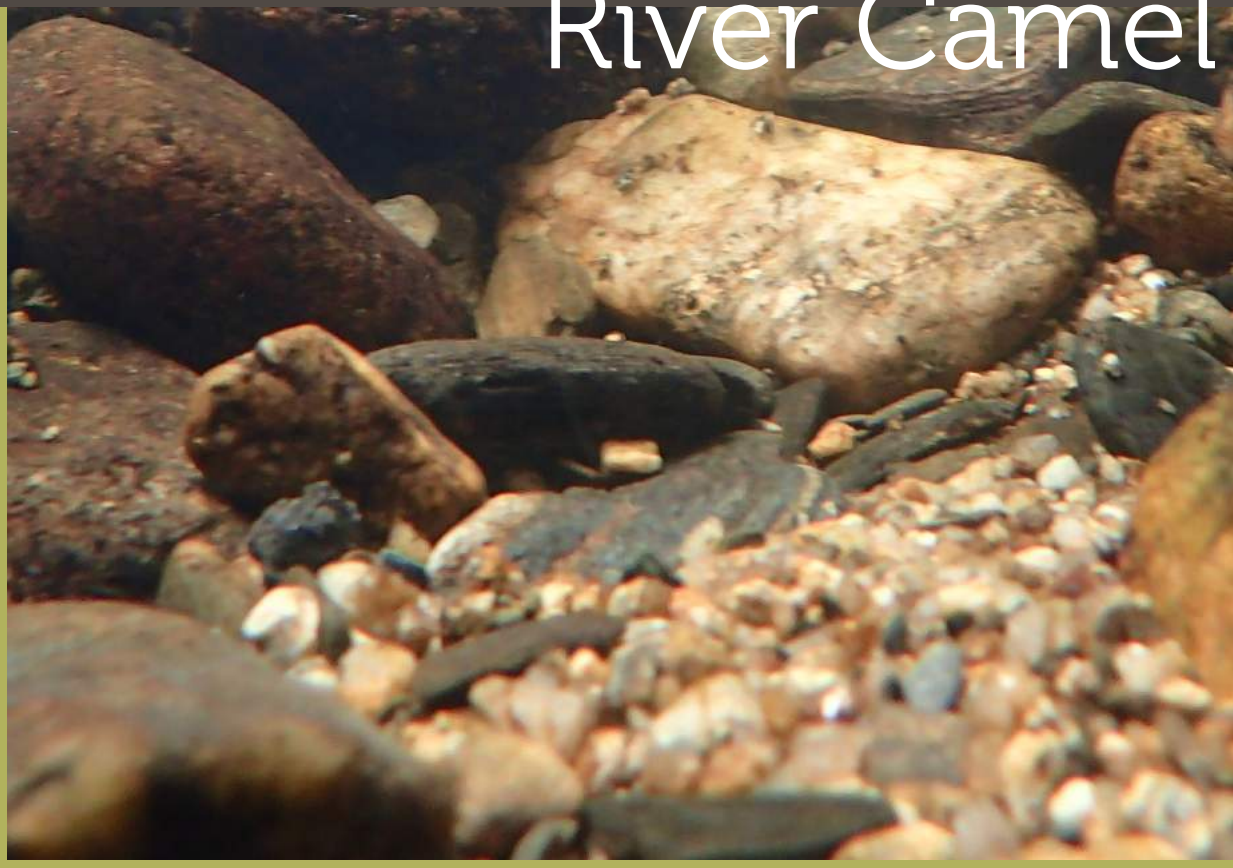
RIVERFLY CENSUS CONCLUSIONS

River Camel



Salmon & Trout Conservation

KEEPING OUR WATERS WILD • EST 1903

www.salmon-trout.org

@SalmonTroutCons

REPORT OUTLINE

OUR KEY POINTS

The 'take home' messages and recommendations from our survey on the River Camel

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 Camel

OUR THOUGHTS

We use our findings to discuss potential key issues on the river

ACKNOWLEDGEMENTS & CONTACT

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

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

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

OUR KEY POINTS

The Salmon & Trout Conservation (S&TC) Riverfly Census on the Camel has revealed that overall the river is in good ecological condition. However, by using the power of species-level analysis we have been able to identify potential stressors threatening the ecology of the river. To improve and protect water quality in the Camel and the wildlife that live there, here are our recommendations:

- Further investigation should take place in the upper catchment to identify exactly what chemicals are responsible for the SPEAR stress signatures and what actions can be taken to reduce their entry into the environment.

- Infrastructure at Nanstallon and Scarletts Well sewage works needs to be suitable to accommodate projected population growth and protect the Camel's water quality. A suitable, consistent water quality monitoring regime also needs to be in place to keep track of ecological impact in the river as this growth occurs.

- Further investigation into whether there is a relationship between the chemical impact demonstrated by the invertebrate community and the forestry operations taking place around Polbrock Bridge.

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 invertebrate communities which live in flowing water

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.

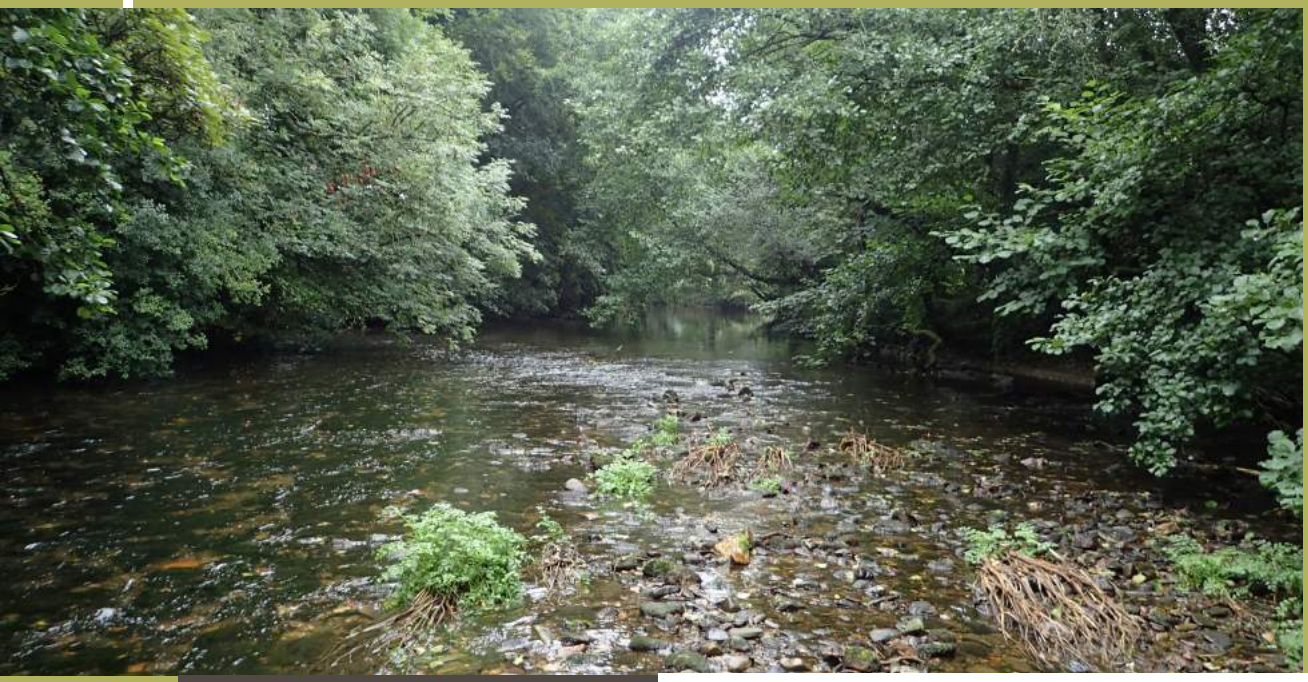
STUDY

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.

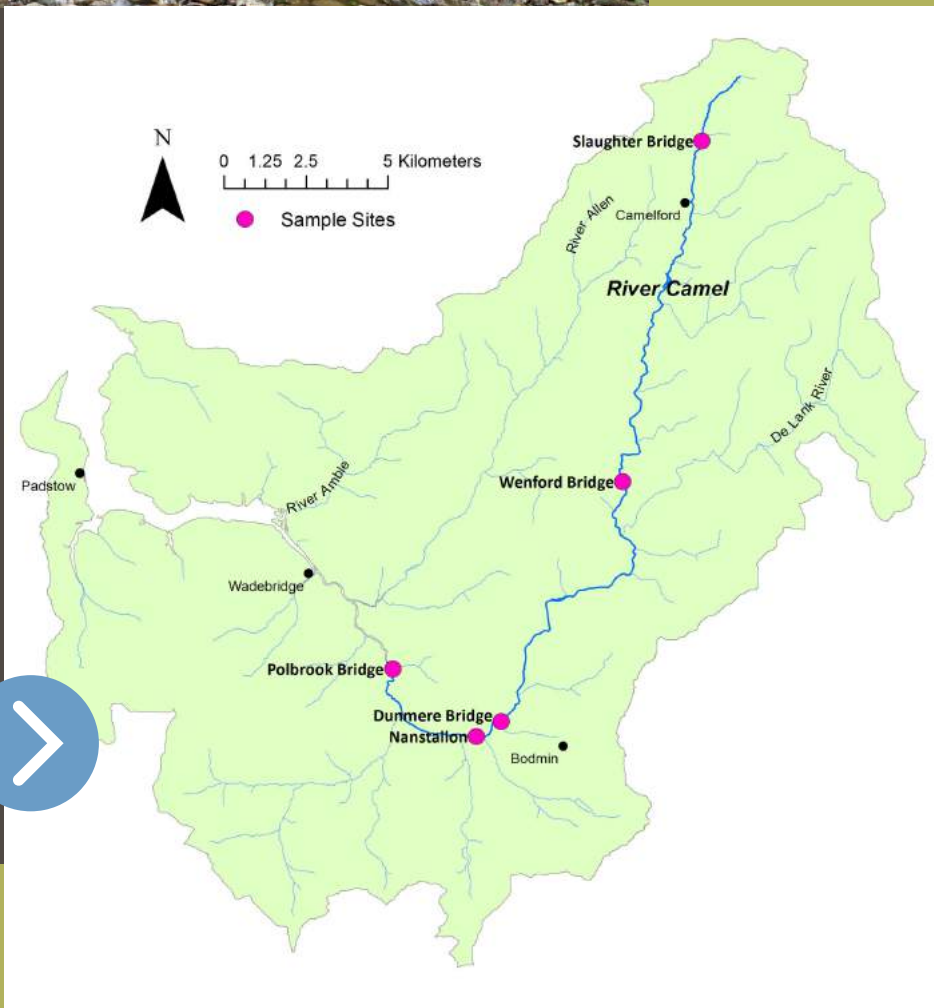
Results



Riverfly Census sampling on the Camel began in 2015 and continued for three years on five sites: Slaughter Bridge, Wenford Bridge, Dunmere Bridge, Nanstallon and Polbrock Bridge.

Polbrock Bridge could not be sampled in autumn 2017 due to unfavourable sampling conditions.

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



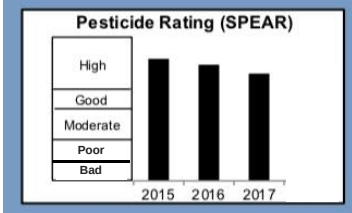
1 WHAT WE'VE FOUND
Slaughter Bridge

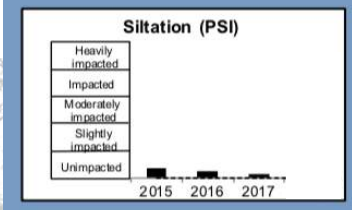
The invertebrate community was unimpacted by nutrient or flow stress at Slaughter Bridge for the entire survey period. Sediment stress was also absent with the exception of a slight impact PSI score in autumn 2017. Due to natural variability some increase in autumn is expected, as during winter periods rainfall is greater and soil erosion is commonly at its maximum (Walling and Amos, 1999).

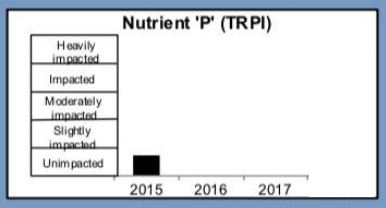
The complex chemical biometric, SPEAR, failed the proposed WFD standard (Beketov et al. 2009) in autumn 2015, but recovered to the high range each spring, suggesting a seasonal impact.

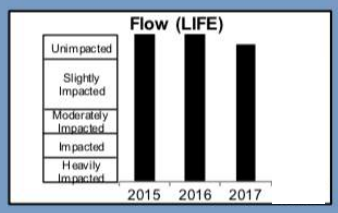
SPRING BIOMETRICS

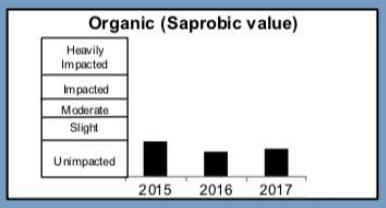
	2015	2016	2017
BMWP	159	145	121
ASPT	7.23	7.25	6.72
Annual Mayfly Sp. Richness	8	6	6
Total Abundance	521	-	144
EPT	21	18	12
CCI	10.00	11.05	14.93
LIFE	8.55	8.96	8.32
PSI	92.98	94.44	96.67
SPEAR	59.65	56.85	52.04
TRPI	85.19	100.00	100.00
Saprobic	1.77	1.54	1.61





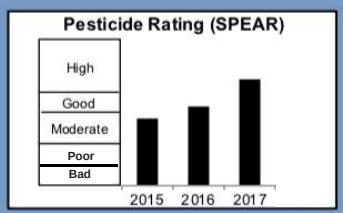


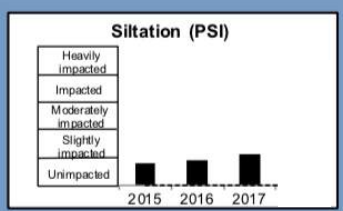


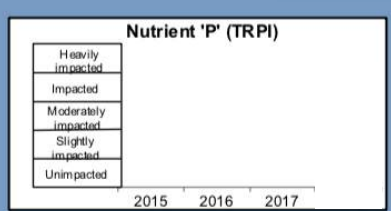


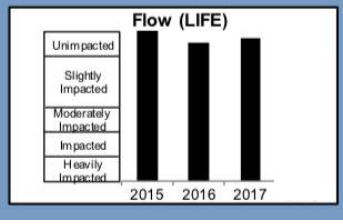
AUTUMN BIOMETRICS

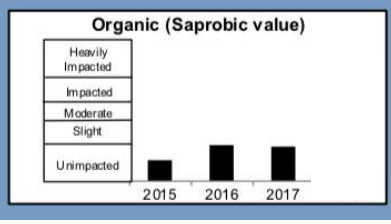
	2015	2016	2017
BMWP	142	172	125
ASPT	6.45	6.62	6.58
Annual Mayfly Sp. Richness	8	6	6
Total Abundance	430	758	264
EPT	13	16	13
CCI	9.25	13.63	15.65
LIFE	8.65	8.29	8.37
PSI	83.67	81.97	77.50
SPEAR	32.19	38.18	51.03
TRPI	100.00	100.00	100.00
Saprobic	1.44	1.76	1.73











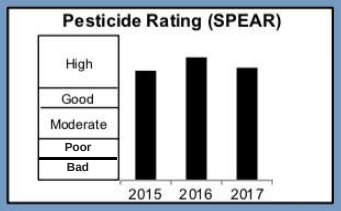
2 WHAT WE'VE FOUND
Wenford Bridge

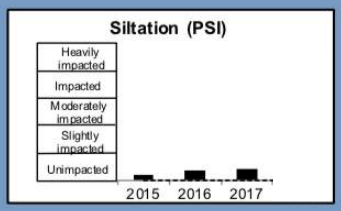
The LIFE biometric revealed no impact from flow stress on the invertebrate community at Wenford Bridge during 2015-2017. Nutrient and sediment stress were also absent apart from a slight impact in autumn 2015. When there is sufficient flow, stress from sediment and phosphorus is buffered, as there is greater dilution and increased velocity to carry excess fine sediment downstream.

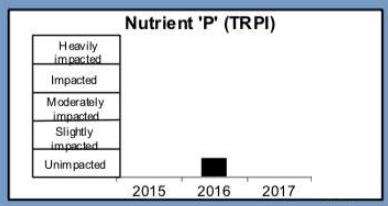
All results were above the proposed WFD threshold for SPEAR, indicating minimal chemical stress on the invertebrate community.

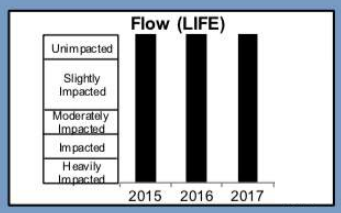
SPRING BIOMETRICS

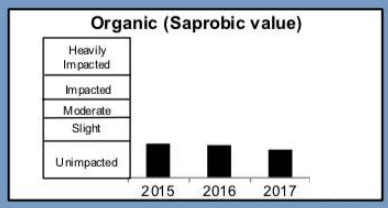
	2015	2016	2017
BMWP	152	184	133
ASPT	6.90	7.36	6.65
Annual Mayfly Sp. Richness	6	10	7
Total Abundance	502	768	345
EPT	16	25	17
CCI	9.38	16.04	8.53
LIFE	8.55	8.88	8.63
PSI	95.74	93.15	92.00
SPEAR	52.97	59.69	54.47
TRPI	100.00	86.67	100.00
Saprobic	1.75	1.70	1.61





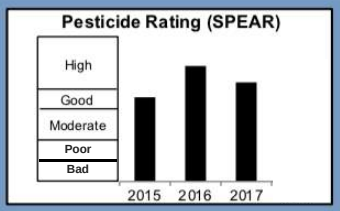


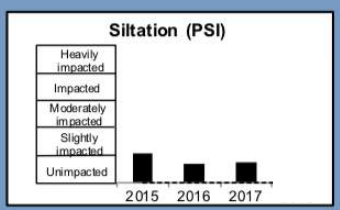


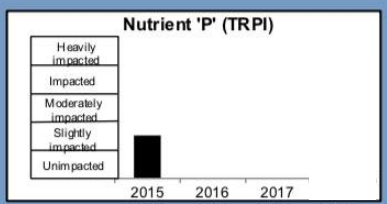


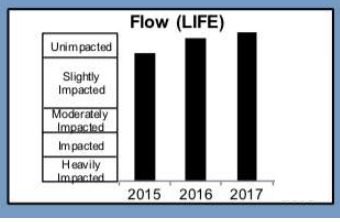
AUTUMN BIOMETRICS

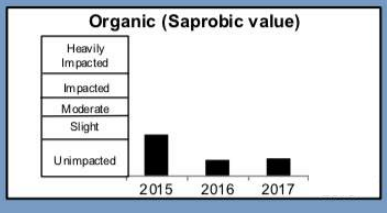
	2015	2016	2017
BMWP	142	171	128
ASPT	6.45	6.58	6.40
Annual Mayfly Sp. Richness	6	10	7
Total Abundance	293	545	489
EPT	13	17	18
CCI	7.11	23.68	10.50
LIFE	8.09	8.39	8.56
PSI	78.95	85.71	84.91
SPEAR	40.80	56.09	47.90
TRPI	69.35	100.00	100.00
Saprobic	1.89	1.35	1.39









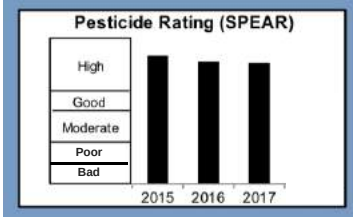


3 WHAT WE'VE FOUND
Dunmere Bridge

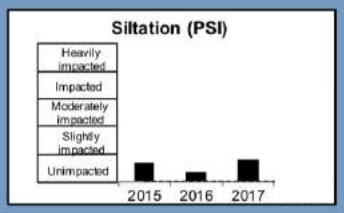
Stress from excess sediment was most notable in autumn 2017. However, as previously mentioned, some sediment increase in autumn is expected. Slight flow stress was also indicated in autumn 2017, potentially suggesting flow was not sufficient to move excess sediment off of river gravels.

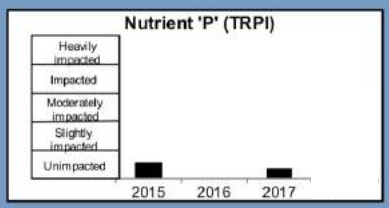
Additionally, the SPEAR biometric scores also failed proposed WFD standards at this time, which may have been a result of less dilution in the river.

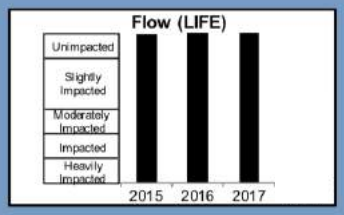
SPRING BIOMETRICS

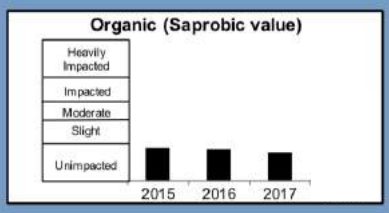


	2015	2016	2017
BMWP	162	142	135
ASPT	7.04	7.10	6.75
Annual Mayfly Sp. Richness	7	7	7
Total Abundance	510	649	275
EPT	18	21	16
CCI	15.11	11.14	9.72
LIFE	8.48	8.71	8.58
PSI	86.44	92.42	84.31
SPEAR	62.06	58.61	58.06
TRPI	88.89	100.00	93.13
Saprobic	1.70	1.66	1.62

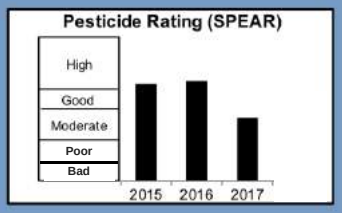




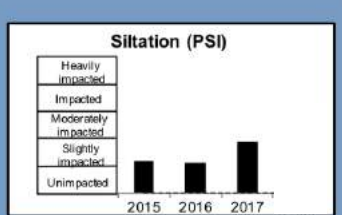


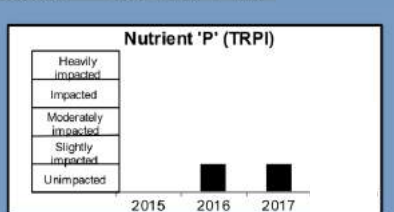


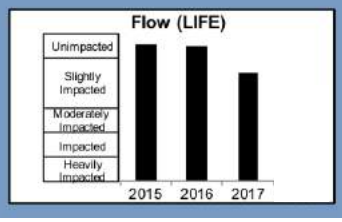
AUTUMN BIOMETRICS

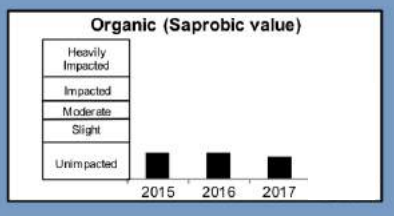


	2015	2016	2017
BMWP	112	192	104
ASPT	6.59	6.62	5.47
Annual Mayfly Sp. Richness	7	7	7
Total Abundance	166	635	247
EPT	10	19	11
CCI	7.92	17.65	7.50
LIFE	8.29	8.25	7.71
PSI	76.67	77.78	61.90
SPEAR	47.17	49.00	30.46
TRPI	100.00	80.00	80.00
Saprobic	1.58	1.57	1.49







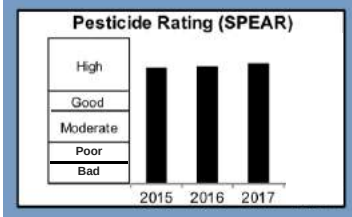


4 WHAT WE'VE FOUND
Nanstallon

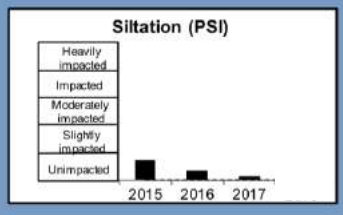
At Nanstallon slight stress from nutrient occurred in spring 2015 and borderline moderate stress occurred in spring 2017. Slight sediment stress on the invertebrate community was indicated in autumn during 2016 and 2017.

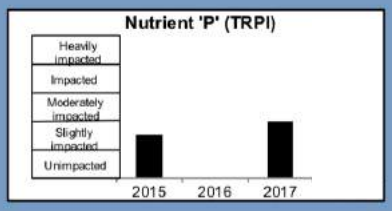
The complex chemical biometric, SPEAR, did show a greater impact from chemicals in autumn, but all scores were above the proposed WFD threshold and recovered in spring.

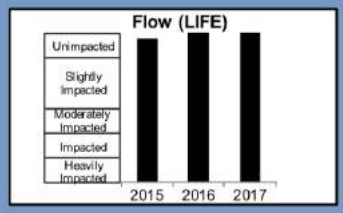
SPRING BIOMETRICS

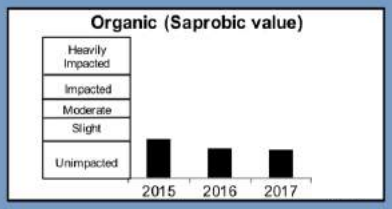


	2015	2016	2017
BMWP	179	159	116
ASPT	6.63	6.63	7.25
Annual Mayfly Sp. Richness	8	6	5
Total Abundance	882	1027	314
EPT	18	21	11
CCI	10.56	13.72	12.38
LIFE	8.40	8.83	8.75
PSI	85.25	92.42	96.77
SPEAR	56.01	57.02	58.30
TRPI	69.66	100.00	59.86
Saprobic	1.84	1.65	1.62

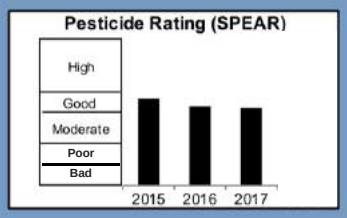




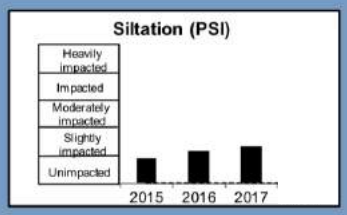


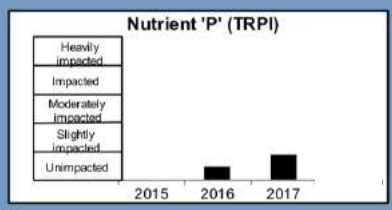


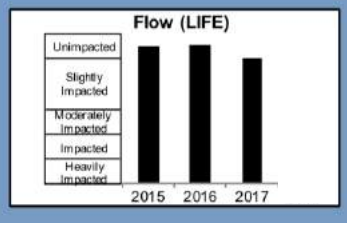
AUTUMN BIOMETRICS

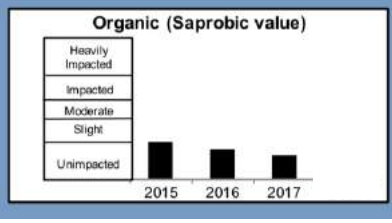


	2015	2016	2017
BMWP	111	150	153
ASPT	6.16	6.00	5.88
Annual Mayfly Sp. Richness	8	6	5
Total Abundance	741	823	600
EPT	12	14	17
CCI	8.08	10.21	12.65
LIFE	8.25	8.29	8.00
PSI	81.82	76.56	73.53
SPEAR	41.26	37.83	37.15
TRPI	100.00	90.91	81.82
Saprobic	1.80	1.65	1.50







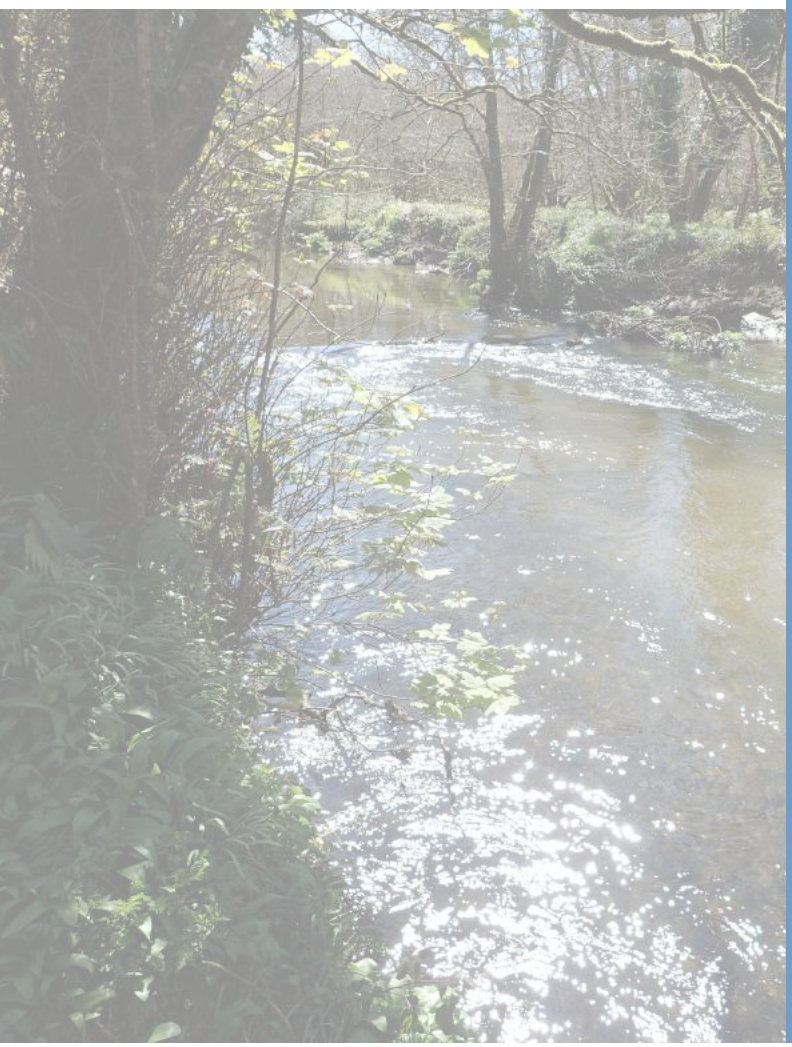


5 WHAT WE'VE FOUND
Polbrock Bridge

Due to unfavourable sampling conditions, Polbrock Bridge could not be sampled in autumn 2017.

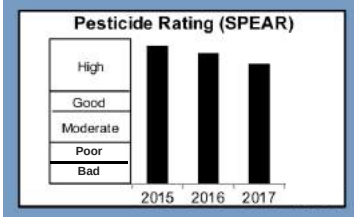
The invertebrate community at Polbrock Bridge exhibited no stress from flow throughout the survey period.

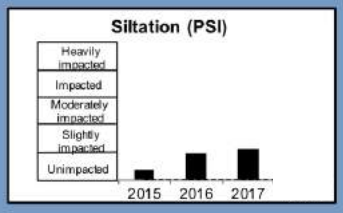
Moderate stress from chemicals and nutrients occurred in autumn 2015, but both recovered the following spring. Slight stress from excess sediment occurred in spring 2017.

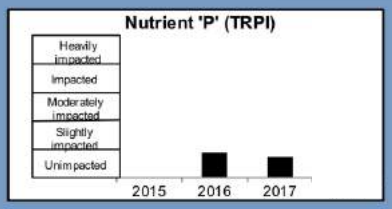


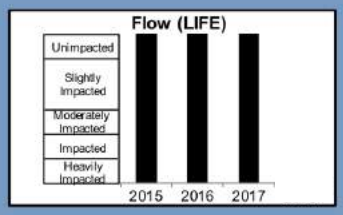
SPRING BIOMETRICS

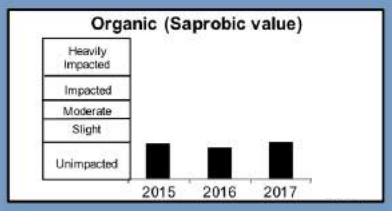
	2015	2016	2017
BMWP	149	182	178
ASPT	7.84	7.28	7.12
Annual Mayfly Sp. Richness	8	6	-
Total Abundance	2460	1643	2741
EPT	25	24	25
CCI	12.05	17.63	15.75
LIFE	8.81	8.51	8.59
PSI	92.31	80.49	77.91
SPEAR	66.81	63.44	58.34
TRPI	100.00	81.82	85.71
Saprobic	1.78	1.66	1.79





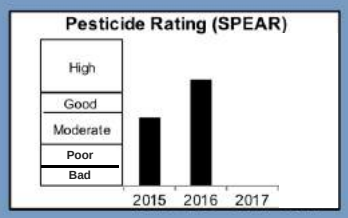


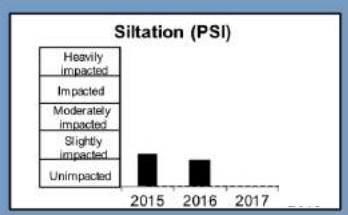


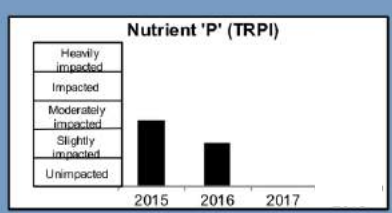


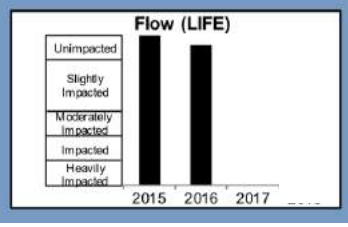
AUTUMN BIOMETRICS

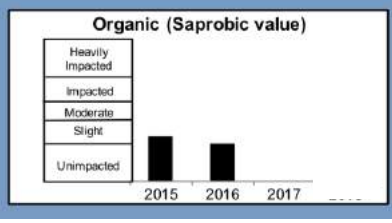
	2015	2016	2017
BMWP	114	161	-
ASPT	5.70	6.71	-
Annual Mayfly Sp. Richness	8	6	-
Total Abundance	3129	2382	-
EPT	11	15	-
CCI	7.65	16.63	-
LIFE	8.50	8.32	-
PSI	76.79	80.33	-
SPEAR	32.91	50.61	-
TRPI	53.75	70.00	-
Saprobic	1.95	1.80	-











Discussion

Overall, our three years of Riverfly Census monitoring have indicated the River Camel is a relatively clean river. The Camel often showed evidence of good eel (elver) runs during spring sampling. Only the Camel and Axe showed this out of all our study rivers. Golden Ringed Dragonfly (Cordulasgaster boltoni) nymphs were also detected in our samples throughout the river, another indication of good water quality (these were recorded in-situ and returned to the river). Additionally, no faunal invasive species were found during the 3 year study. Despite this, there were still some ecological pressures indicated by the invertebrate community, which are discussed below.

An ephemeral seasonal impact of chemical pollution was indicated at the furthest upstream Riverfly Census site, Slaughter Bridge. Land use in the upper parts of the Camel catchment is mainly agricultural, with high volumes of cattle and sheep farming (Fig. 1). It is possible that veterinary medicines used to protect livestock from diseases may explain the chemical signatures found in autumn. Rainfall events, especially those close to the time of application, may result in increased delivery of chemicals to rivers through surface run-off (Gouy et al. 1999).

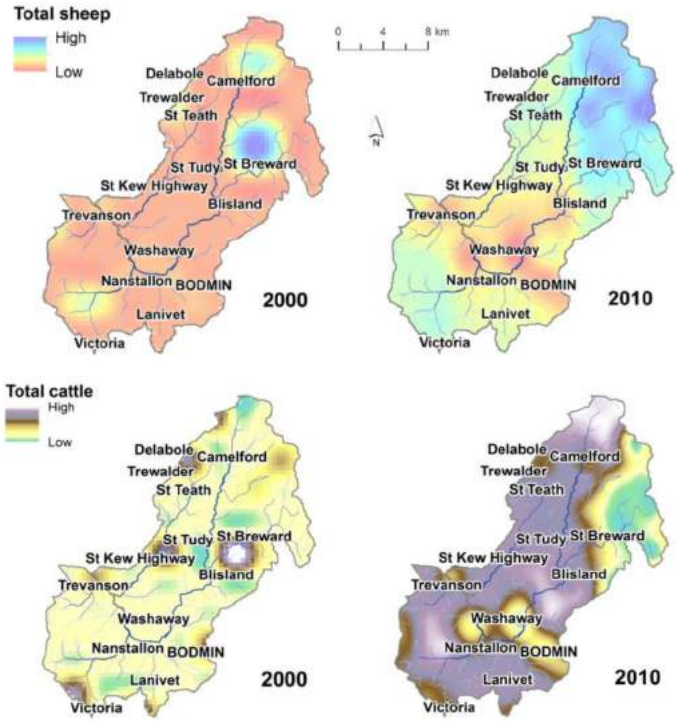


Fig. 1 - Changes in total area of land being cultivated for sheep and cattle from 2000 to 2010 in the River Camel catchment from Agricultural Census data (West Country Rivers Trust, 2014)

Slightly elevated chemical, nutrient and sediment signatures were present at Dunmere Bridge and Nanstallon, when compared to the other Camel Riverfly Census monitoring sites. This area is the most urban in the catchment and two wastewater treatment plants (Nanstallon and Scarletts Well) operate here. These two plants are responsible for treating the majority of the population's sewerage (Fig. 2). It is likely these treatment works are contributing some phosphorus, sediment and chemical (through pharmaceuticals in wastewater) loading to the river.

Increases in population are projected to be significant in these two sewerage catchments (Fig. 2). The increased dependence on these works will lead to higher flows and effluent loading and therefore could potentially increase the volume of phosphorus, sediment and chemicals being discharged into the river. It is essential that suitable infrastructure is in place to mitigate these risks and protect water quality in the Camel.

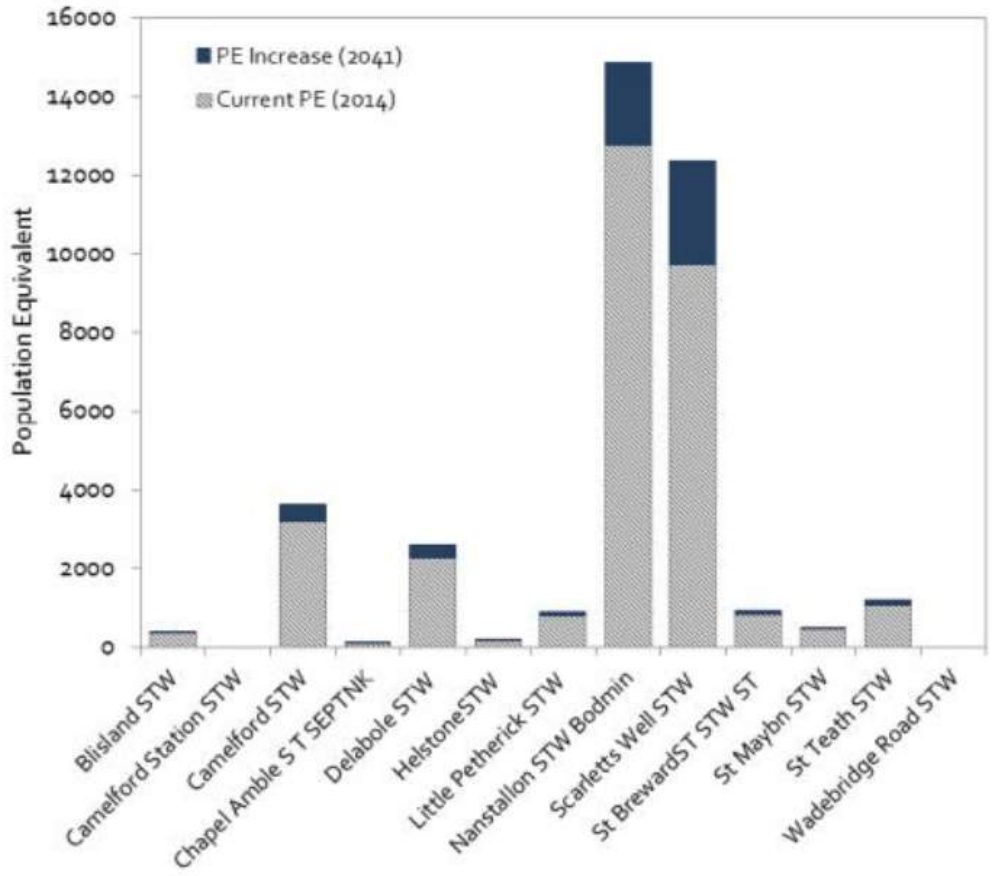


Fig. 2 - South West Water projected growth in population equivalent within sewerage catchments surrounding the River Camel (West Country Rivers Trust, 2014)

In autumn 2015, Polbrock Bridge (our furthest downstream site) exhibited notable chemical and nutrient signatures. Recovery occurred the following year, but impacts in autumn 2017 could not be determined due to unfavourable sampling conditions. It would be interesting to know whether this stress was a unique event or something that occurs regularly. The land adjacent to the Polbrock Bridge site is used for forestry, particularly for conifers (Fig. 3). There are environmental issues associated with this kind of forestry, through leaching of acid and toxic chemicals into watercourses (Reynolds, 2004). Diversity of invertebrate species is good at this site, which doesn't indicate acidity pressure. However, this type of land use may explain the moderate SPEAR signature in autumn 2015.

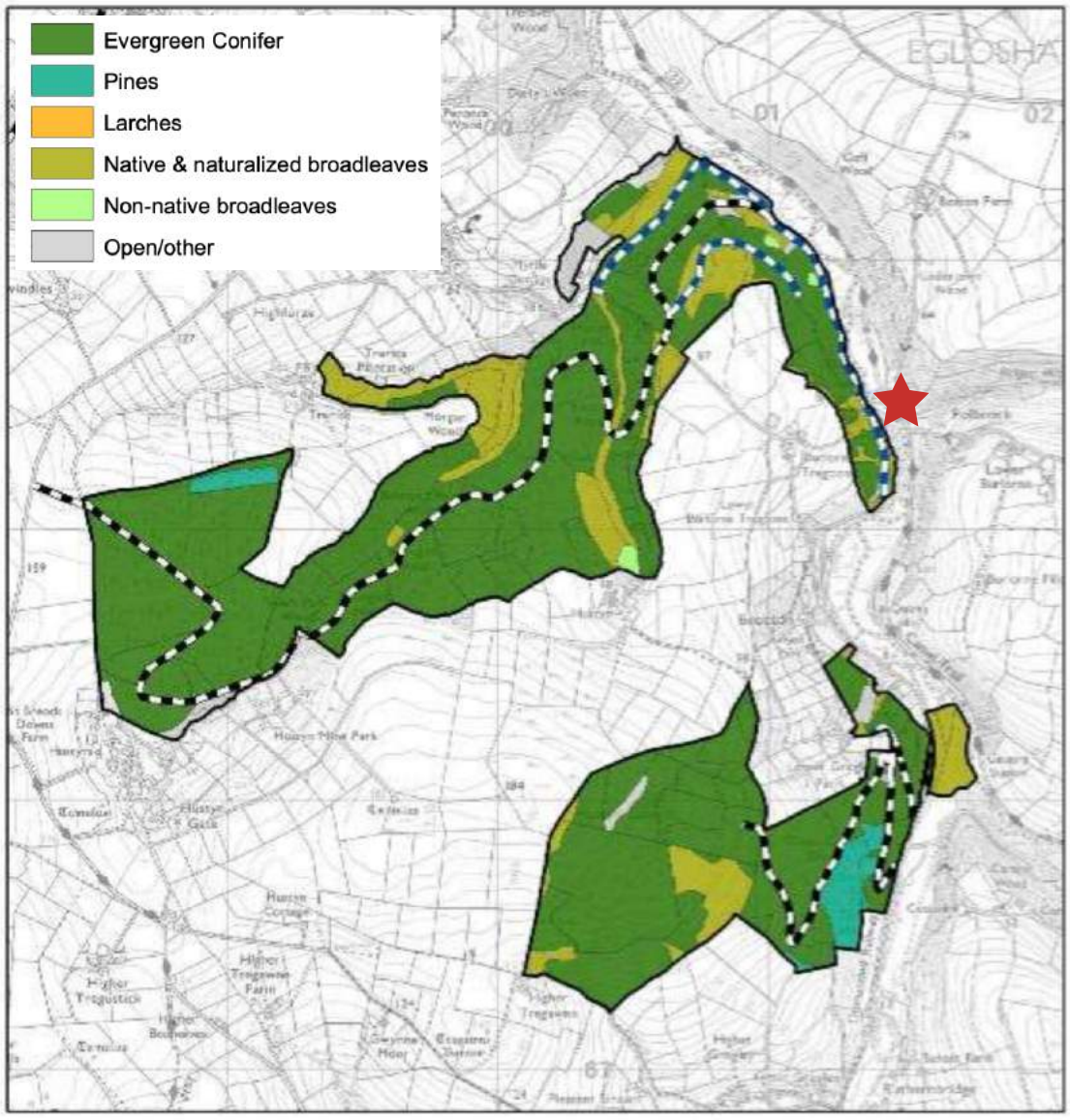


Fig. 3 - Woodland composition of Bishop's & Hustyn Camel Valley Forest Plan area adjacent to River Camel. Polbrock Bridge Riverfly Census monitoring site indicated by red star. (Forestry Commission, 2018)

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.

We hope the Riverfly Census has gone some way towards helping to address these missing 'reference points' by providing the first species-level baseline for many of the rivers surveyed. But this is just the first step! We welcome working with local groups to better understand the possible pressures and moving towards a more sustainable future for our waterways.

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.

Forestry Commission. (2018). Camel Valley Forest Plan 2018-2028.

Gouy V, Dur JC, Calvet R, Belamie R and Chaplain V. (1999). Influence of adsorption-desorption phenomena on pesticide run-off from soil using simulated rainfall. Pesticide Science: 55, pp. 175-182.

Reynolds, B. (2004). Continuous cover forestry: possible implications for surface water acidification in the UK uplands. Hydrology and Earth System Sciences: 8(3), pp. 306-313.

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

Westcountry Rivers Trust. (2014). Natural England pollution risk assessment & source apportionment: Camel Catchment. Natura 2000 Catchment Risk Assessment Reports.