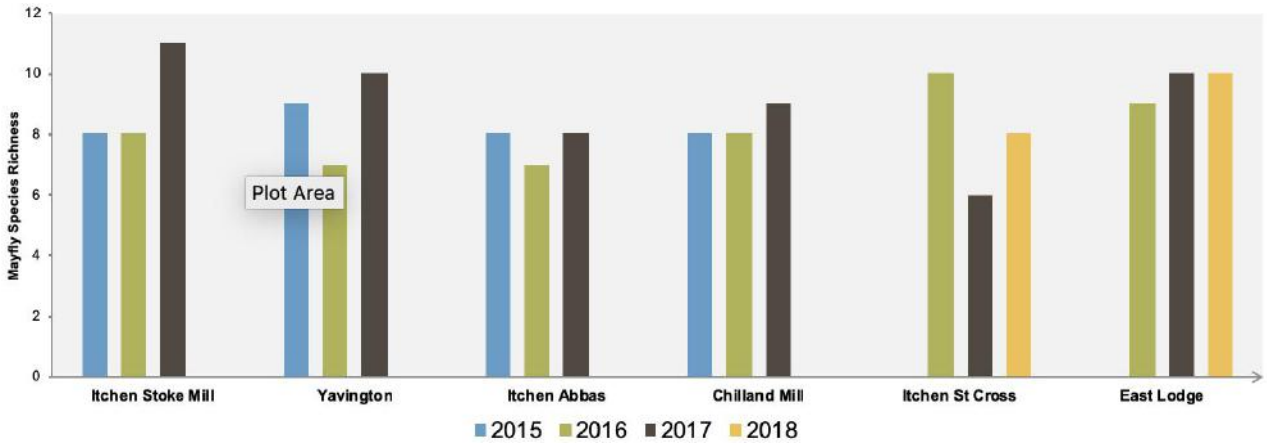


Fig. 2 - River Itchen annual mayfly species richness 2015-2018, S&TC Riverfly Census. Please note, monitoring on Itchen St Cross & East Lodge took place 2016-2018.

The overall 3 year average was also below target (8.6 species) but nearer the target than the Test. Statistical analysis of the mayfly species richness between the two rivers indicated the Test had significantly lower mayfly species richness compared to the Itchen $t(18.86)= 2.35$, $p=0.03$ (Fig. 3).

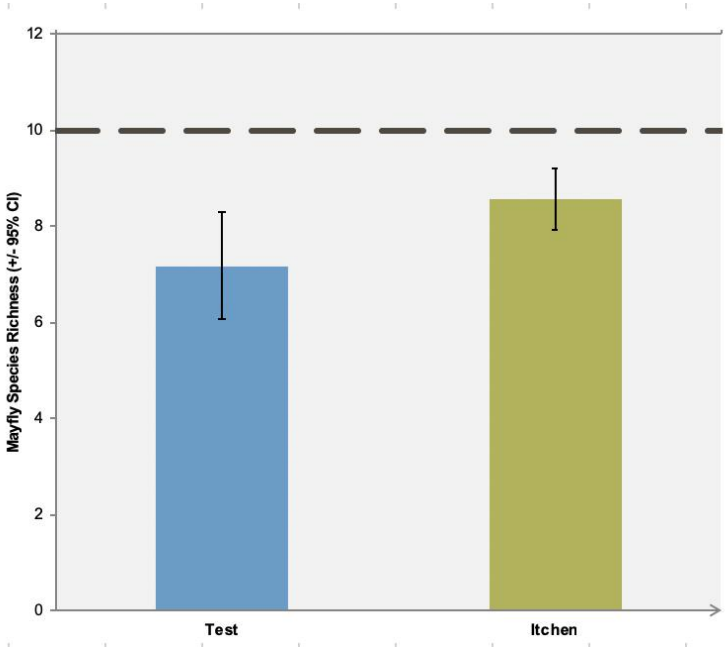


Fig. 3 - Test & Itchen mean cumulative annual mayfly species richness (+/- 95% CI) 2015-2018. Unpaired t-test, 18.86 df, $p < 0.05$.

HISTORICAL MAYFLY SPECIES COMPARISON

Annual mayfly species richness values from Itchen S&TC Riverfly Census data were compared to historical values from species-level invertebrate data collected by the Environment Agency (EA) and the Centre of Ecology and Hydrology (CEH) for 1978 and 1982 for Chilland, Itchen St Cross and East Lodge.

Locations of where this data was collected are shown in Fig. 4.

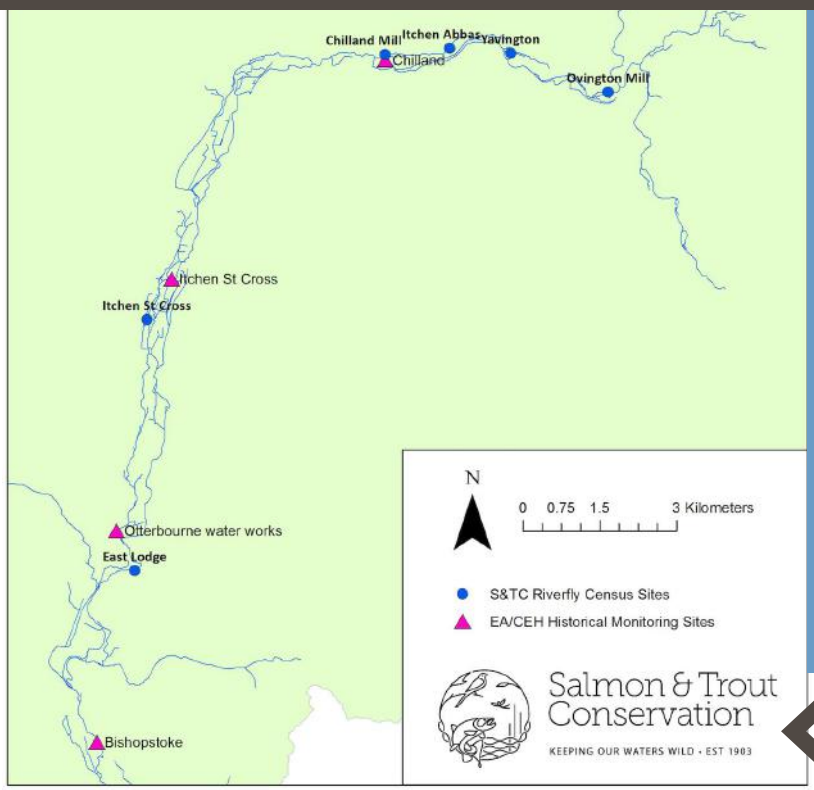


Fig. 4 - S&TC/EA/CEH Itchen invertebrate monitoring site location overlaps

Mean annual mayfly species richness was significantly higher in 1978/82 on the Itchen compared to our data between 2015-2018; $t(15)= 4.65$, $p=0.0003$, with mean annual mayfly species richness historically four species greater (12.4 ± 1.52 CI) than current values (8.67 ± 1.02 CI)(Fig. 5).

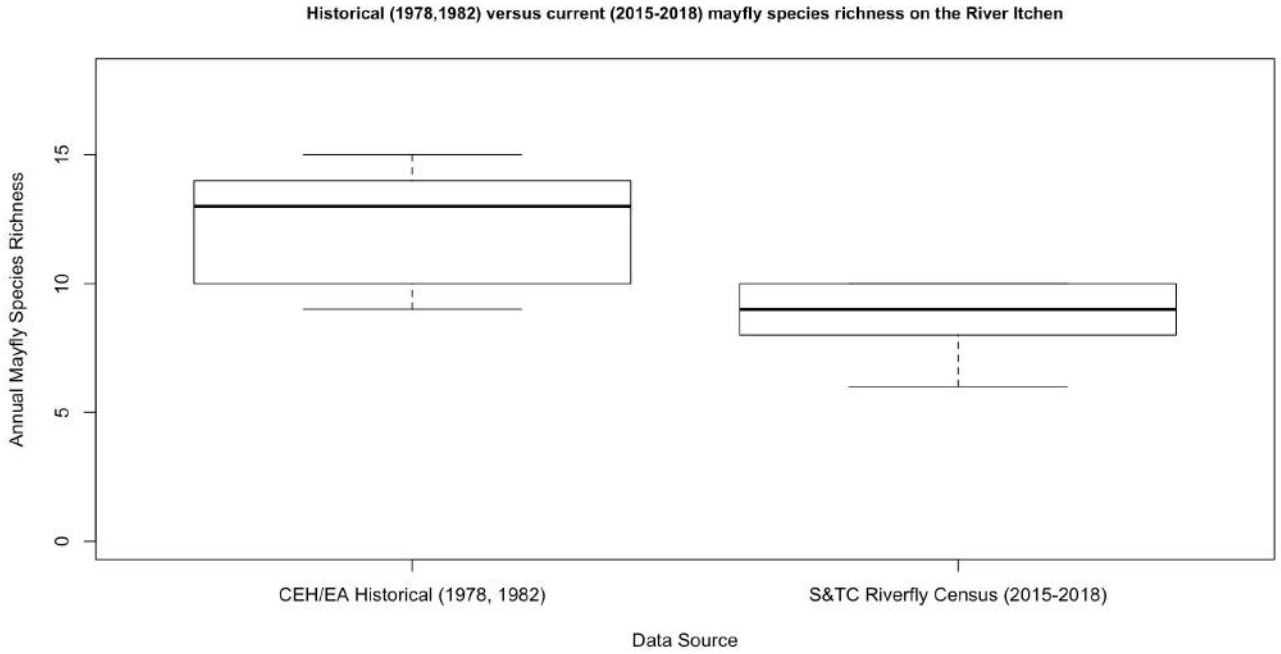
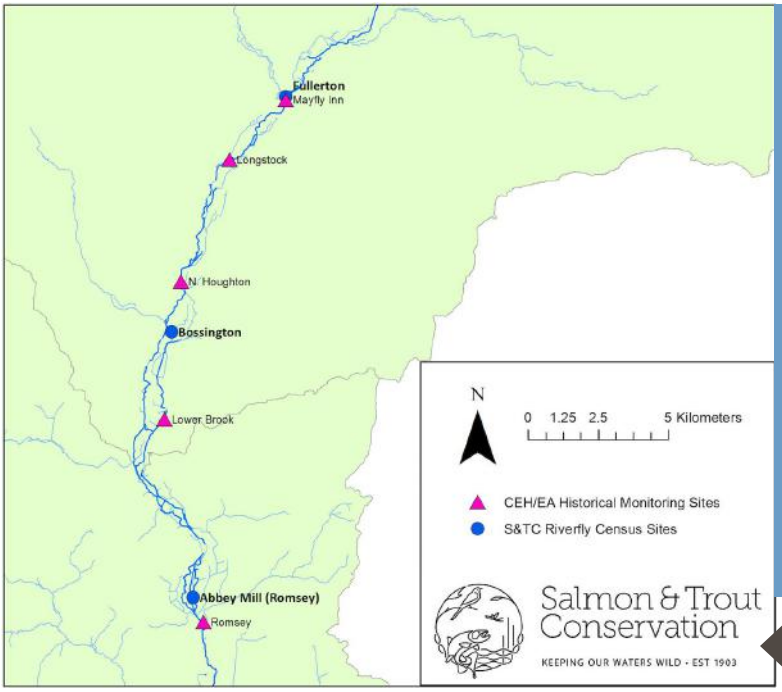


Fig. 5 - River Itchen CEH/EA historical (1978,1982) versus S&TC current (2015-2018) cumulative annual mayfly species richness. Unpaired t-test, 15 df, $p < 0.05$.



Additional historical species-level invertebrate data collected by the EA and CEH was obtained for the Test covering the years 1987, 1989 and 1992.

The S&TC sites used for comparison were Bossington, Fullerton and Abbey Mill (Romsey), locations of where the recent and historical data were collected are shown in Fig. 6.

Fig. 6 - S&TC/EA/CEH Test invertebrate monitoring site location overlaps

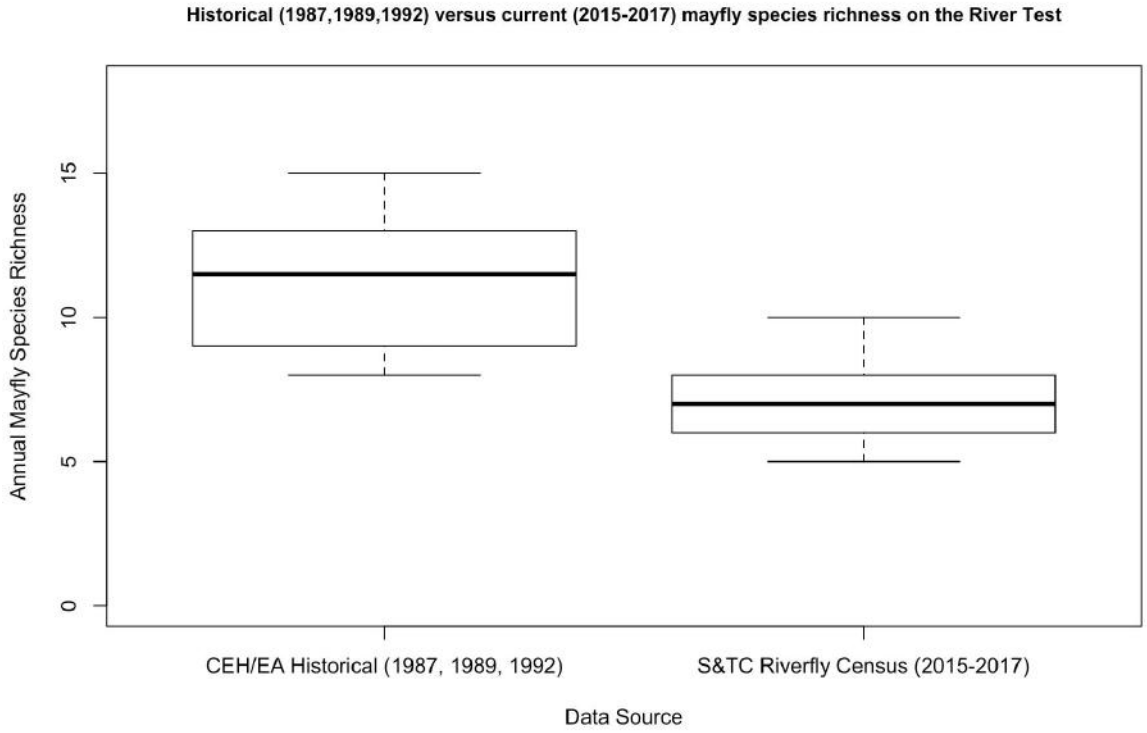


Fig. 7 - River Test CEH/EA historical (1987,1989,1992) versus S&TC current (2015-2017) cumulative annual mayfly species richness. Unpaired t-test, 8 df, p > 0.05.

Historical mean annual mayfly species richness was not significantly higher in than our 2015-2017 data on the Test; t(8)= 3.61, p=0.0069. However, there was still a four species difference between the CEH/EA historical mayfly species mean (11.33 ± 2.71 CI) and the S&TC mayfly species mean (7.00 ± 1.33 CI)(Fig. 7).

FRESHWATER SHRIMP

The freshwater shrimp (Gammarus pulex) is regarded as one of the most important invertebrate species in chalk streams in terms of biomass and food for fish (Welton, 1979). These shrimps are essential to ecosystem function as they are detritivores; breaking down leaf litter and recycling nutrients. The highest abundances are typically found in autumn, so only this season is evaluated.

In 2017, S&TC and the local Environment Agency agreed a target of ≥500 Gammarus pulex for autumn on the Test and Itchen.

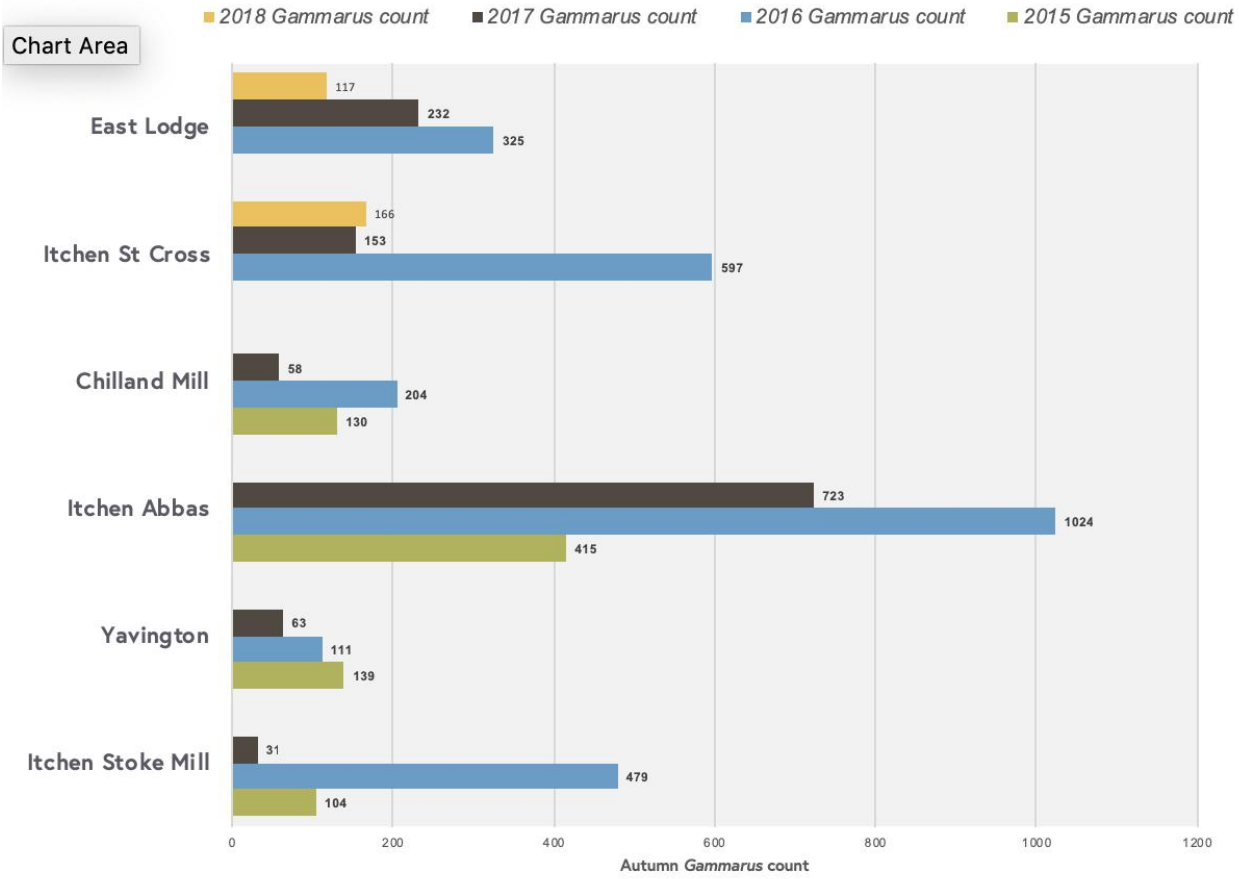


Fig. 8 - River Itchen autumn Gammarus pulex abundance from S&TC Riverfly Census sampling (2015-2018). Please note, monitoring on Itchen St Cross & East Lodge began in 2016

Despite a variety of other factors influencing Gammarus abundance, such as habitat and organic input, ≥500 is still a reasonable number to expect on a healthy chalkstream. On the Itchen, 2016 appeared to be the best year for Gammarus pulex abundance in the S&TC Riverfly Census autumn samples. Half of the sites achieved over (or only slightly below) the 500 target (Fig. 8). However, Yavington and Chilland Mill were consistently under target during the three years. The lowest Gammarus abundance was found at Itchen Stoke Mill in 2017. Mean G. pulex over the three year survey on the Itchen was 291.41 ± 133.99 CI.

Three of the Test sites achieved the Gammarus target, but this was only for one year out of the three years sampled. Polhampton and Fullerton both achieved target in autumn 2017 (1865 and 557 respectively), whereas Bossington achieved target in 2016 (499). The lowest count occurred at Whitchurch in 2016 (79). Excluding the highest and lowest values, autumn Gammarus counts fell between 105 and 269 for 2015-2017, well below the 500 target (Fig. 9). Mean G. pulex over the three year survey on the Test was 309.60 ± 250.98 CI.

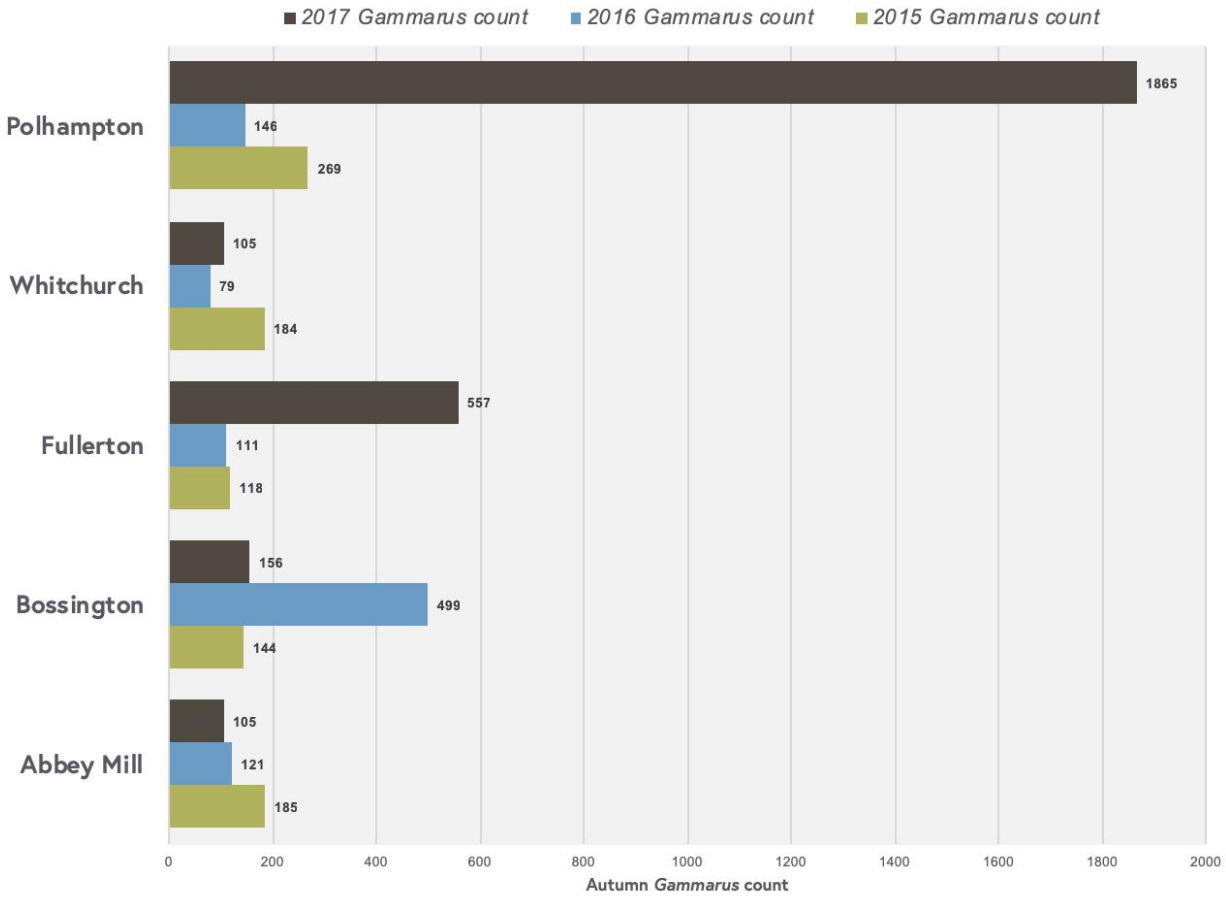


Fig. 9 - Test autumn Gammarus pulex abundance from S&TC Riverfly Census sampling (2015-2017)

Sediment Pressure

In the River Test, pressure from excess fine sediment was consistently demonstrated in the biometric scores. Every site, in spring and in autumn, exhibited a moderately sedimented signature at least once over the three year survey period. No site achieved an unimpacted sedimentation score throughout the survey, indicating all sites are experiencing some level of ecological impact from excess fine sediment. The lowest sedimentation impact was at Polhampton in autumn 2016 and 2017, with PSI scores of 71.19 and 72.09 respectively, which indicated clean conditions in the Upper Test.

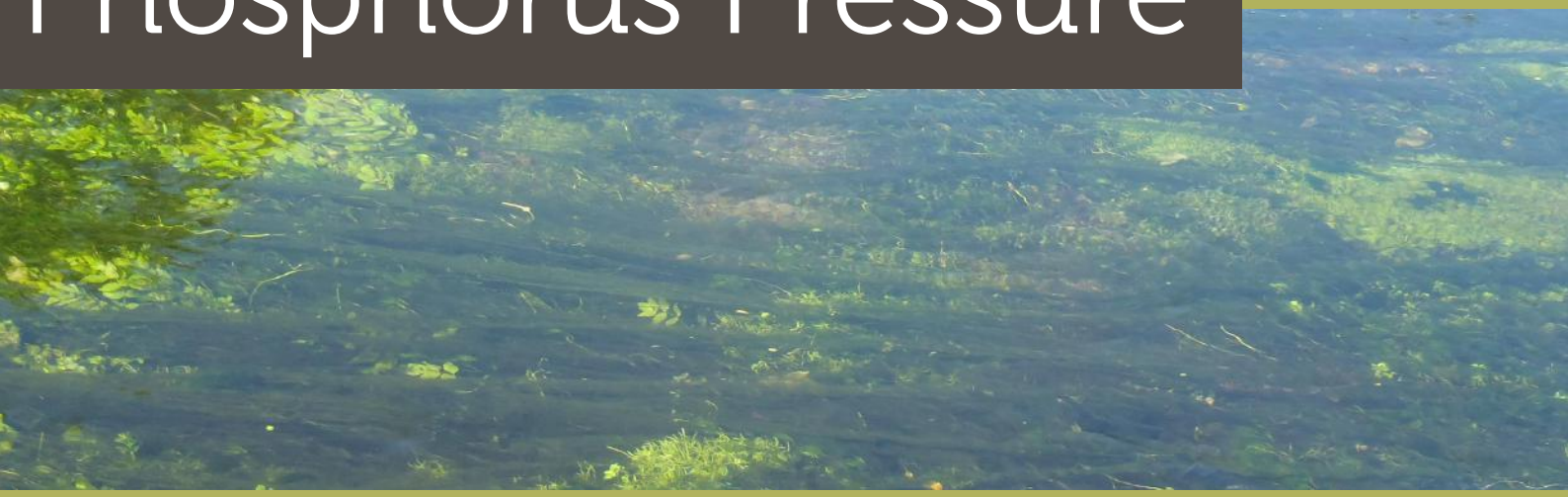
Biometric scores from the insect community in the Itchen also demonstrated sediment pressure, although less pronounced than the Test. No Itchen site achieved an unimpacted sedimentation score in the survey. The lowest (and therefore most impacted) PSI score was 40.35 at Yavington in autumn 2017. Itchen St Cross also exhibited a moderate sediment stress signature in autumn 2017 (PSI: 44.26). However, it is important to note that flow stress signatures were also stronger this year at both sites (LIFE: 7.21 and 7.41). Flow and sediment have a strong relationship, whereby lower flows reduce the ability of a river to transport sediment, resulting in a greater sediment deposition rate. There is also seasonal variation, whereby autumn biometric values typically demonstrate a greater impact than spring values because of factors such as reduced summer flows

Final effluent discharge data from the Environment Agency (see APPENDIX T2) shows that from 2012 onwards, suspended solids (SS) in the final effluent of the sewage treatment works around the Test generally showed a decreasing trend and stabilisation, but the monitoring is intermittent. Annual mean SS concentrations were never over 25 mg/l, the historical SS standard, during the time period evaluated (2012-2017). The highest annual SS means occurred at Romsey Greenhill STW, Stockbridge STW and Kings Sombourne STW. During 2015 and 2016 annual means at Romsey Greenhill were much higher than previous years (10.5 and 12.2 mg/l respectively), but SS appeared to level out from mid 2016 onwards. Kings Sombourne and Stockbridge had SS annual means over 10 mg/l in 2012 and 2013 respectively, but both sites showed a downward SS trend in the years after.

SS concentrations from discharges that feed into the Itchen were generally lower and more consistent than the Test discharges (See APPENDIX I2). Itchen Abbas Trout Farm had the most variable SS, with recurring annual peaks around 10-15 mg/l SS. Despite this, overall annual SS averages remained between 4 and 6 mg/l, with the exception of the year 2013 (7.58 mg/l). The largest SS spike events during the time period examined (2012-2017) were observed at West Lea Farm Shop Watercress in 2016 and Springvale Watercress (The Watercress Company) in 2017 (32.5 and 21.1 mg/l respectively).

Currently there is no official monitoring protocol or standard for sedimentation. Suspended solids monitoring is still sporadically carried out by the Environment Agency, but this measure has many limitations. SS sampling takes into account sediment in the water column only, overlooking the sediment deposited on river gravels. Deposited sediment is particularly problematic for the hyporheic zone, a crucial habitat and refuge for various stages of aquatic organisms such as microbes, macroinvertebrates and fish.

Phosphorus Pressure



In the Test, in-river orthophosphate levels were consistently over the 0.05 mg/l standard for a chalkstream (JNCC, 2014) at the Mayfly Inn EA monitoring site. Annual means from 2015-2016 were over double the CSMG target (0.126, 0.115 and 0.114 mg/l respectively). This site is downstream from the U/S Andover STW in-river site. At this location orthophosphates remained well under target from 2012 to 2017; annual means ranged from 0.022-0.035 mg/l (See APPENDIX T1). At our Fullerton census monitoring site the biological community did exhibit phosphorus stress, reflected by the TRPI scores.

It is important to note that despite being situated on a tributary of the Test (River Anton) Fullerton STW discharges directly into the Test just upstream of the Mayfly Inn, so this site has the cumulative loading from two sewage treatment works. Despite this loading, in river orthophosphate concentrations downstream of the Mayfly Inn site at Longstock mostly achieved the 0.05 mg/l target, when averaged annually. However, this reduction in concentration may be a result of dilution from the River Anton and there may be an impact legacy from phosphate levels held, and remobilised, in the bed of the river.

We are aware there is work by the local Environment Agency in this area to enforce tighter phosphorus targets at these works, but we are concerned by the restriction in application due to the time scales involved in water company investment cycles. Given the additive effect of discharges over such a small area, in such a historically, culturally and ecologically important river, a phosphorus target lower than the existing 1 mg/l target would be a positive step forward in the Test's recovery.

In the Itchen, in-river orthophosphate concentrations were relatively stable at the EA sites examined over the time period evaluated (2012-2017). Nuns walk stream and Otterbourne memorial garden were the most variable, but still not far from the 0.05 mg/l CSMG target (See APPENDIX I1). Annual orthophosphate means ranged from 0.042-0.06 mg/l, with the exception of 2013 at Nuns walk stream, which experienced a large orthophosphate event of 0.43 mg/l in July, resulting in a higher annual mean of 0.078 mg/l. It is positive to see that in-river orthophosphate concentrations are largely meeting the target, but we remain concerned that the 0.05 mg/l target is still too high for a chalkstream. Especially when taking into consideration that the discharge consents of watercress farms on the river are 0.06 mg/l.

However, mean orthophosphate in the final effluent of the Itchen watercress farms was all within the 0.06 mg/l consent level at the sites examined from 2012-2017 (See APPENDIX I2). Springvale cress (owned by The Watercress Company) was the most variable, though still within consent. From 2012-2013 annual means ranged from 0.053-0.056 mg/l. Mid 2014 onwards saw a decreasing trend in orthophosphate concentrations with the exception of a couple of peak events (0.15 mg/l in December 2015 and 0.09 mg/l in August 2017).

The impact of such spike events on the biology of the river is yet to be determined. Continuous versus pulse exposure to phosphorus is an area that warrants research to quantify the exact impact nutrients are having on the system.

Looking at the TRPI scores, the Itchen's invertebrate community did not indicate any severe phosphorus stress at the sites sampled. The lowest scoring (most impacted) site was Itchen Abbas in 2015, with TRPI scores of 60.59 and 57.14 in spring and autumn. However, the study sites often showed marked benthic algal growth which may be associated with a legacy of phosphorus in the substrate or ephemeral monitoring not detecting spikes of phosphorus in the river.

REFERENCES

Joint Nature Conservation Committee (JNCC). 2014. Common standards monitoring guidance for rivers. ISSN 1743-8160.

Beketov MA, Foit K, Schäfer, RB. 2009. SPEAR indicates pesticide effects in streams–comparative use of species-and family-level biomonitoring data. 157(6) pp. 1841-1848.

Walling DE and Amos CM. 1999. Source, storage and mobilisation of fine sediment in a chalk stream system. Hydrological processes, 13, pp. 323-340.

Welton J.S. (1979) Life history and production of the amphipod Gammarus pulex in a Dorset chalk stream. Freshwater Biology, 9, pp. 263-275.

SUPPLEMENTARY MATERIAL

APPENDIX I1 - EA Itchen In River Orthophosphate Monitoring Data 2012-2017

APPENDIX T1 - EA Test In River Orthophosphate Monitoring Data 2012-2017

APPENDIX I2 - EA Itchen Final Effluent Discharge Monitoring Data, Total Phosphorus & Suspended Solids 2012-2017

APPENDIX T2 - EA Test Final Effluent Discharge Monitoring Data, Total Phosphorus & Suspended Solids 2012-2017

EA data sourced from Open Access Water Quality Data Explorer.
Statistics calculated in RStudio Version 1.1.383.