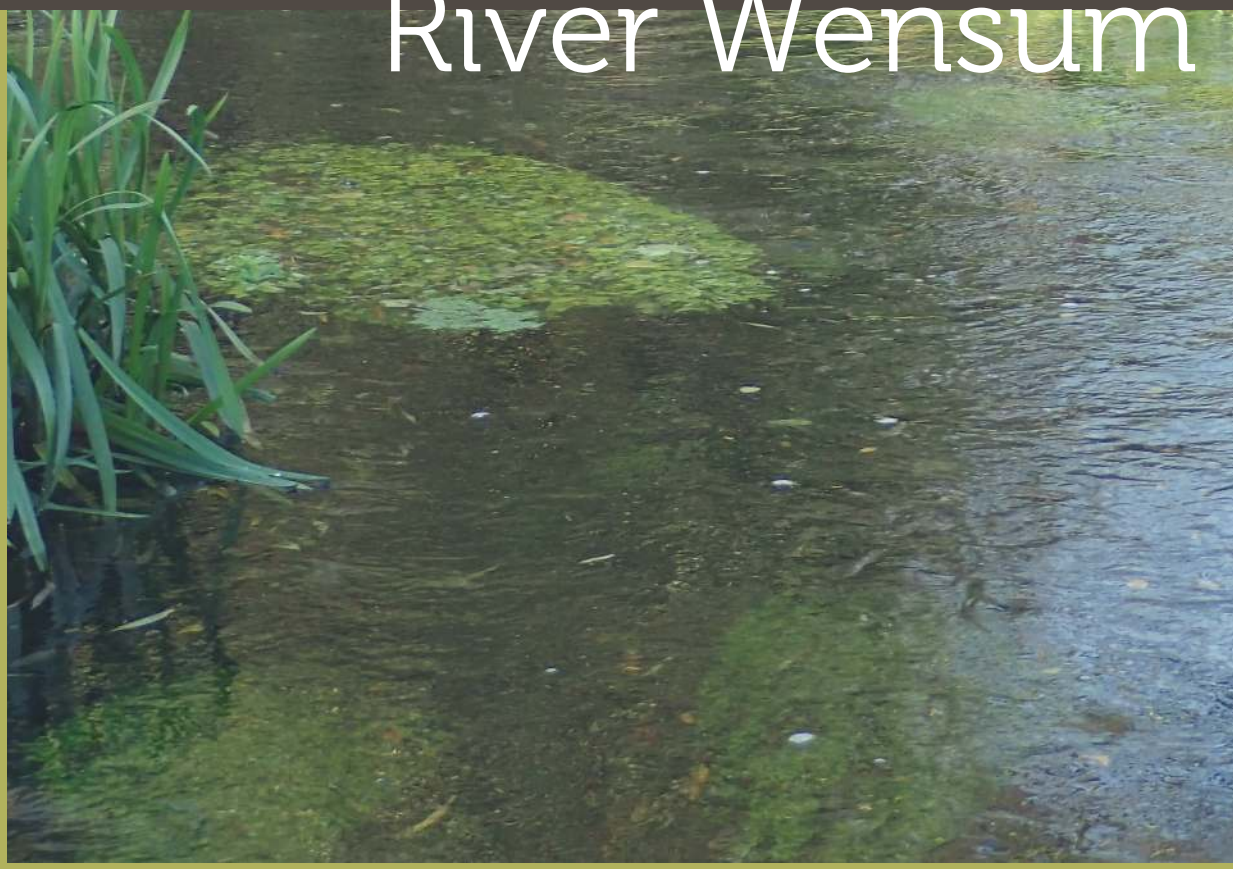
RIVERFLY CENSUS CONCLUSIONS

River Wensum



Salmon & Trout Conservation

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REPORT OUTLINE

OUR KEY POINTS

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

WHAT WE'VE DONE

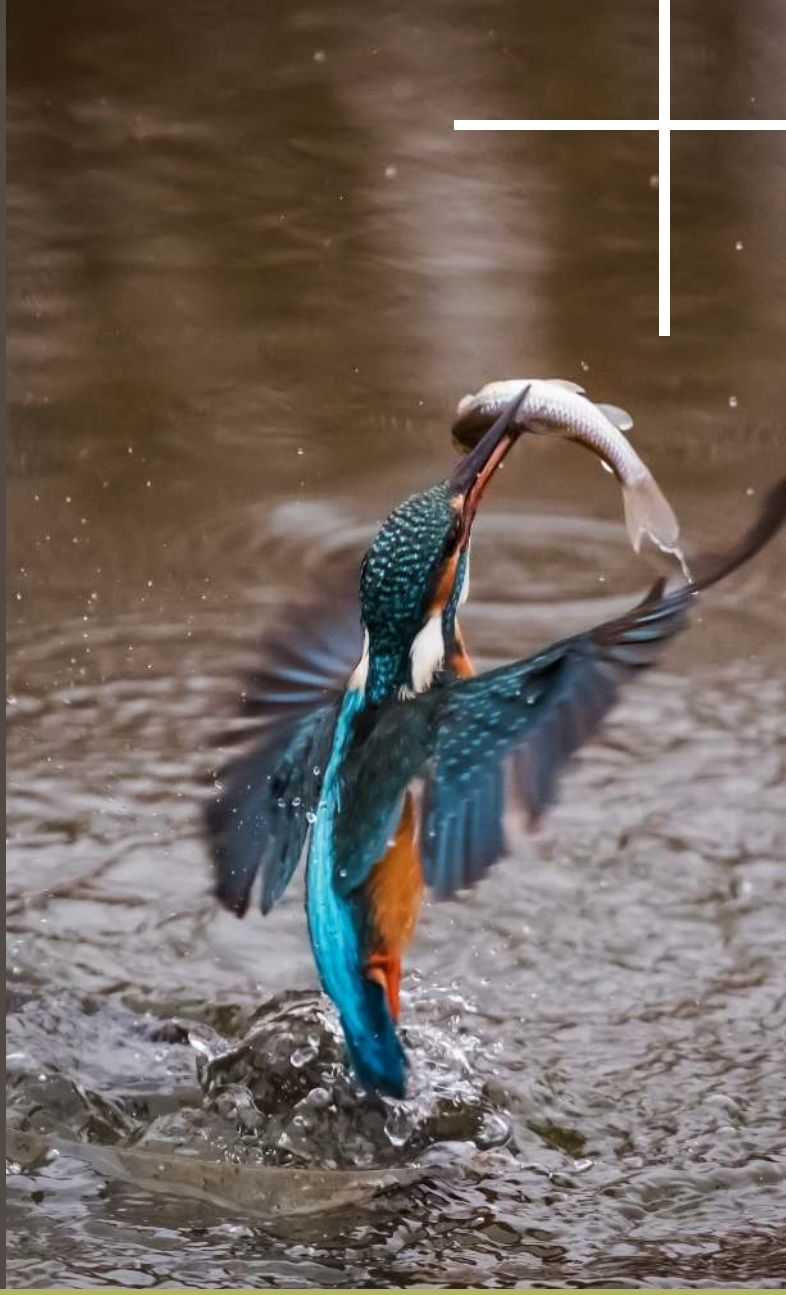
A summary of the Riverfly Census process and objectives

WHAT WE'VE FOUND

A site-by-site presentation of the S&TC Riverfly Census results on the Wensum

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 Wensum has revealed that ecologically the river is in crisis. The River Wensum is a chalkstream, one of only about 200 in the world. With evidence of poor water quality and low riverfly diversity, it is clear that this unique environment needs help. Here are our findings and recommendations:

- It is clear from our results that biologically the River Wensum is under intense stress from excess fine sediment and phosphorus. The evidence points to these coming from mostly agricultural origin. If this river is ever to fully recover, it is imperative that more incentives are made available for farmers to use their land in a more water quality conscious way. Also, adequate enforcement must be in place to protect water quality if incentives fail.

- Chemical impact was persistent throughout our samples. Further investigation into whether chemicals are mainly from diffuse agricultural sources or urban point sources would be beneficial to implement effective management.

- Obstructions, such as mills, have been shown to have a major influence on river condition, partly through raising the surface of the water upstream of the construction. To improve water quality in the Wensum restoring a natural flow regime by mitigating the impact of mills is essential.

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

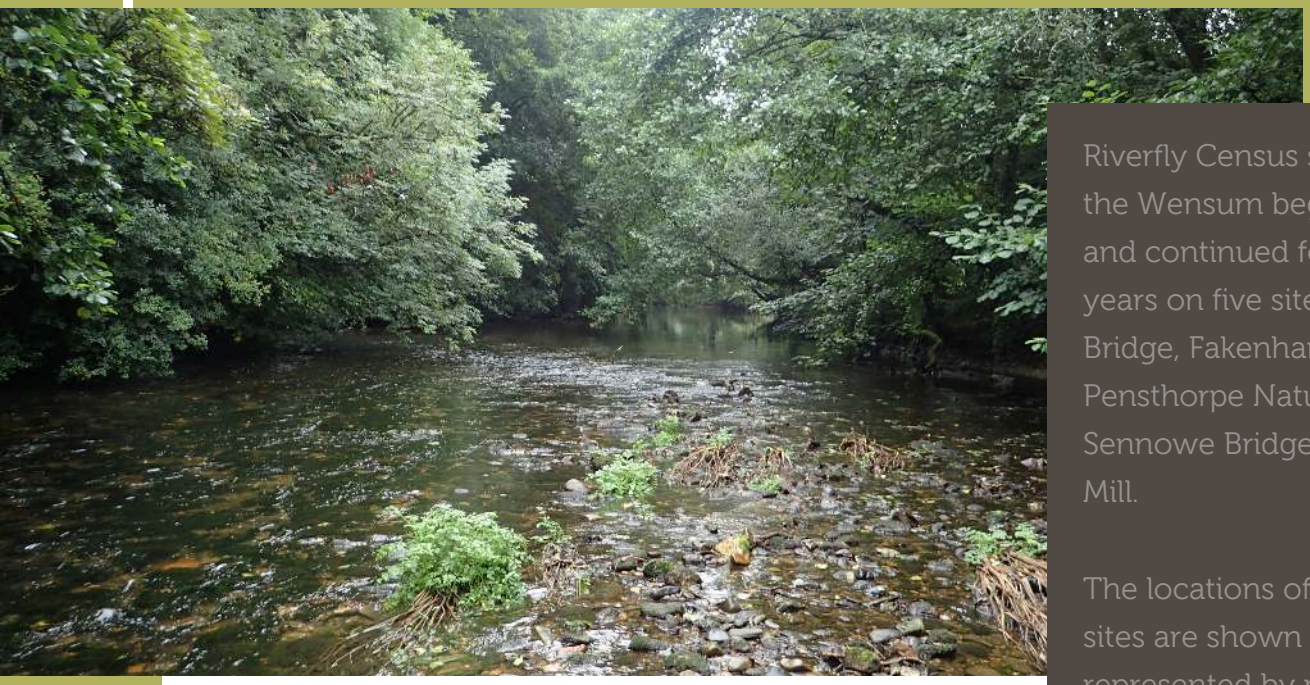
Species presence/absence data was inputted into Aquascience's biometric calculator to obtain scores against key stress types. The data was then evaluated in a whole catchment context to pinpoint likely suspects contributing to river deterioration.

MAKE A STAND

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

WHAT WE'VE FOUND

Results



Riverfly Census sampling on the Wensum began in 2015 and continued for three years on five sites: Doughton Bridge, Fakenham Common, Pensthorpe Nature Park, Sennowe Bridge and Bintry Mill.

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

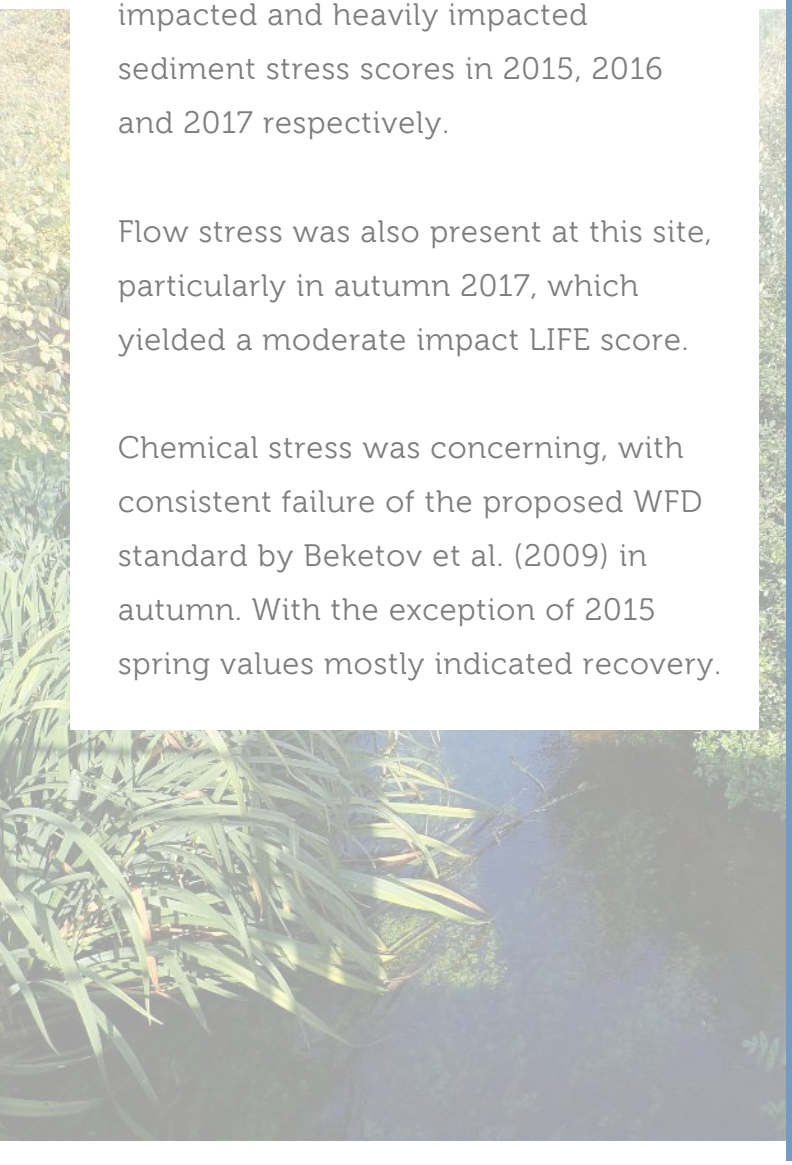
1 WHAT WE'VE FOUND
Doughton Bridge

The invertebrate community at Doughton Bridge exhibited high stress from nutrient pollution in autumn 2017. However, nutrient stress was less pronounced in the previous years; values were mostly around the slight impact mark, with a moderate impact peak in autumn 2016.

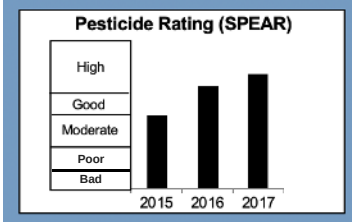
Sediment stress was considerable throughout the survey period during both seasons. During spring PSI scores were borderline moderate, with a moderate peak in 2017. In autumn, Doughton Bridge had moderate, impacted and heavily impacted sediment stress scores in 2015, 2016 and 2017 respectively.

Flow stress was also present at this site, particularly in autumn 2017, which yielded a moderate impact LIFE score.

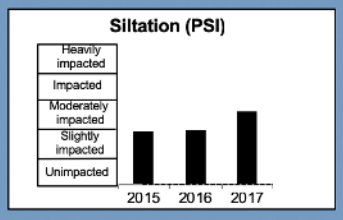
Chemical stress was concerning, with consistent failure of the proposed WFD standard by Beketov et al. (2009) in autumn. With the exception of 2015 spring values mostly indicated recovery.

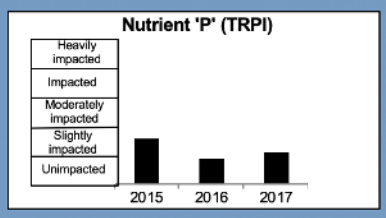


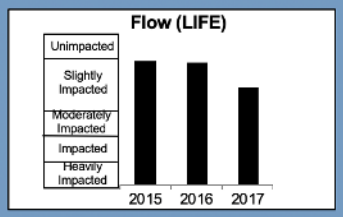
SPRING BIOMETRICS

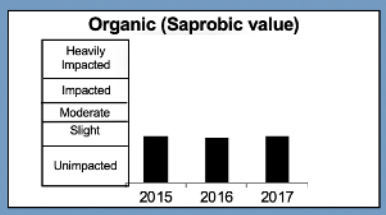


	2015	2016	2017
BMWP	-	-	-
ASPT	5.71	6.44	5.81
Annual Mayfly Sp. Richness	6	6	3
Total Abundance	507	1502	168
EPT	10	18	8
CCI	10.00	14.70	-
LIFE	7.95	7.93	7.44
PSI	62.16	61.70	48.15
SPEAR	34.29	48.06	53.96
TRPI	68.65	82.61	77.78
Saprobic	1.99	1.98	1.99

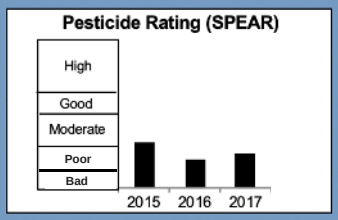




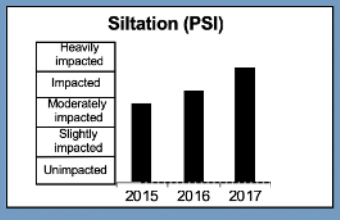


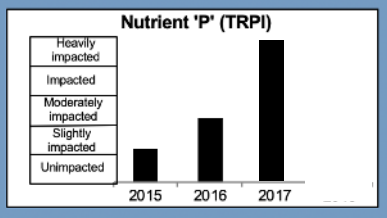


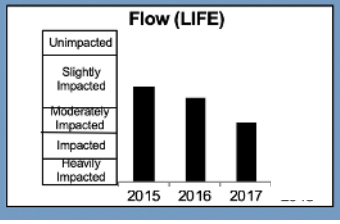
AUTUMN BIOMETRICS

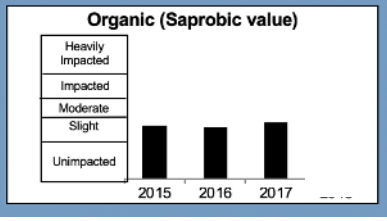


	2015	2016	2017
BMWP	-	-	-
ASPT	5.27	4.96	4.73
Annual Mayfly Sp. Richness	6	6	3
Total Abundance	874	397	154
EPT	8	6	2
CCI	10.23	7.89	4.20
LIFE	7.37	7.17	6.67
PSI	44.44	34.88	18.75
SPEAR	21.74	13.38	16.54
TRPI	76.92	55.56	0.00
Saprobic	2.13	2.11	2.19







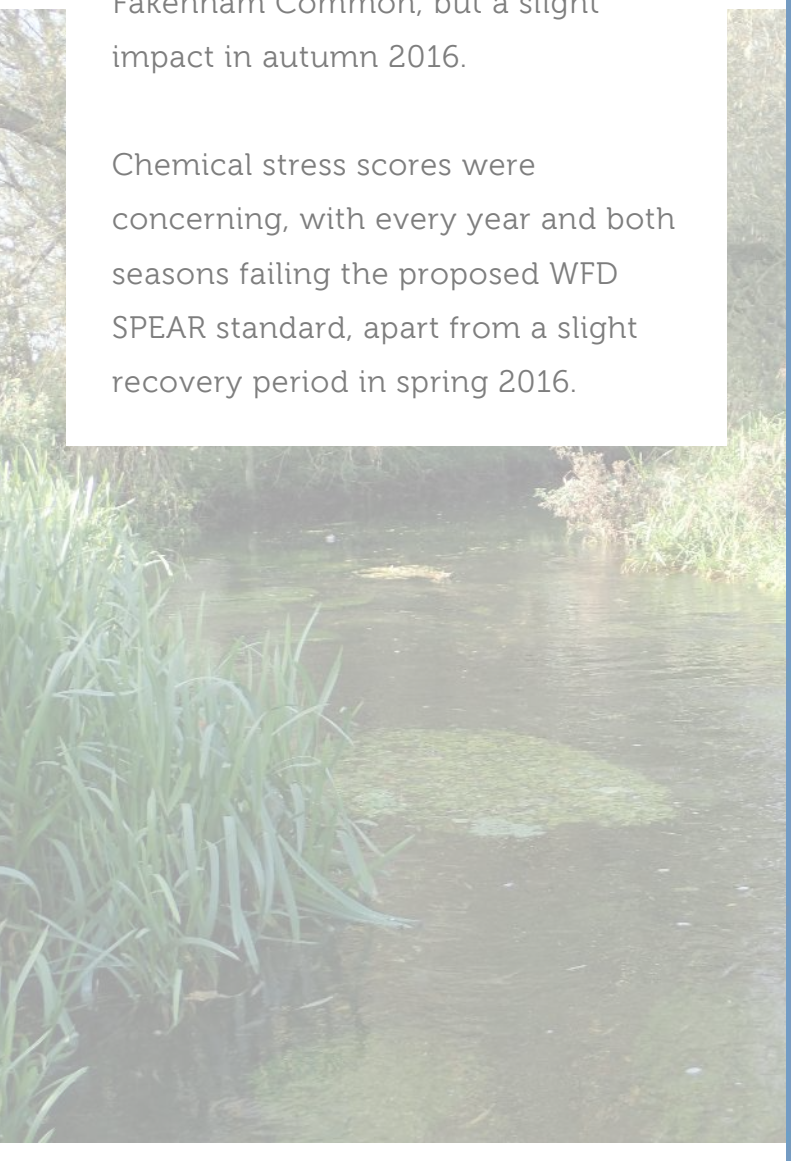


2 WHAT WE'VE FOUND
Fakenham Common

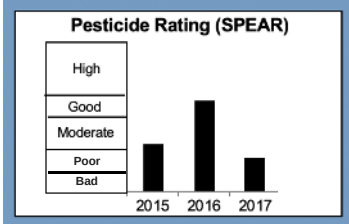
The LIFE biometric revealed a consistent slight impact from flow stress on the invertebrate community at Fakenham Common during 2015-2017. Sediment stress scores in autumn were mostly moderate, although a borderline moderate score was also present in spring 2016.

Nutrient stress was most pronounced in spring 2016, where a borderline moderate impact occurred. For the other two survey years, impact was slight. In autumn 2015 and 2017 there was no impact from nutrient stress at Fakenham Common, but a slight impact in autumn 2016.

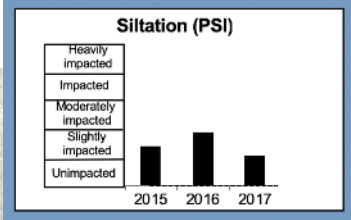
Chemical stress scores were concerning, with every year and both seasons failing the proposed WFD SPEAR standard, apart from a slight recovery period in spring 2016.

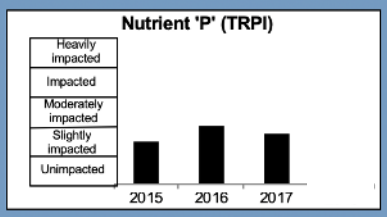


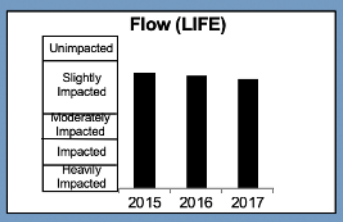
SPRING BIOMETRICS

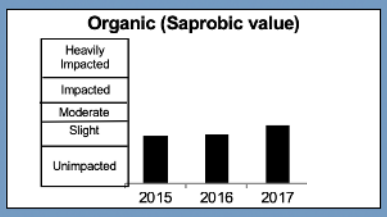


	2015	2016	2017
BMWP	-	-	-
ASPT	6.14	5.63	6.00
Annual Mayfly Sp. Richness	4	6	2
Total Abundance	537	997	107
EPT	10	14	6
CCI	8.67	7.35	-
LIFE	7.78	7.71	7.67
PSI	72.41	62.22	78.95
SPEAR	22.47	42.14	15.70
TRPI	70.77	60.00	65.80
Saprobic	2.00	2.03	2.22

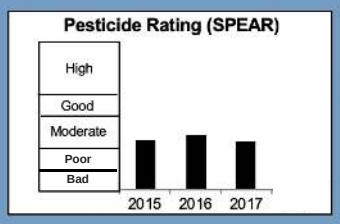




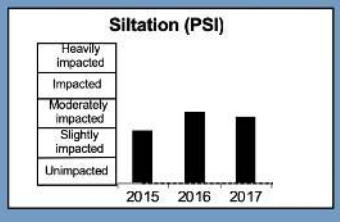


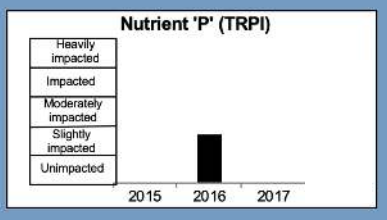


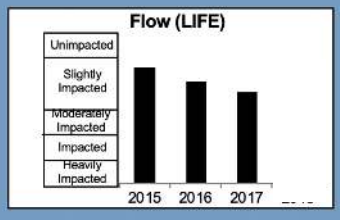
AUTUMN BIOMETRICS

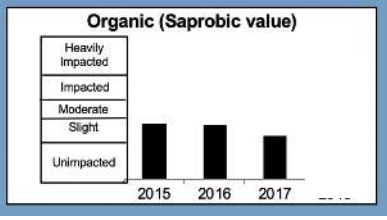


	2015	2016	2017
BMWP	-	-	-
ASPT	5.47	5.59	5.12
Annual Mayfly Sp. Richness	4	6	2
Total Abundance	996	1064	140
EPT	9	8	6
CCI	5.33	8.10	7.33
LIFE	7.80	7.54	7.32
PSI	62.79	50.00	52.94
SPEAR	23.63	25.54	23.17
TRPI	100.00	66.67	100.00
Saprobic	2.19	2.17	1.95









3 WHAT WE'VE FOUND
Pensthorpe Nature Park

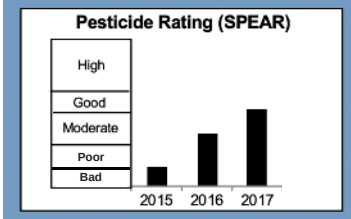
Moderate nutrient stress scores and impacted sediment stress scores were found in Spring 2016, flow stress was also elevated at this time.

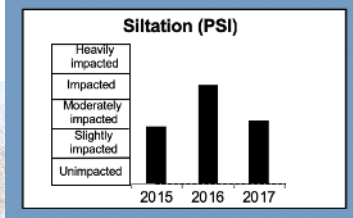
In autumn nutrient and sediment stress followed a similar pattern, with borderline moderate scores in 2015, moderate scores in 2016 and borderline impacted scores in 2017. Flow stress was the most pronounced in 2017.

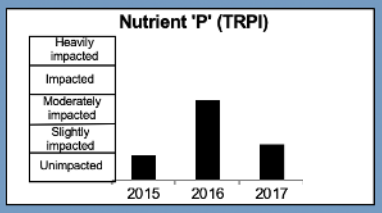
The proposed WFD target for the complex chemical biometric SPEAR was only met once at Pensthorpe throughout the survey period, in spring 2017.

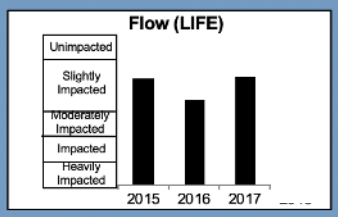
SPRING BIOMETRICS

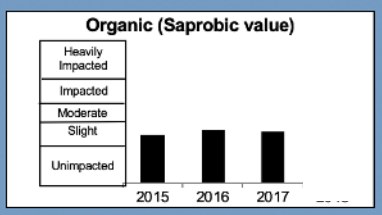
	2015	2016	2017
BMWP	-	-	-
ASPT	5.15	4.93	5.89
Annual Mayfly Sp. Richness	3	2	1
Total Abundance	803	919	61
EPT	6	5	6
CCI	3.75	4.25	-
LIFE	7.64	7.21	7.67
PSI	59.26	29.63	54.55
SPEAR	9.07	25.06	36.83
TRPI	82.20	44.44	75.00
Saprobic	2.03	2.12	2.09





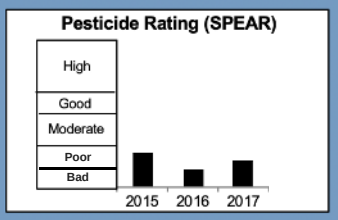


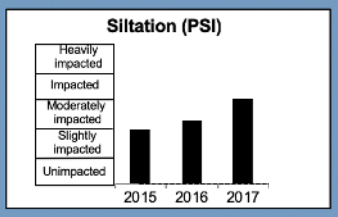


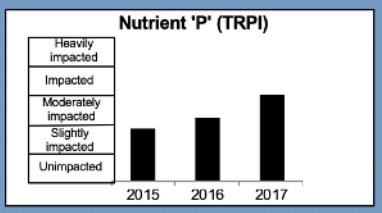


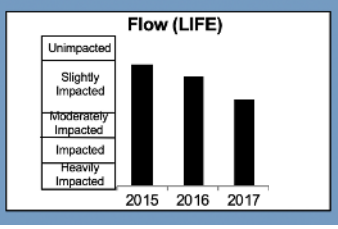
AUTUMN BIOMETRICS

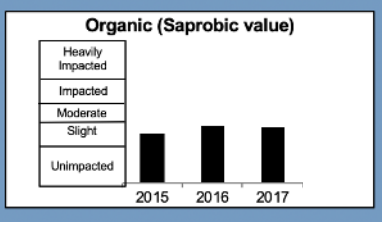
	2015	2016	2017
BMWP	-	-	-
ASPT	5.38	4.93	5.00
Annual Mayfly Sp. Richness	3	2	1
Total Abundance	1108	649	361
EPT	8	5	3
CCI	4.60	3.80	4.67
LIFE	7.94	7.69	7.23
PSI	61.29	54.55	40.00
SPEAR	16.55	8.72	12.59
TRPI	63.64	55.56	40.00
Saprobic	2.08	2.22	2.19









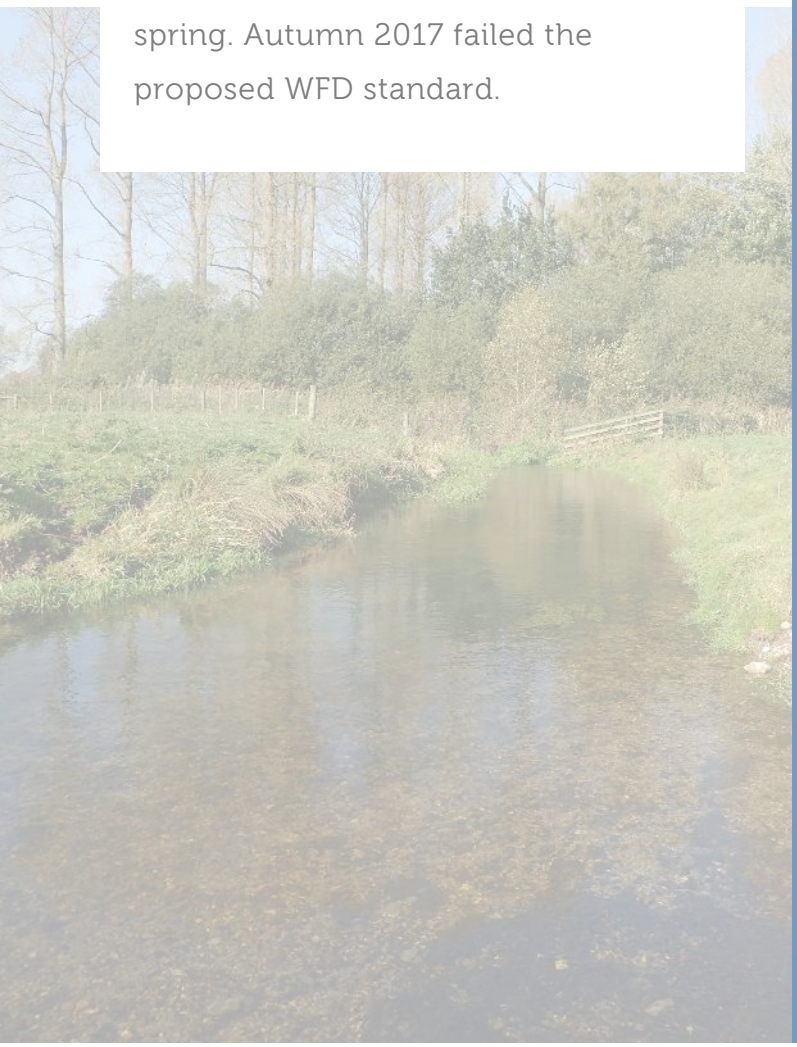


4 WHAT WE'VE FOUND
Sennowe Bridge

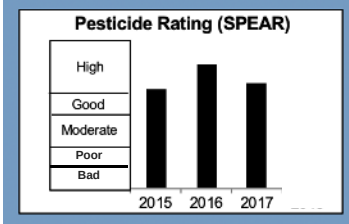
Sediment and nutrient stress scores at Sennowe Bridge were notable (impacted and borderline impacted respectively) in autumn 2017.

In spring the invertebrate community exhibited borderline moderate stress from nutrients in 2015 and 2016. Sediment stress was moderate in autumn 2015 and both seasons during 2016.

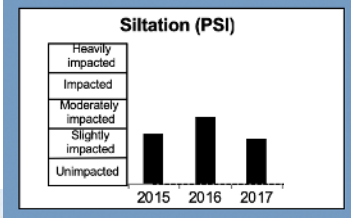
The complex chemical biometric, SPEAR, showed an impact from chemicals in autumn, but recovery in spring. Autumn 2017 failed the proposed WFD standard.

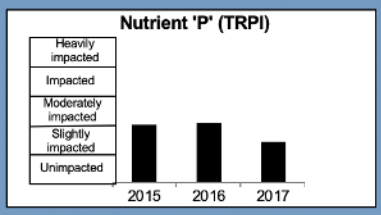


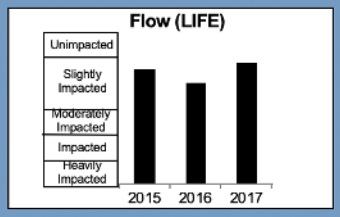
SPRING BIOMETRICS

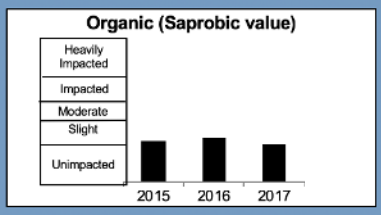


	2015	2016	2017
BMWP	-	-	-
ASPT	6.30	5.60	6.06
Annual Mayfly Sp. Richness	6	7	4
Total Abundance	395	529	228
EPT	18	18	11
CCI	10.00	9.38	-
LIFE	7.77	7.50	7.91
PSI	65.12	52.63	67.65
SPEAR	46.30	57.98	49.83
TRPI	60.00	58.82	71.43
Saprobic	1.88	1.95	1.79

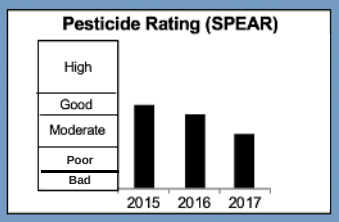




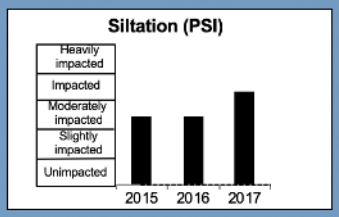


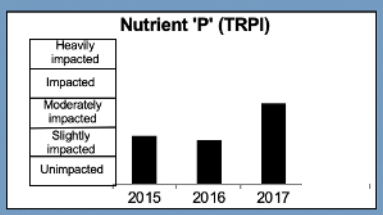


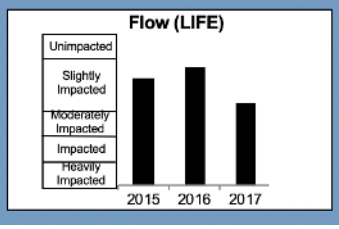
AUTUMN BIOMETRICS

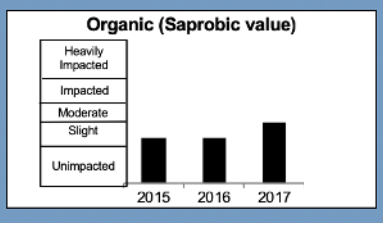


	2015	2016	2017
BMWP	-	-	-
ASPT	5.63	5.83	5.64
Annual Mayfly Sp. Richness	6	7	4
Total Abundance	503	790	3402
EPT	12	12	5
CCI	10.95	10.26	8.18
LIFE	7.64	7.83	7.13
PSI	51.11	52.00	34.78
SPEAR	39.11	34.83	26.10
TRPI	66.67	70.00	44.44
Saprobic	1.97	1.97	2.29









5 WHAT WE'VE FOUND
Bintry Mill

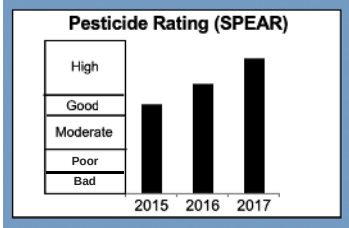
The invertebrate community at Bintry Mill consistently experienced flow stress during both seasons throughout the survey period.

Pressure from excess sediment was concerning, stress scores were mostly moderate, with an impacted peak in autumn 2017.

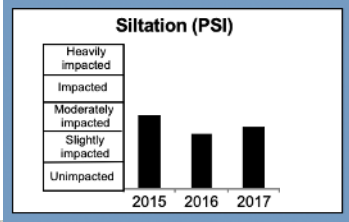
Nutrient stress was indicated, with moderate scores in spring 2015 and spring 2016. Borderline moderate scores also occurred in autumn 2015 and autumn 2017.

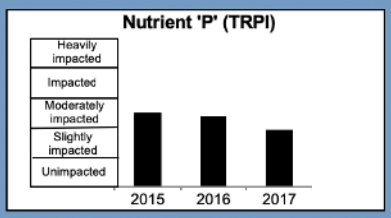
Chemical impact was notable in autumn throughout the survey period, failing the proposed WFD SPEAR standard. However, appeared to recover in spring.

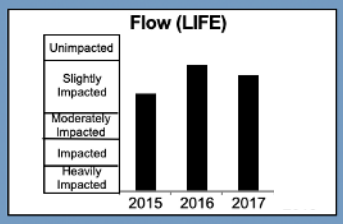
SPRING BIOMETRICS

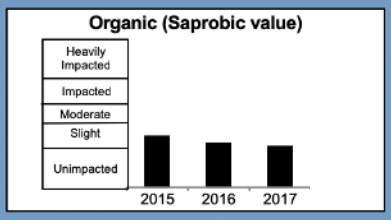


	2015	2016	2017
BMWP	-	-	-
Annual Mayfly Sp. Richness	6.48	6.41	6.50
R (Species Richness)	4	4	5
Total Abundance	459	993	374
EPT	15	15	14
CCI	8.13	9.32	-
LIFE	7.38	7.92	7.72
PSI	50.00	62.50	57.14
SPEAR	40.62	49.63	61.13
TRPI	51.25	52.94	62.50
Saprobic	2.04	1.92	1.84

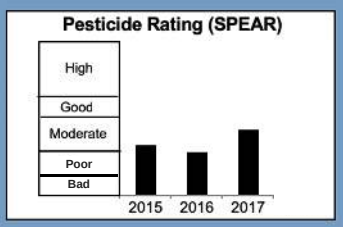




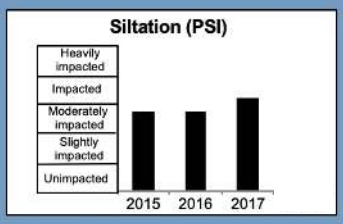


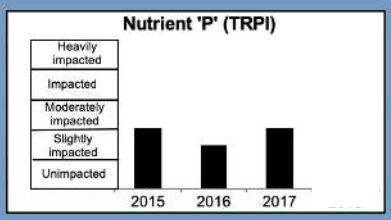


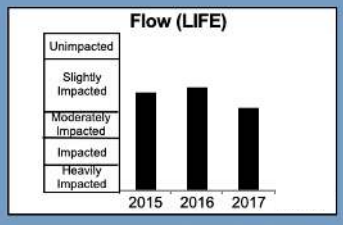
AUTUMN BIOMETRICS

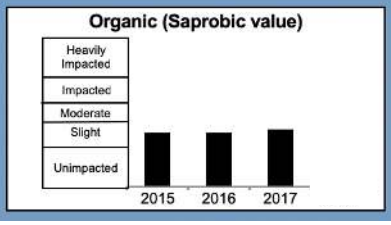


	2015	2016	2017
BMWP	-	-	-
ASPT	5.39	5.12	5.90
Annual Mayfly Sp. Richness	4	4	5
Total Abundance	832	1092	542
EPT	9	8	9
CCI	7.86	7.27	8.57
LIFE	7.35	7.46	7.08
PSI	46.00	45.76	36.96
SPEAR	22.46	19.50	29.64
TRPI	60.00	71.43	60.00
Saprobic	2.06	2.08	2.14









Discussion

Arable farming dominates the Wensum catchment, with general cropping comprising 36% of farms and cereal farming comprising 29%. The remaining farms are used for livestock (with a small percentage being mixed livestock and arable). Since the 1900s the catchment has remained predominantly arable, with an intensive programme of land drainage in the 1940's enabling expansion and intensification of cultivation (Natural England, 2009). Growth of urban areas and infrastructure at Norwich, Dereham and Fakenham, has also occurred (Fig. 1). The population in Norwich has been predicted to increase by nearly 16% between 2011 and 2041 (Environment Agency, 2014).

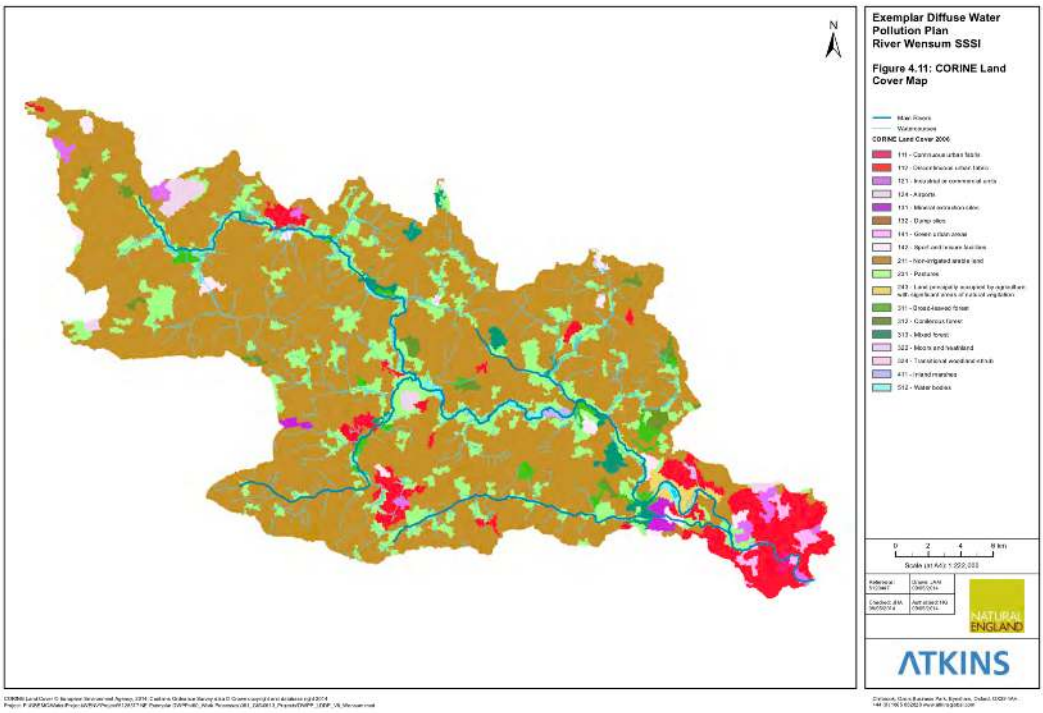


Fig. 1 - River Wensum catchment land use. Brown - non-irrigated arable land. Light green - Pastures. Red - Urban. (Natural England, 2015).

Modelling by Natural England (2015) indicated that diffuse water pollution is a main component of the phosphate balance to the River Wensum, but that pressures from population and point source pollution are of greater significance. This may be true for the further downstream reaches, but our sites (which cover the area upstream of the urban hotspot of Norwich) emphasise that the diffuse contribution is still significant. Doughton Bridge demonstrated considerable nutrient pressure in autumn, particularly in 2017, which is indicative of diffuse run-off from increased rainfall. This site is above all the main urban areas, yet the invertebrate community still exhibited marked stress from phosphorus.

At Fakenham Common, stress on the invertebrate community from nutrient pollution was the least out of all our sites, with autumn 2015 and autumn 2017 exhibiting no impact. As this site is located in an urban hotspot with one of the largest sewage treatment works in the catchment, a stronger nutrient stress signature would be expected. Phosphate stripping was installed at the Fakenham treatment works during the Asset Management Plan (AMP) 2000-2005, and further phosphate stripping was instigated under the AMP 2010-2015. Our findings could be construed as supporting evidence that the stripping is having a positive ecological impact.

Sediment and chemical pressure was extensive throughout our survey at all sites. Many chemicals bind to soil and are delivered to watercourses via sediment run-off. Sources of contaminated sediments in the Wensum catchment arise from damaged road verges and bank channels, most likely from poaching by livestock, and an increase in run-off generation from the compaction of farm tracks. Sediment production is particularly high in the area directly next to our three middle sample sites, but the upper area around the River Tat tributary may also be delivering high sediment loads to the river (Fig. 2). Silt can be transported considerable distances before being deposited in the river channel.

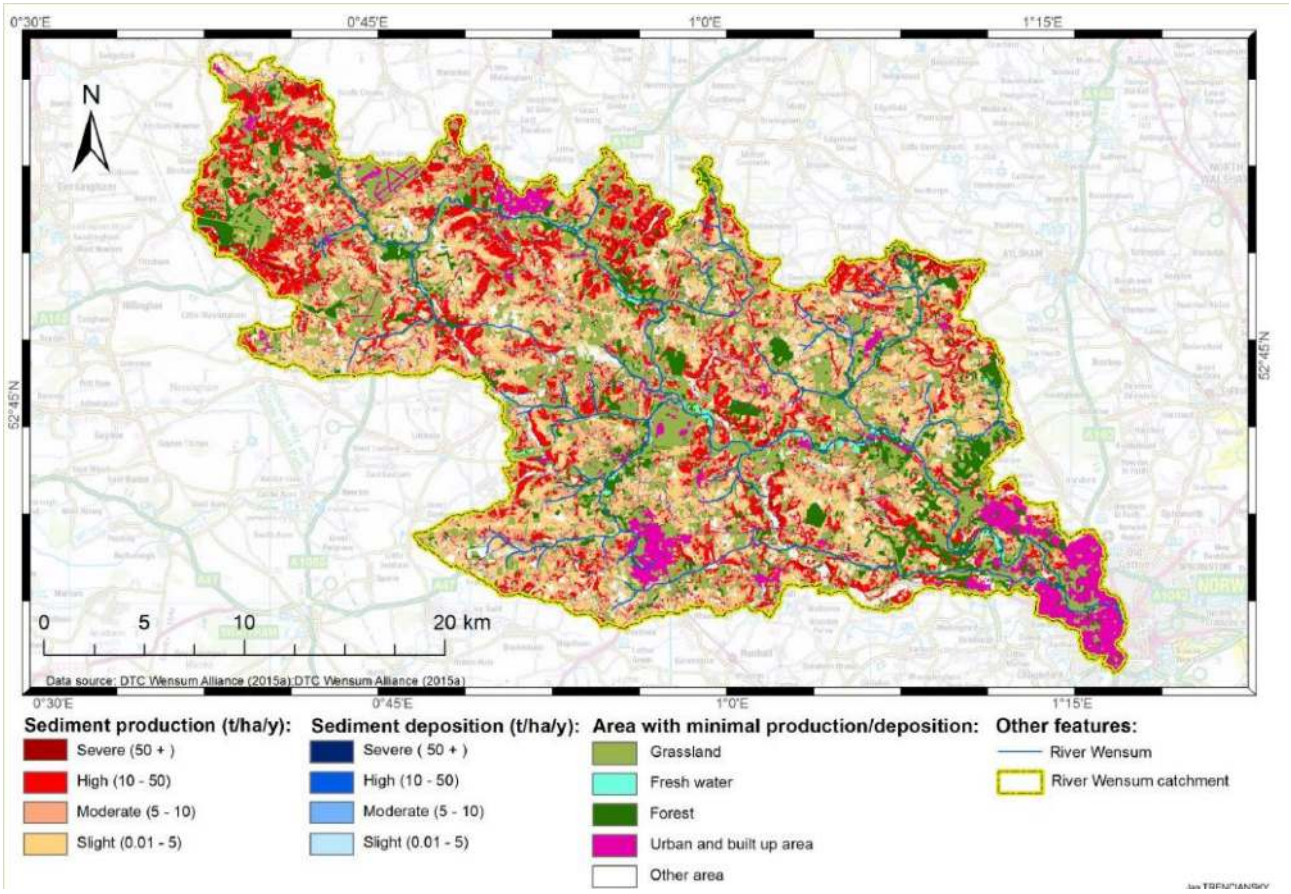


Fig. 2 - Modelled sediment production and deposition in the Wensum catchment (Garowski, 2016)

Mills have been identified as a key problem for hydrology and water quality in the Wensum. The Wensum's 14 redundant mill structures have been named as the most significant factor affecting morphology of the river channel - 67% of the Wensum was identified as being backed up behind these structures (Natural England, 2009). Our sample sites are located in stretches of the river considered damaged, degraded or severely degraded in terms of geomorphology and are all relatively close to mill structures (Fig. 3). The invertebrate communities at all sites indicated flow stress according to the LIFE scores. Mills disrupt the natural flow regime and are hotspots for for silt accumulation, so this may also explain why the previously mentioned sediment impact is so marked.

Suggested management options at mills on the Wensum have been generally to lower the level of mill structures and integrate bed levels, or employ habitat management options up and downstream. These methods would benefit the river but ultimately, complete removal of mills would be best. Where alterations are made to mills, it would be beneficial to continue species-level invertebrate monitoring before and after the changes, to measure efficiency in terms of biological improvement.

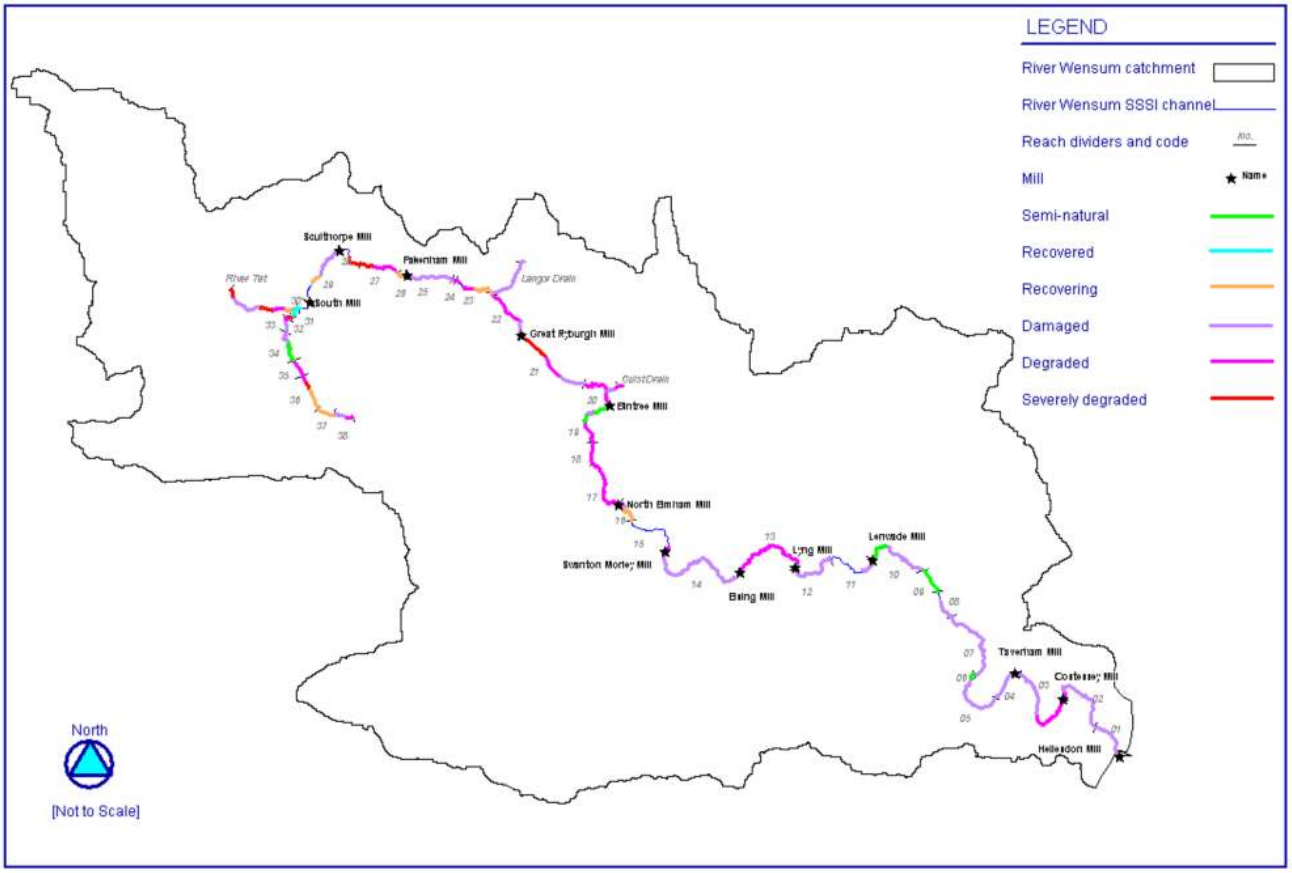


Fig. 3 - River Wensum Geomorphological Appraisal reach status and mill locations (Natural England, 2009)

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.

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