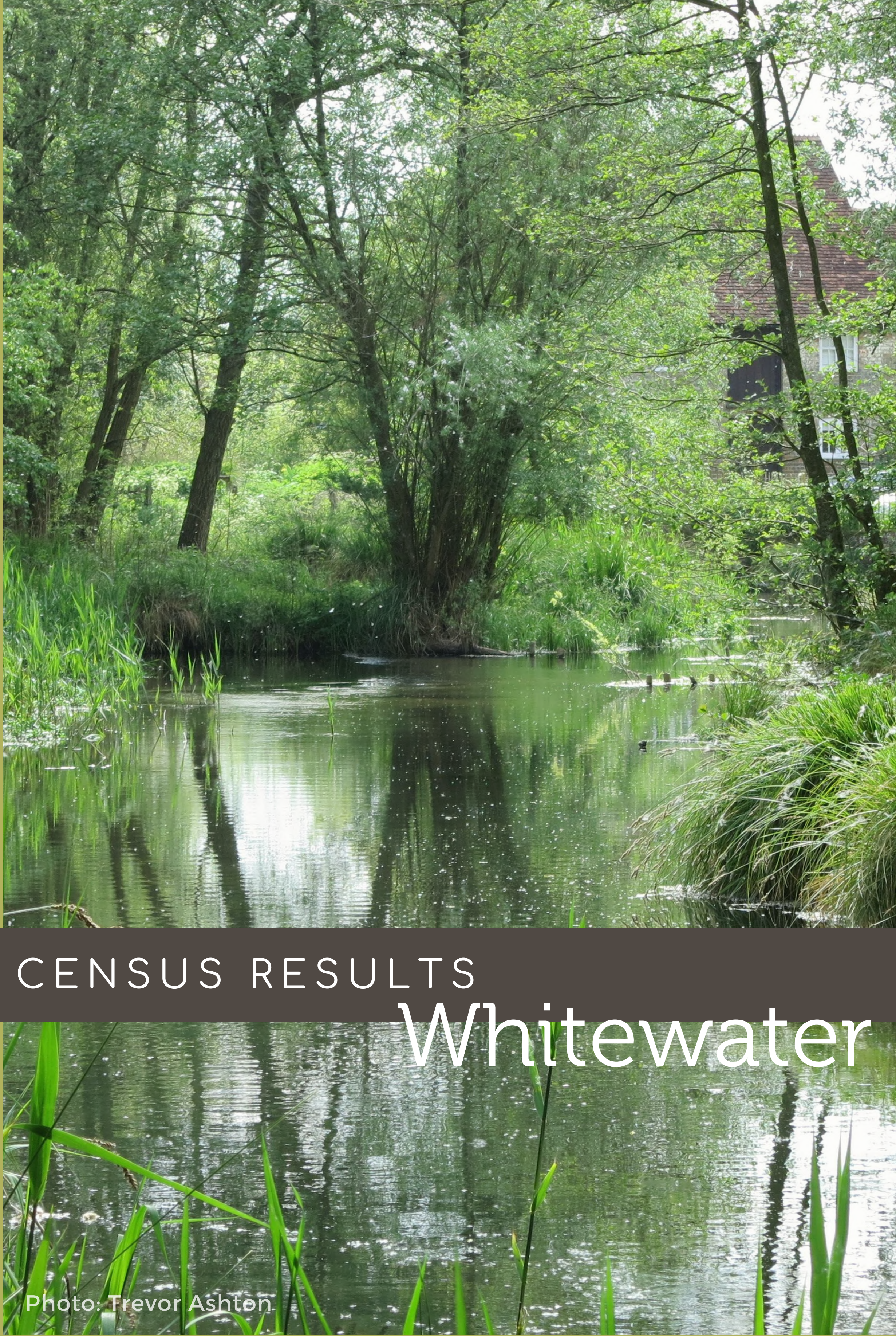


Photo: Trevor Ashton

RIVERFLY CENSUS RESULTS

Whitewater

Salmon & Trout Conservation

KEEPING OUR WATERS WILD • EST 1903

www.salmon-trout.org

@SalmonTroutCons

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

Metric	Name/Meaning	Measures	Healthy rating
BMWP	Biological Monitoring Working Party score	Scores, mostly at family level, invertbrate sensitivity to organic pollution. Looks at invertebrate presence but not abundance.	≥71
ASPT	Average Score Per Taxa	Calculated by dividing the BMWP score by the Number of Taxa (Ntaxa)	≥6
WHPT	Walley Hawkes Paisley Trigg index	As BMWP but using a greater number of Taxa (families)	Requires RIVPACS O:E (observed to expected) for a particular watercourse
WHPT ASPT	Walley Hawkes Paisley Trigg Average Score Per Taxa	Calculated by dividing the WHPT score by the Number of Taxa (Ntaxa)	
Number of Taxa	(or NTaxa)	The number of indivdual species	≥35
Riverfly - species	Mayfly, stonefly and caddisfly species	The number of riverfly species	≥20
Riverfly - numbers	Total mayfly, stonefly and caddisfly	The number of individual riverflies	N/A
CCI	Community Conservation Index	The community richness and relative rarity of its species	≥15
LIFE	Lotic Invertebrate Flow Evaluation	Indicates the flow velocity	≥7
PSI	Proportion of Sediment-sensitive Invertebrates	Indicates the level of sedimentation	61-100
SPEAR	Species At Risk	Indicates the level of pesticides, herbicides and complex chemicals	≥33
TRPI	Total Reactive Phosphurus Index	The level of nutrient enrichment	61-100
Saprobic	Organic enrichment	The amount of degradable organic material	2.29-1.0

WHAT WE'VE DONE: Method

SCOPE

The Riverfly Census has spanned three years. It began in 2015, originally 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.

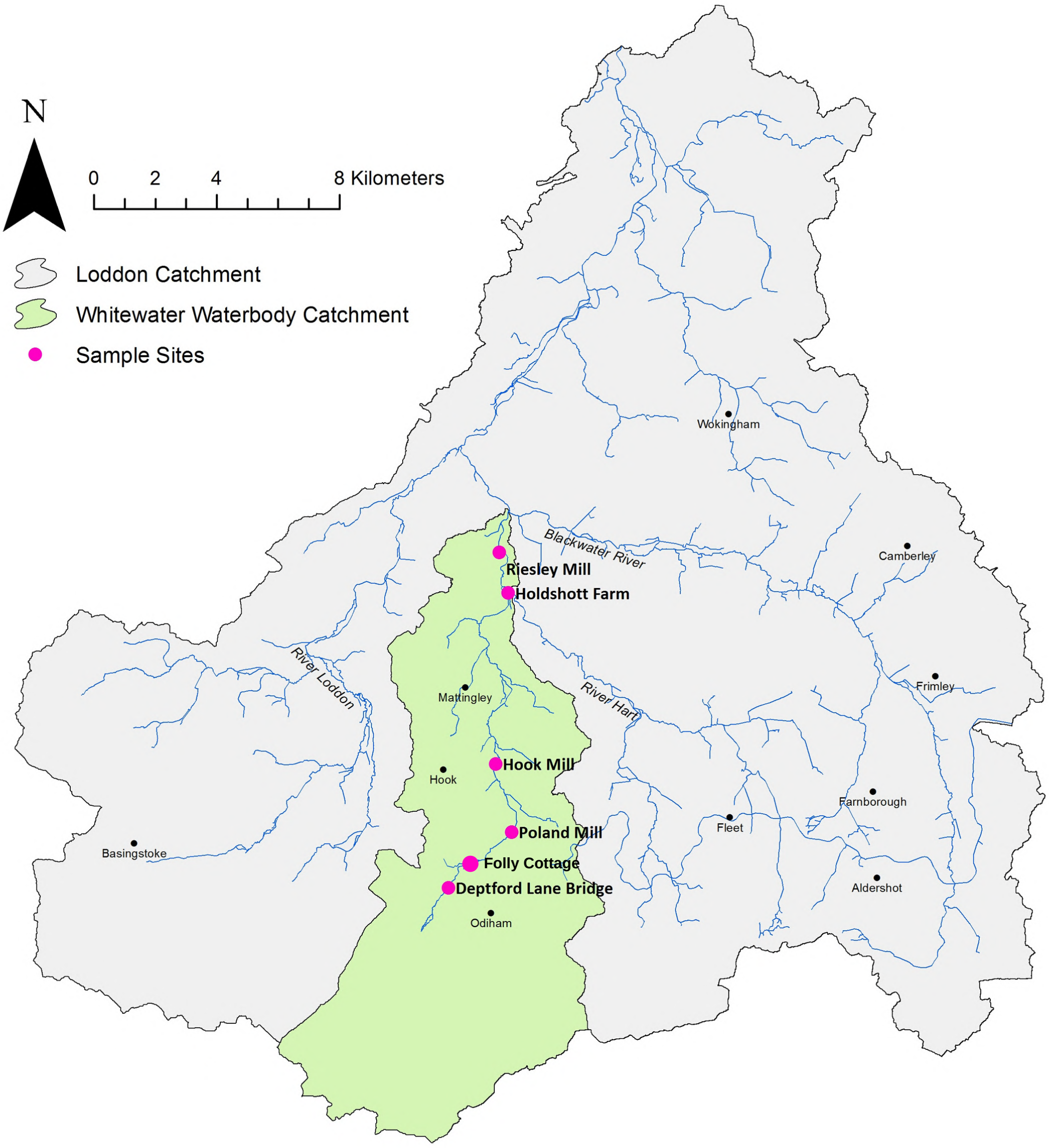
STUDY

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.

WHAT WE'VE FOUND: Results



Riverfly Census sampling on the Whitewater began in spring 2017 on 5 sites: Deptford Lane Bridge, Poland Mill, Hook Mill, Holdshott Farm and Riseley Mill.

Folly Cottage was added to the study in spring 2018. Due to sampling difficulties the Riseley Mill site was moved slightly downstream in the middle of the survey.

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

1 WHAT WE'VE FOUND

Deptford Lane Bridge

The invertebrate community at Deptford Lane Bridge exhibited consistent pressure from excess fine sediment and phosphorus enrichment.

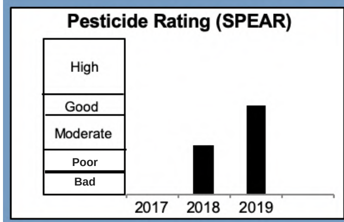
Stress from phosphorus was more pronounced in autumn, with a borderline heavily impacted TRPI signature in 2019. In spring, phosphorus stress was still concerning with moderate signatures in 2018 and 2019. For sediment, a moderate impact or greater was present throughout the survey for both seasons.

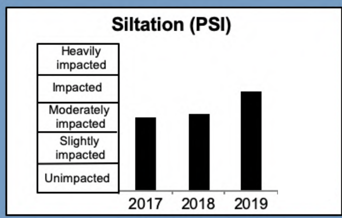
Some flow stress was also indicated in spring and autumn, potentially suggesting flow was not sufficient to move excess sediment off of river gravels.

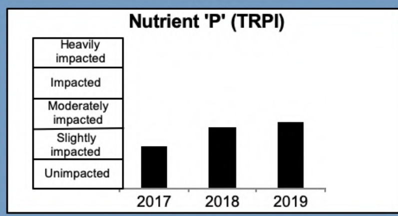
Failures against the proposed WFD SPEAR standard for chemicals (Beketov *et al* 2009) occurred in spring 2018 and autumn 2019

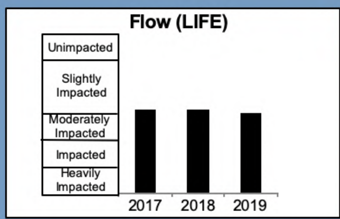
SPRING BIOMETRICS

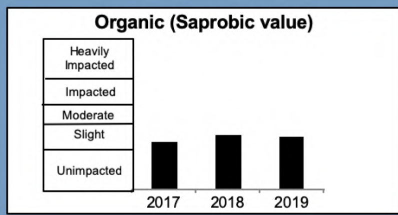
	2017	2018	2019
BMWP	85	66	91
ASPT	5.31	4.71	5.06
Annual Mayfly Sp. Richness	2	3	3
Total Abundance	342	NA	NA
EPT	11	7	11
CCI	8.93	9.23	5.54
LIFE	7.06	7.07	7.00
PSI	50.00	48.28	32.50
SPEAR	NA	21.74	39.73
TRPI	72.73	60.00	56.25
Saprobic	1.94	2.09	2.06





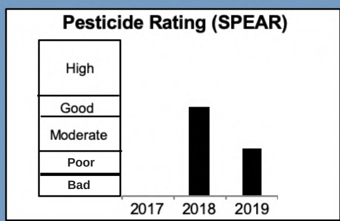


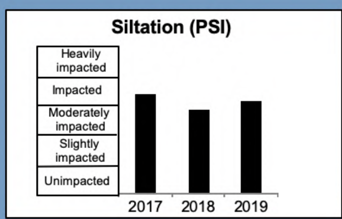


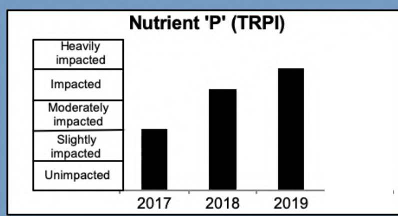


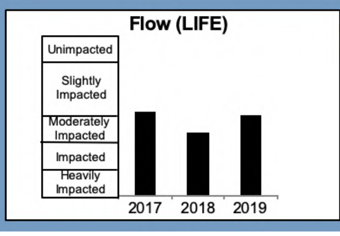
AUTUMN BIOMETRICS

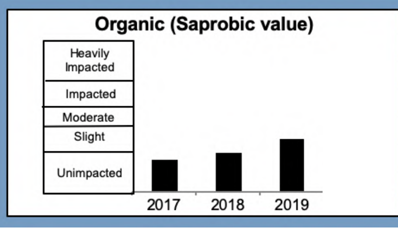
	2017	2018	2019
BMWP	81	81	44
ASPT	5.06	5.40	4.40
Annual Mayfly Sp. Richness	2	3	3
Total Abundance	264	NA	NA
EPT	5	7	3
CCI	3.82	11.00	4.29
LIFE	7.06	6.67	7.00
PSI	33.33	43.33	37.50
SPEAR	NA	39.15	21.13
TRPI	60.00	33.33	20.00
Saprobic	1.64	1.78	2.05











2

WHAT WE'VE FOUND

Folly Cottage

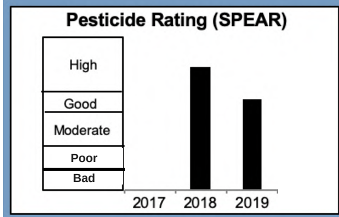
Folly Cottage was added to the survey in 2018. The invertebrate community only exhibited moderate stress from excess fine sediment in spring 2018.

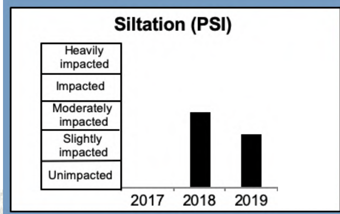
Nutrient stress was considerable in 2018 during both seasons, but recovery occurred in 2019.

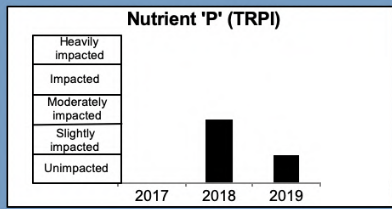
The proposed WFD SPEAR standard for chemical stress failed in autumn 2019.

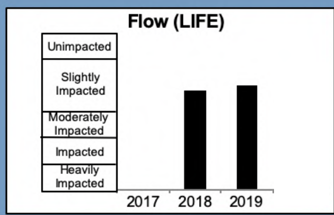
SPRING BIOMETRICS

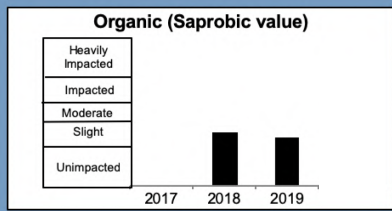
	2017	2018	2019
BMWP	NA	106	84
ASPT	NA	6.24	5.60
Annual Mayfly Sp. Richness	NA	6	5
Total Abundance	NA	NA	NA
EPT	NA	13	12
CCI	NA	11.25	9.17
LIFE	NA	7.40	7.50
PSI	NA	48.72	63.64
SPEAR	NA	55.99	41.21
TRPI	NA	57.14	81.82
Saprobic	NA	2.09	1.99





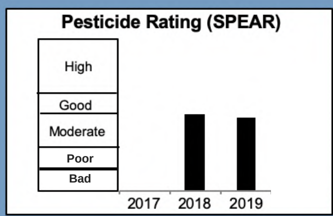


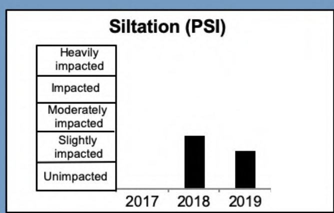


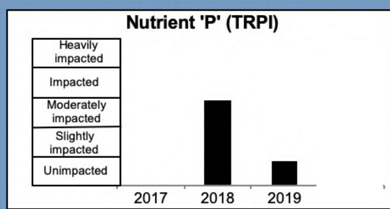


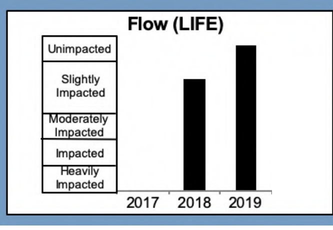
AUTUMN BIOMETRICS

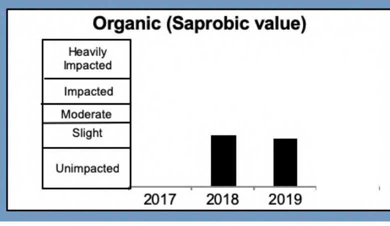
	2017	2018	2019
BMWP	NA	88	71
ASPT	NA	5.50	4.73
Annual Mayfly Sp. Richness	NA	6	5
Total Abundance	NA	NA	NA
EPT	NA	7	8
CCI	NA	8.89	7.27
LIFE	NA	7.67	8.31
PSI	NA	63.64	74.29
SPEAR	NA	34.64	33.58
TRPI	NA	42.86	83.33
Saprobic	NA	2.05	1.96











3 WHAT WE'VE FOUND

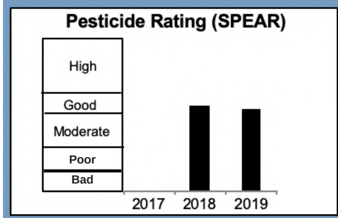
Poland Mill

Stress from excess fine sediment was exhibited by the invertebrate community at Poland Mill, with moderate stress signatures in spring 2018, autumn 2017 and autumn 2019.

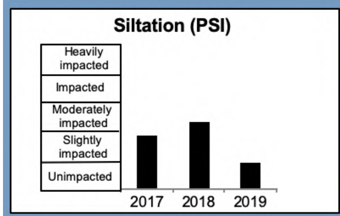
A concerning nutrient stress peak was indicated in autumn 2019 and moderate impact was present in spring 2018.

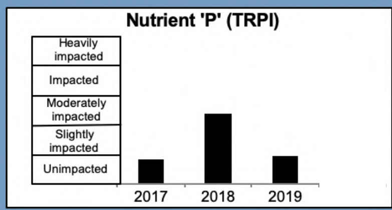
Chemical stress was indicated in autumn 2019, with failure of the proposed WFD SPEAR standard.

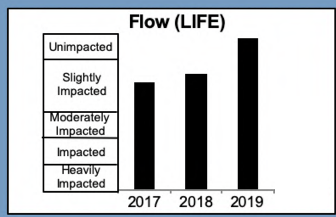
SPRING BIOMETRICS

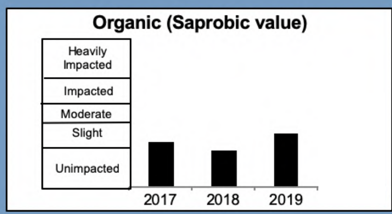


	2017	2018	2019
BMWP	97	126	94
ASPT	6.06	5.48	6.71
Annual Mayfly Sp. Richness	3	4	3
Total Abundance	207	NA	NA
EPT	7	12	11
CCI	17.82	10.28	21.00
LIFE	7.56	7.74	8.40
PSI	63.33	53.70	82.14
SPEAR	NA	38.69	36.94
TRPI	83.33	53.33	81.82
Saprobic	1.91	1.72	2.09

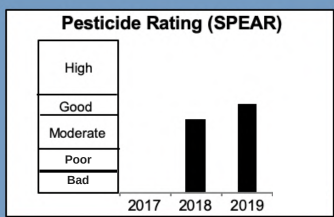




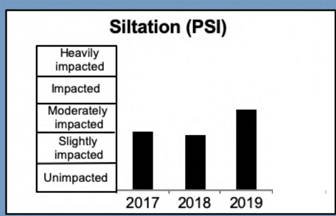


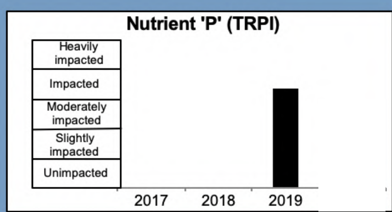


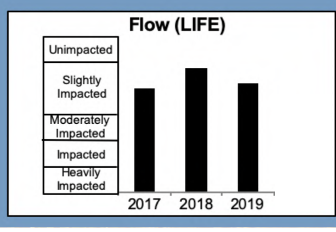
AUTUMN BIOMETRICS

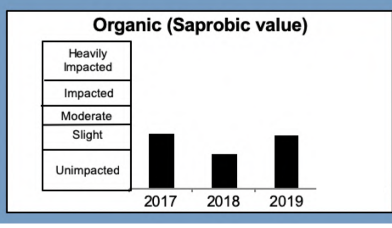


	2017	2018	2019
BMWP	96	91	71
ASPT	5.65	5.69	5.07
Annual Mayfly Sp. Richness	3	4	3
Total Abundance	1107	NA	NA
EPT	6	9	5
CCI	11.20	9.17	10.00
LIFE	7.50	7.88	7.60
PSI	60.00	61.76	44.44
SPEAR	NA	33.16	40.59
TRPI	100.00	100.00	33.33
Saprobic	2.10	1.71	2.07









4 WHAT WE'VE FOUND
Hook Mill

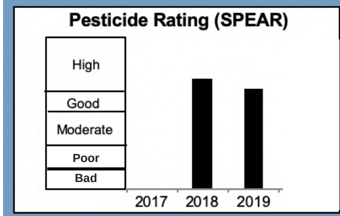
The invertebrate community at Hook Mill did not exhibit any considerable nutrient stress.

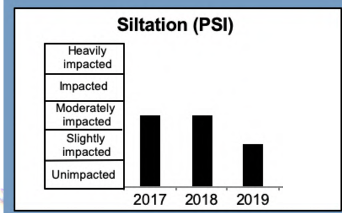
Moderate sediment stress was indicated in spring 2017, spring 2018 and autumn 2018.

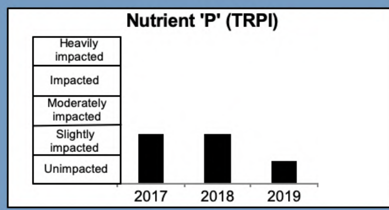
The proposed WFD standard for chemicals was failed in autumn 2019.

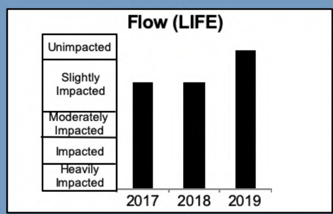
SPRING BIOMETRICS

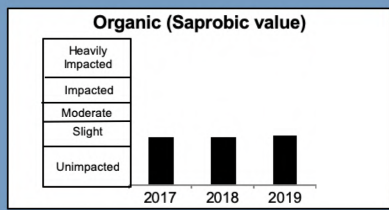
	2017	2018	2019
BMWP	85	114	105
ASPT	6.54	6.00	6.18
Annual Mayfly Sp. Richness	7	8	7
Total Abundance	746	NA	NA
EPT	11	16	14
CCI	8.64	18.90	15.11
LIFE	7.56	7.57	8.20
PSI	50.00	50.00	70.00
SPEAR	NA	50.14	46.04
TRPI	66.67	66.67	84.62
Saprobic	1.98	1.99	2.00





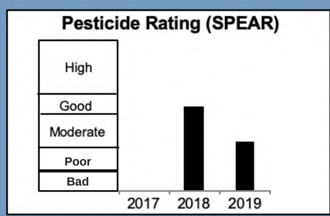


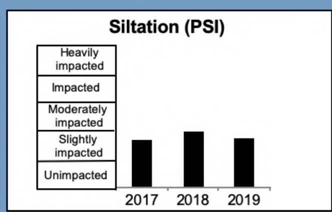


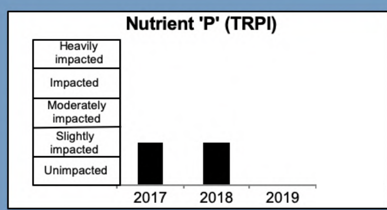


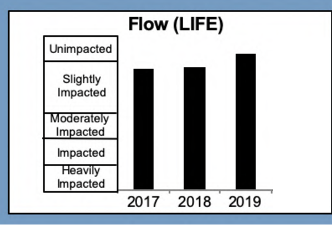
AUTUMN BIOMETRICS

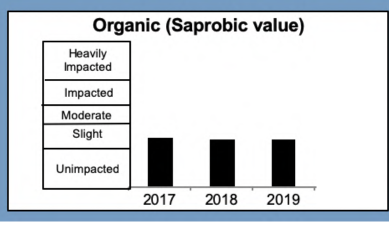
	2017	2018	2019
BMWP	79	106	69
ASPT	5.64	5.89	6.27
Annual Mayfly Sp. Richness	7	8	7
Total Abundance	992	NA	NA
EPT	6	9	4
CCI	4.09	11.50	15.56
LIFE	7.87	7.88	8.15
PSI	66.67	60.61	65.38
SPEAR	NA	38.62	22.33
TRPI	71.43	71.43	100.00
Saprobic	2.00	1.97	1.97











5 WHAT WE'VE FOUND
Holdshott Farm

Sediment stress was less pronounced on the invertebrate community at Holdshott Farm compared to the other survey sites. Moderate impact was only exhibited in autumn 2017 and spring 2019.

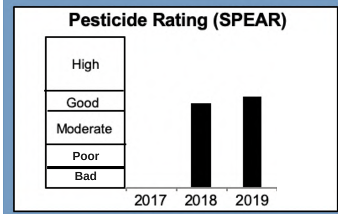
Moderate nutrient stress signatures were also only present in autumn 2017 and spring 2019.

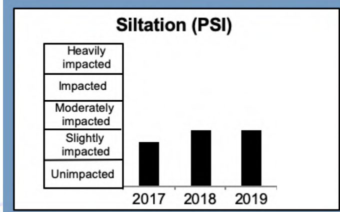
Chemical stress was more pronounced in autumn, with a borderline failure against the proposed WFD standard for SPEAR in 2018 and failure in 2019.

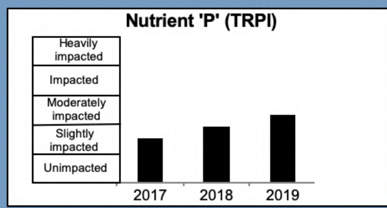
Minimal flow stress was indicated.

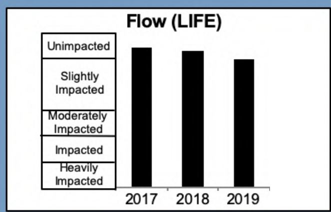
SPRING BIOMETRICS

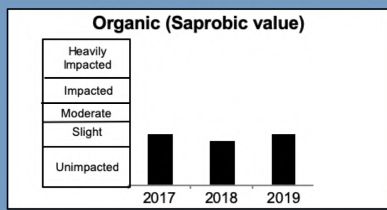
	2017	2018	2019
BMWP	135	154	174
ASPT	6.43	6.16	6.21
Annual Mayfly Sp. Richness	5	8	5
Total Abundance	4346	NA	NA
EPT	13	15	21
CCI	9.52	15.96	19.03
LIFE	8.21	8.14	8.00
PSI	69.39	61.19	60.53
SPEAR	NA	39.04	41.55
TRPI	70.00	62.50	54.17
Saprobic	2.03	1.90	2.04





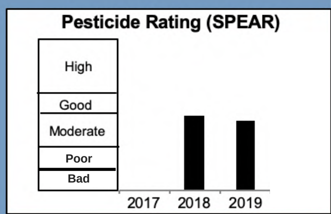


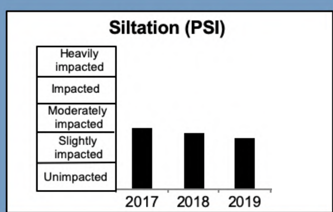


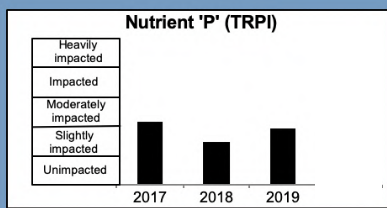


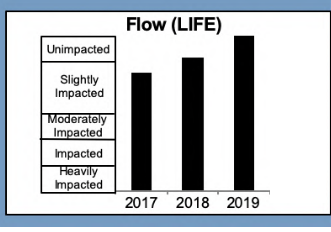
AUTUMN BIOMETRICS

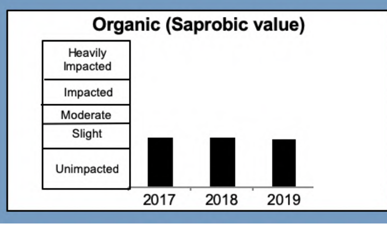
	2017	2018	2019
BMWP	102	103	88
ASPT	6.00	6.44	5.87
Annual Mayfly Sp. Richness	5	8	5
Total Abundance	1233	NA	NA
EPT	7	10	7
CCI	NA	10.29	16.63
LIFE	7.78	8.09	8.53
PSI	57.58	61.11	64.29
SPEAR	NA	33.98	32.00
TRPI	57.14	71.43	62.50
Saprobic	2.02	2.01	1.98











6 WHAT WE'VE FOUND
Riseley Mill

Due to unfavourable sampling conditions Riseley Mill was not surveyed in autumn 2017, the site was relocated slightly further downstream in 2018 because of this.

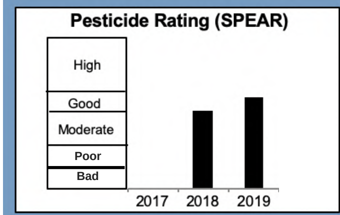
Concerning impact from excess fine sediment stress was exhibited by the invertebrate community throughout 2018 and 2019.

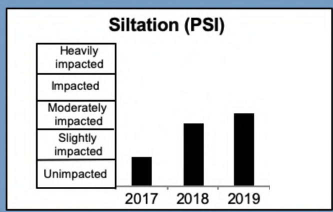
Nutrient stress was pronounced in spring 2018 and 2019, but recovery occurred in autumn.

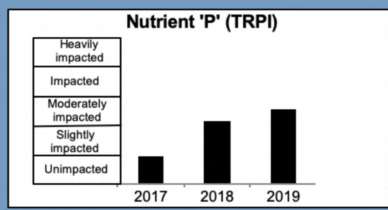
The SPEAR biometrics did not indicate any failure of the proposed WFD standard for chemicals.

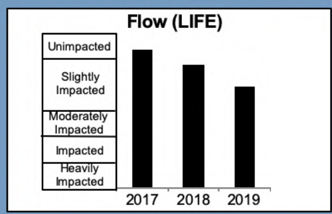
SPRING BIOMETRICS

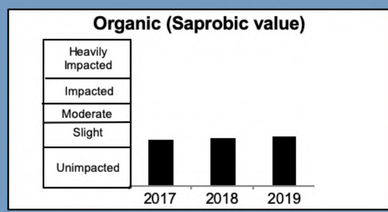
	2017	2018	2019
BMWP	125	123	151
ASPT	6.58	5.59	6.04
Annual Mayfly Sp. Richness	NA	6	7
Total Abundance	661	NA	NA
EPT	12	14	16
CCI	14.78	10.68	14.27
LIFE	8.20	7.88	7.47
PSI	79.41	55.93	49.21
SPEAR	NA	35.81	42.23
TRPI	81.25	57.89	50.00
Saprobic	1.95	1.98	2.00





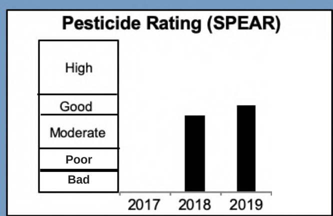


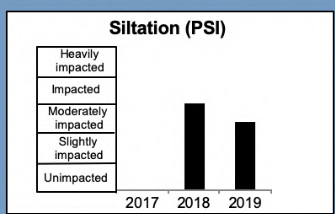


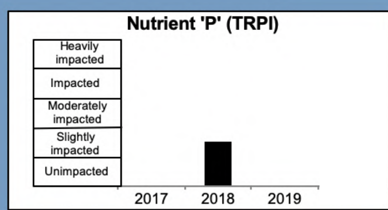


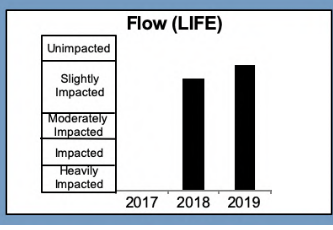
AUTUMN BIOMETRICS

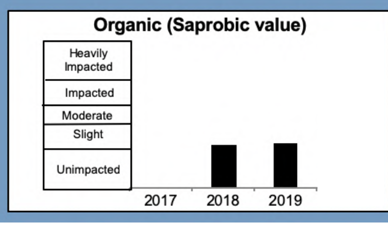
	2017	2018	2019
BMWP	NA	93	86
ASPT	NA	5.81	6.14
Annual Mayfly Sp. Richness	NA	6	7
Total Abundance	NA	NA	NA
EPT	NA	6	7
CCI	NA	5.25	5.14
LIFE	NA	7.65	7.93
PSI	NA	40.00	53.33
SPEAR	NA	35.11	39.62
TRPI	NA	70.00	100.00
Saprobic	NA	1.86	1.89











OUR THOUGHTS: Discussion

The Salmon & Trout Conservation (S&TC) Riverfly Census on the Whitewater has revealed that ecologically the river is in crisis. The River Whitewater is a chalkstream, one of only about 200 in the world. Overall, the most significant water quality pressure was indicated to be sediment, but nutrient and chemical pressure was also concerning in places. Our findings indicated Holdshott Farm to be the healthiest site, although sediment, chemical and nutrient stress was still exhibited here.

The River Whitewater is currently failing to meet Good Ecological Status as required under the Water Framework Directive (Fig. 1). The main pressures and reason for failure were indicated to be physical habitat and barriers to fish passage. This means fish populations are prevented from moving freely through the river. Such barriers include mills, weirs and culverts.

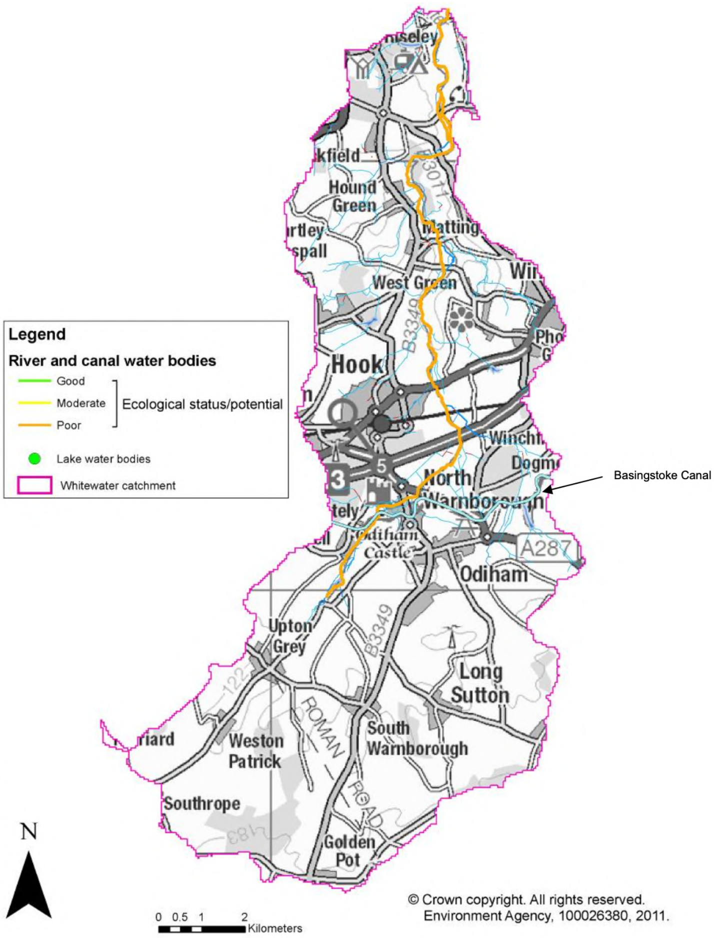


Fig. 1 - Whitewater catchment showing river WFD classification (Environment Agency, 2012)

Physical barriers also impede sediment movement. They change flow, which can promote build up of fine silts. Such accumulation alters the natural river form which can impact the ecological status (Environment Agency, 2012). Our survey showed evidence of this, with persistent sediment stress being indicated by the invertebrate community. Sediment pressure was slightly less pronounced at Folly Cottage and Holdshott Farm, but impact was still indicated as moderate on one and two occasions respectively.

Land use surrounding the Whitewater shifts from predominantly arable to grassland along the river (Fig. 2). Arable farming, especially when it is undertaken right up to the river's edge can contribute high quantities of excess fine sediment to a watercourse. Crop harvesting and ploughing leaves soil bare and vulnerable to washing off during rain events. Water friendly farming techniques such as cover crops, buffer strips and zero tillage (where feasible) would benefit the upper reaches of the Whitewater by reducing the sediment load.

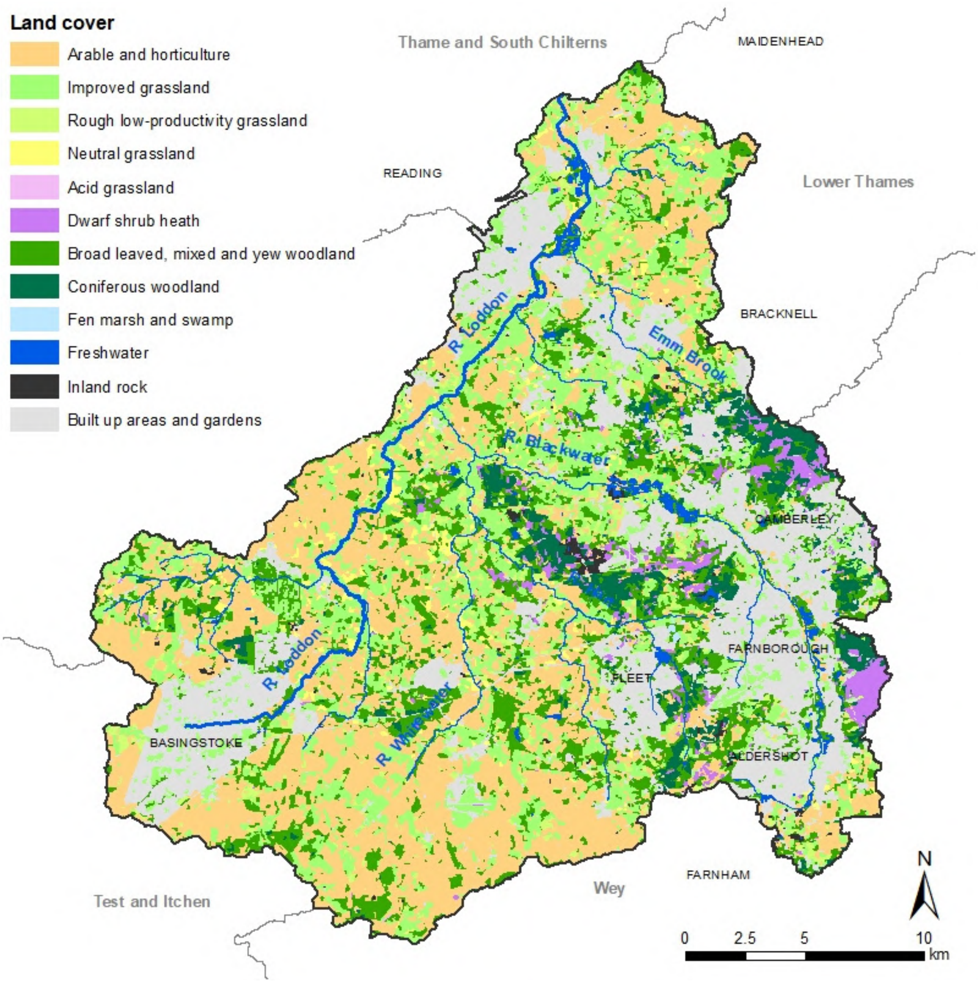


Fig. 2 - Land use in the Loddon catchment, NERC (2011) Landcover Map 2007. Data obtained under non-commercial licence. Centre for Ecology and Hydrology (CEH), Oxfordshire.

Many chemicals, such as pesticides and herbicides used in arable agriculture, bind to soil and are delivered to watercourses via sediment run-off. Chemical stress was indicated at all sites apart from Riseley Mill. With the exception of Deptford Lane Bridge, a seasonal chemical impact was exhibited by the invertebrate community, with all failures of the proposed WFD SPEAR standard for chemicals occurring in autumn (Beketov *et al*. 2009).

Burrowing from signal crayfish can also increase bank erosion and introduce greater sediment loads into the river (Turley *et al*. 2017). Therefore, it is important not to overlook this as a contributing factor to sediment stress in the Whitewater. Invasive North American signal crayfish (*Pacifastacus leniusculus*) were detected at all of the sites monitored in our Whitewater survey (Fig. 3). These crayfish are capable of exerting change in ecological condition to the river both directly, through disease, predation, competition or displacement, and indirectly by disrupting food chain dynamics and altering physical and chemical habitat characteristics (Turley *et al*. 2017). In 1981 mass mortality of the native white-clawed crayfish (*Austropotamobius pallipes*) was observed and following this, the species completely disappeared from the Whitewater and Loddon rivers (Environment Agency, 1998). Crayfish plague, of which signals are carriers, was suspected as the cause but this was unconfirmed.

Signal crayfish were found most frequently at Hook Mill. Juvenile signal crayfish recruitment was particularly high at Poland Mill in spring 2019. A lack of leeches and molluscs found at these sites infers an ecosystem impact from signal crayfish predation (Mathers *et al*. 2017).

Taking appropriate measures to reduce the signal crayfish population may benefit the Whitewater's ecology. Activities such as trapping will not eradicate populations of signal crayfish, but in some cases can increase the total number of individual macroinvertebrates (Moorhouse *et al*. 2014).

Fig. 3 - Signal Crayfish (Pacifasticus leniusculus) at Folly Cottage, Spring 2019.

Nutrient stress was less pronounced than sediment stress in the Whitewater at our surveyed sites, but was still indicated as moderate on many occasions. Excess phosphate entering the Whitewater is likely to be from a combination of sources, including runoff from arable agriculture and wastewater discharges.

The Odiham sewerage drainage area is served by the North Warnborough Sewage Pumping Station (SPS). This pumping station is reported to fail most years for a variety of reasons, including blockages, misconnections and groundwater ingress (Hart District Council, 2016). Failure often results in the discharge of raw sewage directly into the Whitewater. Although our methodology evaluates longer term invertebrate community responses and not the biological impact of specific gross pollution incidents such as this, the failings of this system may have increased consequences for water quality in the future.

Applications for new housing developments in Odiham and North Warnborough have recently been made, for example, planning application 19/00069/FUL. This application was withdrawn in November 2019, but if developments like this were to go ahead, the sewerage demand in the area would increase (Hart District Council, 2019). For any future development, it is essential that the sewerage infrastructure is sufficient to protect the environment. Thames Water stated that capacity to accommodate significant growth was not available in the North Warnborough area and that upgrades to the network should be anticipated (Thames Water, 2014). Further investigations are being made to find out whether any improvements have been made at the North Warnborough SPS, as part of the most recent Asset Management Plan (AMP) cycle.

During the survey two caseless caddis species relatively rare to the Whitewater system (according to historical Environment Agency records) were found. These were *Metalype fragilis*, found at Poland Mill and *Polycentropus irroratus*, found at Holdshott Farm.

FINAL WORD

Many of our rivers lack historical reference points, making it difficult to know exactly what optimal conditions in our rivers should look like. It is only with a reliable 'benchmark' of health that we can properly quantify deterioration or recovery, and only with robust long term monitoring can we truly understand the changes occurring in our freshwater systems.

Our Riverfly Census data has highlighted the subtle but lethal pressures facing UK rivers, but we need help to extend species level invertebrate analysis to many more. Our new project, SmartRivers, will enable volunteers to monitor the water quality in their rivers to a near-professional standard. SmartRivers compliments existing Riverfly Partnership monitoring but provides more information. The high-resolution nature of the data also means that S&TC is able to work with the Environment Agency and others to address the causes of poor water quality and drive forward positive change.

REFERENCES

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

Environment Agency (2012). Loddon Catchment Implementation Plan.

Environment Agency (1998). Audit of priority species of rivers and wetlands. White-clawed Crayfish *Austropotamobius pallipes* in South Hampshire and the Isle of Wight.

Hart District Council (2019). Notice of Decision, Application 19/00069/FUL.

Hart District Council (2016). Hart District Council Strategic Flood Risk Assessment.

Mathers et al. (2017) Temporal variability in lotic macroinvertebrate communities associated with invasive signal crayfish (*Pacifastacus leniusculus*) activity levels and substrate character. Biological Invasions: 20, pp 567–582.

Moorhouse et al. (2014). Intensive removal of signal crayfish (*Pacifastacus leniusculus*) from rivers increases numbers and taxon richness of macroinvertebrate species. Ecology and Evolution: 4(4) pp. 494-504

Turley et al. (2017) The effects of non-native signal crayfish (*Pacifastacus leniusculus*) on fine sediment and sediment-biomonitoring. Science of the Total Environment: 601–602, pp. 186-193.

Thames Water (2014) Letter response to Hart Council Local Plan Housing Development Options.

ACKNOWLEDGEMENTS

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

Thank you to the Whitewater Valley Preservation Society for reaching out to us and making this survey possible.

WVPS would like to thank the following for their generous support, which allowed the Society to commission this study: South East Water, Cllr Jonathan Glenn at Hampshire County Council, Hook Parish Council and the Greywell Flyfishers.

Report composed by Lauren Mattingley. For Riverfly Census enquiries contact: lauren@salmon-trout.org