

Water Quality of the River Stour

First Year Report and Review

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Figure 1 Sorting a sample of freshwater invertebrates as part of the Angler's Riverfly Monitoring Initiative ARMI

1. Aims of this Project:

To investigate the water quality of the River Stour and its tributary the River Brett using the Angler's Riverfly Monitoring Initiative ARMI (developed by The Riverfly Partnership) and water chemistry measurements – methods which are recognised by the Environment Agency.

To determine whether or not there is pollution of the rivers and, if there is, to highlight this and press for improvements to the water quality.



2. Background

There has been a great deal of concern over the last few years, both in the media, in the public domain and in academic circles, regarding pollution of UK rivers and particularly the release of untreated sewage, agricultural effluents and road run-off. Water companies have faced scrutiny for the release of untreated sewage. DEFRA (Department of Environment Food and Rural Affairs) and The Rivers Trust have produced records of many of the releases of untreated sewage which have been automatically monitored at some, but not all, sewage treatment works. The sewage works at Dedham in Northeast Essex has been one of the many sites of concern. Dedham had between 40 and 60 monitored releases of untreated sewage into the River Stour in 2021. Such releases are permitted in times of heavy rainfall to prevent sewage works being overwhelmed by the volume of water – these releases are often from Combined Sewage Overflow pipes (CSO's). These releases are of general public concern, particularly in a protected area like the Dedham Vale Area of Outstanding Natural Beauty AONB, and are of specific concern because of potential impacts on the wildlife and ecology of the river. This section of the River Stour is popular for recreational activities such as rowing, canoeing, paddle-boarding as well as paddling and swimming, therefore there are additional concerns about the possible impacts on public health through human pathogens like *E coli*.

The Environment Agency has responsibility relating to the water quality of rivers, however, they have limited resources to monitor and police water quality.

PACE Manningtree (Practical Actions for Climate and the Environment) is a local community group of volunteers engaged in several local environmental projects and, because of the local concern for the health of the River Stour, PACE recruited a team of volunteers who were prepared to be trained in monitoring the river using the Angler's Riverfly Monitoring Initiative ARMI, which is a method recognised by the Environment Agency. This 'citizen science' approach is being undertaken by about 150 different groups on different rivers across the UK. For the River Stour it was planned to provide regular monthly monitoring of the water quality at several locations. The results of the monitoring can also be uploaded to a national website where they can be accessed and moderated by the Environment Agency. This approach provides regular monitoring of water quality and flags up if and when there are issues requiring further investigation by the Environment Agency.

3. Methods

Members of PACE and the Environment Agency walked the section of the River Stour from below the village of Dedham to above the confluence with its tributary the River Brett which is near the villages of Higham and Langham. 4 sites were selected which were best suited for taking samples of the freshwater invertebrates by the ARMI Riverfly method. This is a standardized method used throughout the UK and involves taking a timed 3-minute kick-sample which dislodges the freshwater invertebrates from the bed of the river into a net (the standard net is 25cm wide with a net mesh of 1mm) Figure 2. The contents of the net are rinsed free of any fine silt (Figure 3) then transferred to a tray where the different invertebrates can be sorted, identified, and counted by the trained volunteers (Figure 1).



Figure 2 Taking a 3-minute kick sample at Langham



Figure 3 Rinsing a sample on the River Brett at Higham

For the basic ARMI Riverfly method there are 8 target taxa:

- Cased Caddisflies (Trichoptera)
- Caseless Caddisflies (Trichoptera)
- Burrowing Mayflies (Ephemeridae)
- Olive Mayflies (Baetidae)
- Blue winged olive Mayflies (Ephemerellidae)
- Flat Mayflies (Heptageniidae)
- Stoneflies (Plecoptera)
- Freshwater Shrimps (*Gammarus*)

Some examples of the target freshwater invertebrates are illustrated in Figure 4.

It has been well researched that some of these taxa are typically absent or found in reduced numbers in polluted rivers. From the type of invertebrate taxa in the sample and the number of individuals of each taxon it is possible to indicate the water quality.

In June 2022, 9 volunteers from PACE were trained in the ARMI Riverfly method by a recognised trainer Ian Hawkins.

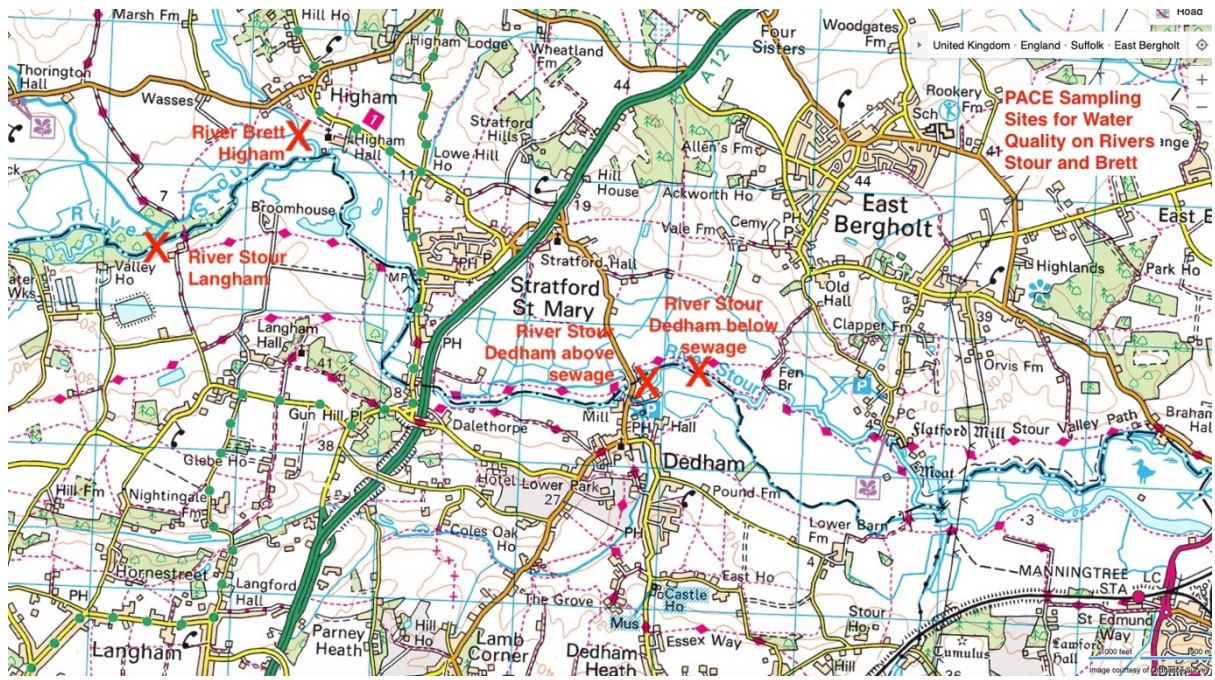
4 sites were selected for regular monthly samples (See Map 1):

Higham, Downstream of Bridge, River Brett Grid Ref TM 033353

Langham Low Lift, River Stour Grid Ref TM 023344

Dedham Above Sewage Treatment Works, River Stour Grid Ref TM 058337

Dedham Below Sewage Treatment Works, River Stour Grid Ref TM 063337



Map 1: Locations of 1 Sampling Site on the River Brett and 3 Sampling Sites on the River Stour



Figure 4. Clockwise from top left: Cased Caddisfly; Burrowing Mayfly; Freshwater Shrimp; Blue-winged Olive.

Sampling Dates were selected each month according to suitability of weather, river condition and availability of trained volunteers ensuring that there would be at least 2 volunteers at each sample site for safety reasons. The sampling dates were as follows:

26 July 2022

23 August 2022

24 September 2022

29 October 2022

24 November 2022

18 December 2022 – not possible to sample this month because the rivers were in spate.

1 February 2023 – first date we could sample after the river levels had dropped.

28 February 2023

24 March 2023

25 April 2023

31 May 2023

23 June 2023

The volunteers also took the following chemical and physical records at each site:

- Description of the river condition such as speed of flow, depth, vegetation etc.
- pH – taken using a handheld pH meter. Figure 5. This indicates the acidity or alkalinity of the water on a scale of 1 (acid) to 14 (alkaline).
- Conductivity – taken using a handheld Conductivity meter in both “Parts per thousand ppt” (this indicates the concentration of suspended particles in the water) and “milli-siemens ms” (this indicates the concentration of free ions or charged particles in the water).
- Temperature of the water – taken using a handheld temperature probe in °C.
- Dissolved oxygen – taken with a handheld Oxygen meter measuring % Dissolved Oxygen. This meter will show 100% if the water is saturated with oxygen; if oxygen is depleted the meter shows less than 100%. A reading of over 100% is possible if, for example, plants are photosynthesising and producing oxygen.



Figure 5. Water chemistry meters. From Left, pH; Conductivity; Temperature and Dissolved Oxygen

After each sampling date the records were entered onto a Spreadsheet for each of the river sites. (These spreadsheets are available as Appendix 1 – one for each of the 4 Sampling Sites)

The ARMI Riverfly Score was calculated for each taxon using the following scale:

1 to 9 individuals	– Score 1
10 to 99 inclusive	– Score 2
100 to 999 inclusive	– Score 3
1000 and over	– Score 4

The ARMI Riverfly Total Score was then calculated for each site by adding together the scores for each of the 8 taxa. For example, if there was one individual of each of the basic 8 taxa then the ARMI Riverfly Total Score would be 8; if there were 10 individuals of each of the 8 taxa then the ARMI Riverfly Total Score would be 16. (In practice, two of the ARMI Riverfly taxa (Stoneflies and Flat Mayflies) are not known to occur in Northeast Essex and finding more than 1000 individuals of any taxon in a sample is unusual, so the maximum ARMI Riverfly Total Score we anticipated is $6 \times 3 = 18$).

The records for each site were also submitted to the national ARMI Riverfly website where they become available to the Environment Agency Coordinator. This Coordinator also determines what is called a “Trigger Level” for each site after several samples have been taken – Trigger levels for our sites were confirmed by the Coordinator in April 2023. If the ARMI Riverfly Total Score drops below this Trigger level, then this would indicate that the water quality was low and would trigger concern in the Environment Agency as a result of which one of their Officers would investigate. (If a Trigger Level were breached at any site, then the volunteers would take a second kick-sample to verify that the score was indeed below the Trigger Level and not a spurious result). The Coordinator was confident of setting Trigger Levels of 6 for the Downstream Higham Bridge site on the River Brett and the Langham Lowlift site on the River Stour, but was not confident to raise the Trigger Levels at the two Dedham sites on the River Stour above 2.

4. Results.

The full results for the year July 2022 to June 2023 12 are available as Appendix 1 which includes a Spreadsheet for each of the 4 sample sites.

The ARMI Riverfly Total Scores are also highlighted in the Spreadsheets and are presented below as bar charts for each site in Diagram 1 a, b, c, d.

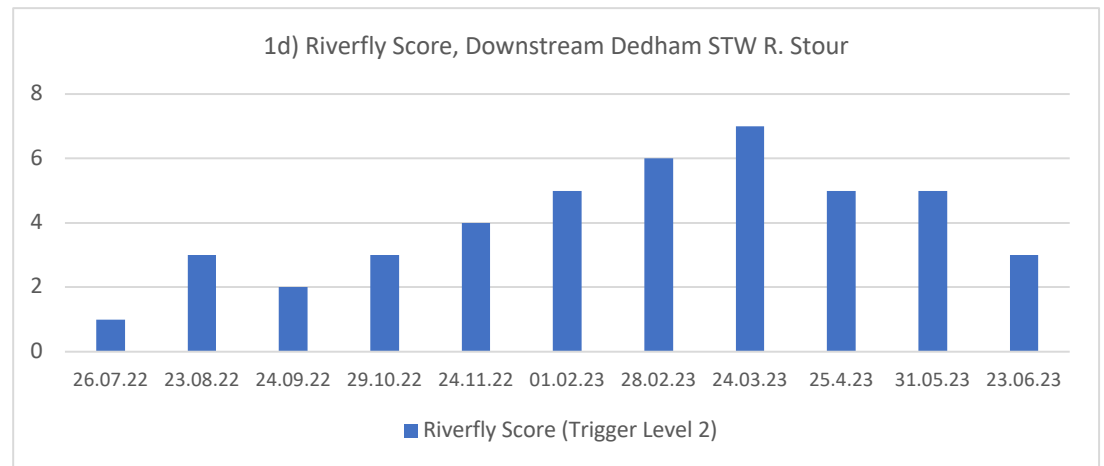
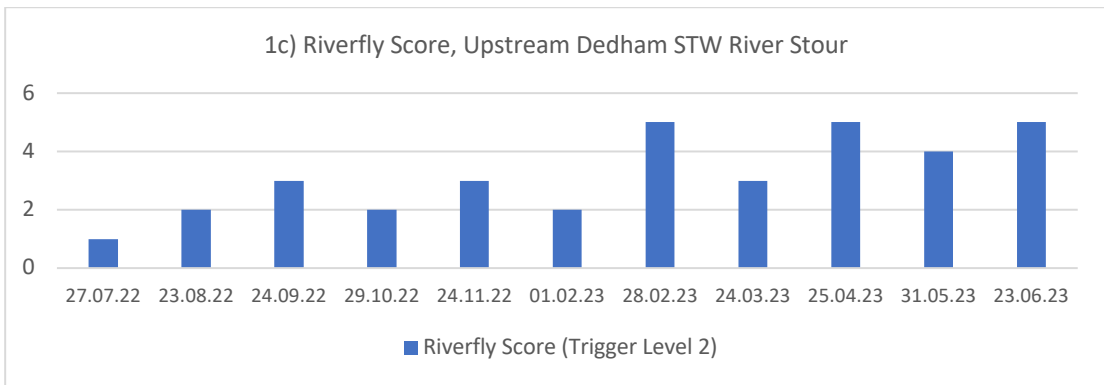
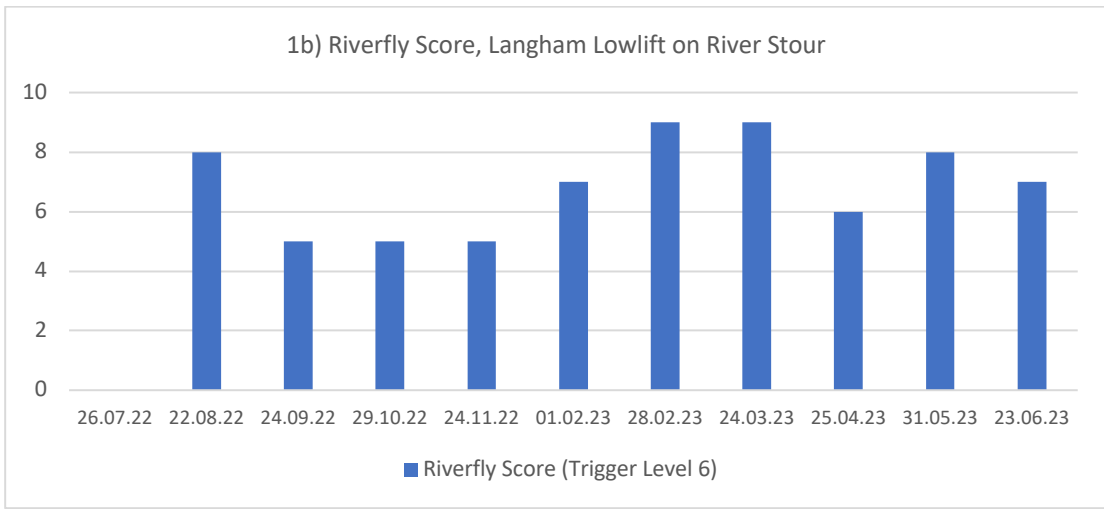
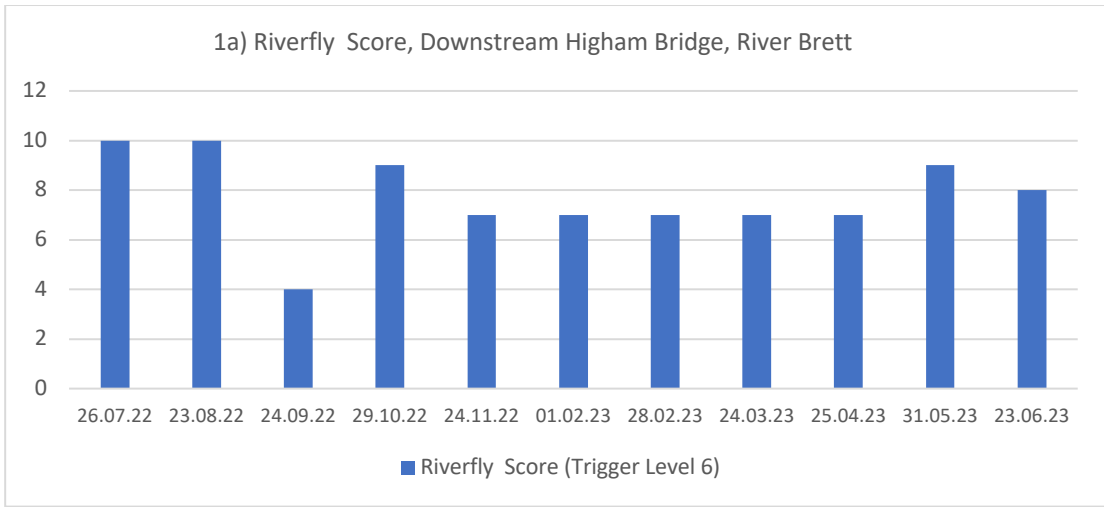


Diagram 1 ARMI Riverfly Total Scores for each sample date, at 1 Site on River Brett and 3 Sites on River Stour

The River Brett at Higham Bridge (Diagram 1a) showed the highest ARMI Riverfly Total Scores varying from 7 to 10, with an exceptionally low total score of 4 in September 2022 and the highest total scores of 10 in July and August 2022.

The River Stour at Langham (Diagram 1b) presented slightly lower total scores varying from 5 to 9 with the lowest total scores of 5 occurring between September and November 2022, and the highest total scores of 9 occurring in February and March 2023.

The Dedham site Upstream of the Sewage Treatment Works STW, River Stour (Diagram 1c) had much lower ARMI Riverfly Total Scores which were between 1 and 3 from July 2022 to January 2023, before rising between February and June 2023 to between 3 and 5.

This was similar to the Dedham site Downstream of the STW (Diagram 1d) with low total scores of 1 to 4 between July and November and better between February and June with total scores of 5 to 7.

The Water Chemistry records are summarised in Table 1 a, b, c, d, e.

Table 1a) shows the pH of the River Brett at Higham varied between 7.3 and 8.3. For the River Stour at Langham the pH varied more with a low pH of 6.5 in August and a high of 8.6 in May. At the two Dedham sites the pH variation was less between 7.5 and 8.5. None of these recorded pH variations are likely to be so significant as to lead to the death of freshwater invertebrates.

Table 1b) and 1c) summarise the Conductivity records for ppt and ms respectively. These do not show large peaks. (For example, an effluent discharge events could result in an ms reading of 1.5 or higher). One notable lower reading was recorded on the Brett at Higham in February 2023 with conductivity of 0.21 ppt and 0.67ms compared with more typical measurements of about 0.4ppt and 0.8ms respectively but this is unlikely to be an issue.

Table 1d) summarises the Water Temperature records at the 4 sites and shows the lowest temperature of 5°C at Langham in February; and the highest water temperature recorded in June at the Dedham Downstream of STW on the River Stour at 24.8°C. The high temperatures at all 4 sites in June was significant, because it could lead to lower Dissolved Oxygen which is covered by Table 1e). The low temperatures in February are unlikely to be a significant issue for the freshwater invertebrates as they are well adapted to such conditions.

Table 1e) summarises the % Dissolved Oxygen records. The lowest Oxygen readings were on the River Brett at Higham Bridge between August and October (August 46%, September 53%, October 30%). This is likely to be associated with high water temperatures and reduced flow conditions. The ARMI Riverfly Total Score dropped to 4 at this location in September. This could be associated with the low oxygen levels. Dissolved Oxygen is a very significant factor for freshwater invertebrates therefore Dissolved Oxygen records are presented in diagram 2 a, b, c, d. However, we must always bear in mind when considering Oxygen readings (and other water chemistry records) that these are taken at a fixed point in time, so they are spot readings. Oxygen levels can vary greatly before or after a spot reading even during the course of one day – for example Oxygen levels tend to increase in the daytime when water plants are photosynthesising and decrease at night when plants are respiring. Nevertheless, the bar chart in 2a) show that the Dissolved Oxygen levels in the River Brett at Higham dropped to lower levels than at the other 3 sites and could well account for the low ARMI Riverfly Total Score of 4 in September 2022. All other Oxygen levels at all sites were above 60%, so for these sites Oxygen is unlikely to have been a limiting factor.

Table 1 Water chemistry records from 1 site on river Brett and 3 Sites on River Stour July 2022 to June 2023

1a) pH

Downstream Higham Bridge, River Brett	Min 7.3 to Max 8.3
Langham Lowlift, River Stour	Min 6.5 to Max 8.6
Dedham Upstream of STW, River Stour	Min 7.6 to Max 8.5
Downstream of STW, River Stour	Min 7.5 to Max 8.4

1b) Conductivity ppt

Downstream Higham Bridge, River Brett	Min 0.21 to Max 0.51
Langham Lowlift, River Stour	Min 0.35 to Max 0.50
Dedham Upstream of STW, River Stour	Min 0.42 to Max 0.55
Downstream of STW, River Stour	Min 0.42 to Max 0.55

1c) Conductivity ms

Downstream Higham Bridge, River Brett	Min 0.67 to Max 0.94
Langham Lowlift, River Stour	Min 0.83 to Max 1.02
Dedham Upstream of STW, River Stour	Min 0.84 to Max 1.01
Downstream of STW, River Stour	Min 0.87 to Max 1.01

1d) Water Temperature Degrees C

Downstream Higham Bridge, River Brett	Min 5.6 to Max 20.5
Langham Lowlift, River Stour	Min 5.0 to Max 22.0
Dedham Upstream of STW, River Stour	Min 6.1 to Max 24.3
Downstream of STW, River Stour	Min 6.6 to Max 24.8

1e) % Dissolved Oxygen

Downstream Higham Bridge, River Brett	Min 30.2 to Max 88.6
Langham Lowlift, River Stour	Min 72.5 to Max 100.0
Dedham Upstream of STW, River Stour	Min 73.8 to Max 116.0
Downstream of STW, River Stour	Min 60.3 to Max 136.0

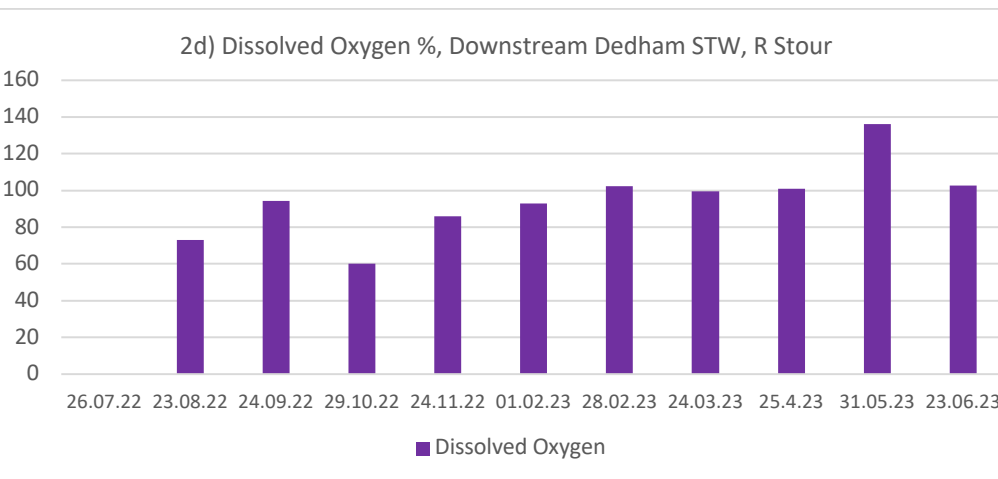
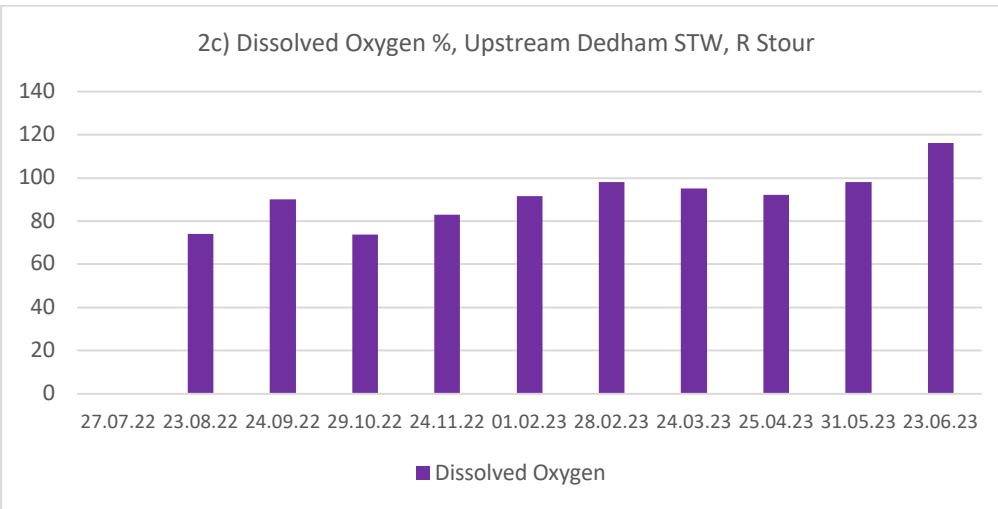
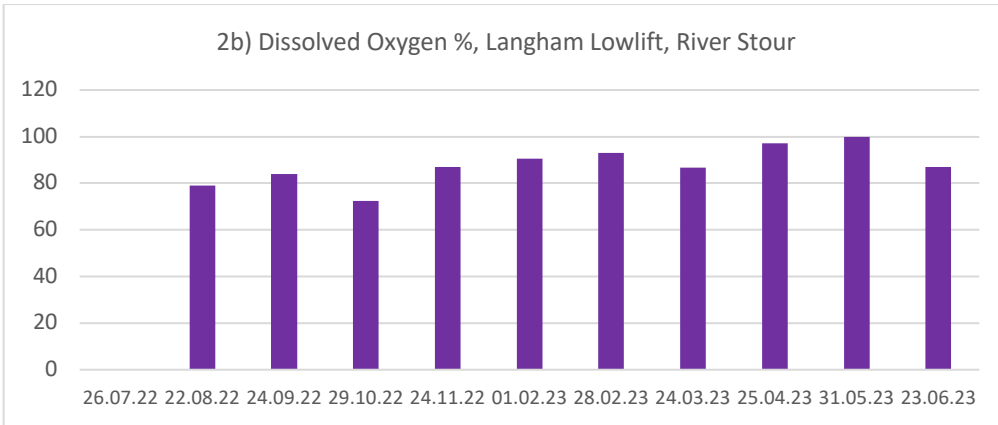
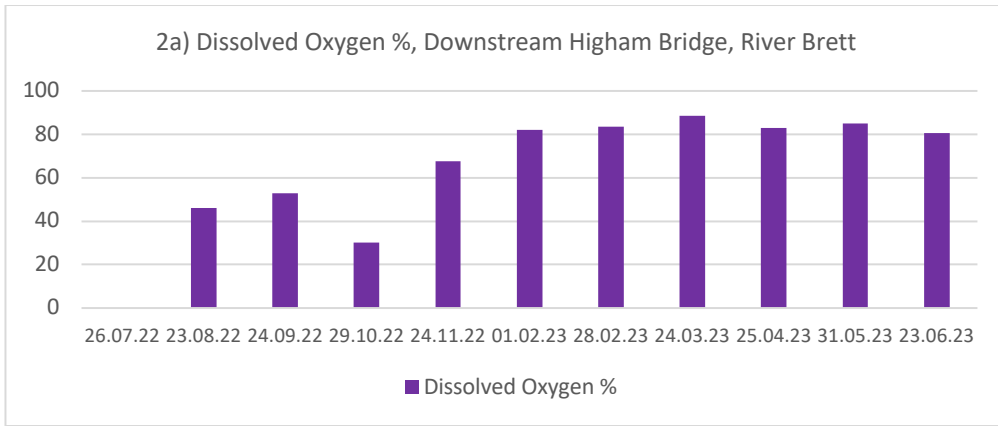


Diagram 2. Dissolved Oxygen % for each sample date, at 1 site on the River Brett and 3 sites on the River Stour.

Physical river conditions varied greatly throughout the year at all 4 sites. Depth of water and Flow Levels at all 4 sites were low when we began sampling in July 2022 and they continued to fall throughout the summer of 2022 through to October. There was significant rainfall in November and December, so Depth and Flow Rates increased dramatically, so much so that by December we were not able to sample for safety reasons because both the River Stour and River Brett were in spate. Lower rainfall in January enabled us to get back to sampling although both the Brett and the Stour were deep and fast flowing for February and March. Depth and Flow Rates then declined rapidly during April, May and June. Occasionally the River Stour at Langham was higher than predicted from rainfall events and it is likely that this coincided with a period when the Water Company were pumping water via the Ely-Ouse-Transfer-Scheme which brings water from the River Ouse in Cambridgeshire to augment the River Stour - in order that water can be pumped out of the River Stour to fill Abberton Reservoir.

Aquatic vegetation also varied hugely throughout the year, particularly on the River Brett where in late Spring and Summer the river channel was almost choked by tall dense vegetation like Burr-reed and Rushes - see Figure 6; whereas in winter the marginal vegetation had completely died back and the channel was free flowing. At the sites on the River Stour, both at Langham and Dedham, there was consistently little marginal vegetation – see Figure 7.



Figure 6. River Brett, dense marginal vegetation in summer Figure 7. River Stour, below Dedham in summer.

We also recorded recreational activity because we considered that this may have a significant impact on the two Dedham sites on the River Stour. The Dedham Upstream site is opposite The Boathouse where up to 20 rowing boats are launched from the south bank and many paddle boards and canoes are launched regularly from the north bank. When the weather is good in Summer and Autumn there are many tourists paddling, launching boats and swimming intentionally or otherwise. Associated with the steady increase of tourists are the increasing number of dogs – many of which are encouraged to swim by their owners. All

together this could amount to significant disturbance to the river bed at the two Dedham sites and this disturbance could occur with increasingly regularity between June and November if the popularity of the site grows. See Figure 8.



Figure 8. Recreational activity on River Stour, near our site Dedham Upstream of Sewage Works, August 2023

The ARMI Riverfly Total Scores were very low at Dedham Upstream STW from July (1) to November (3) and then there was some recovery in February (5) to May (5). At Dedham Downstream STW the ARMI Riverfly Total Scores were similarly very low from July (1) to November (4), with some recovery in March (7) to May (5).

In addition to the tourist activities, free roaming cattle could be another disturbance factor at the two Dedham sites and the Higham Bridge site because they access the river for drinking water. (From April 2023 the cattle were fenced from accessing the River Brett).

Figure 7 shows a bankside area which had been poached by cattle.

It is possible that these levels of disturbance could be factors suppressing the ARMI Riverfly Total Scores particularly at the two Dedham sites.

5. Discussions and Conclusions.

Our team of PACE volunteers have learned a great deal about the River Stour and River Brett during the year July 2022 to June 2023. We understand much about how the rivers change during the year in terms of variations in depth, flow rate, bankside vegetation, water temperature and water chemistry such as pH (Minimum 6.5 Maximum 8.5) conductivity (ppt 0.21 to 0.55; ms 0.67 to 1.02). There were significant variations in Oxygen levels from the lowest of 30% to over 100% and it does appear that the lowest levels of Oxygen of 30% on the River Brett were associated with low ARMI Riverfly Total Score of 4 in late summer and autumn when the flow of the River Brett was at its lowest and water temperatures were high. Many of the freshwater invertebrates will not be able to survive a spell of low Oxygen

which may explain the low ARMI Riverfly Total Score at that time, however, the invertebrates and hence the ARMI Riverfly Total Scores quickly recovered in the River Brett over autumn and winter. Some natural variation of freshwater invertebrates and ARMI Riverfly Scores will occur during the course of any year, however the taxa for ARMI Riverfly have been selected to ensure that they will give a good representation of water quality throughout the year. For example, several of the taxa in ARMI Riverfly have 2 year life cycles so the young stages would be present over a full year cycle.

The ARMI Riverfly Total Scores were notably good for the River Stour at the Langham Low Lift site throughout the year, albeit with a drop in autumn to a total score of 5. This site was relatively undisturbed with good habitats for freshwater invertebrates which reflects in the normally good ARMI Riverfly Total Scores.

It is important to appreciate that our water chemistry measurements are all one-off spot readings. Water chemistry readings can fluctuate widely from hour to hour and day to day, particularly if a harmful event hits the river. With monthly water chemistry readings, we could easily miss a harmful event. You would need lots of very regular water samples to catch significant changes in water chemistry – it can be done but is expensive in time and resources. However, the freshwater invertebrates are in the river the whole time and they face whatever harmful events hit them. If they can't survive they die and will not be recorded in the ARMI Riverfly sample, so they represent a cumulative picture of what has happened to the water quality over the past month or so. This is why the ARMI Riverfly Total Scores can be more useful as indicators than the water chemistry readings.

The ARMI Riverfly Total Scores were low for both the Dedham sites (above AND below the Sewage Works) for the majority of the year. They are BOTH significantly lower than the River Stour at the Langham Low Lift site. Something is depressing the ARMI Riverfly Total Scores at BOTH of the Dedham sites. We do not know what that is yet and it could be a combination of issues. As these low scores are for the majority of the year, there appears to be a chronic problem which could be related to several issues - sewage input, agricultural run-off, road run-off, are some of the common issues.

Repeated disturbance of the river bed is another possible factor which could influence the ARMI Riverfly Total Scores. When we selected the two Dedham sampling sites early in 2022 there was little recreational and cattle activity, but these activities increased dramatically during the course of the year and are two activities requiring further investigation as they may have been the cause of lower scores. Most of the ARMI Riverfly taxa are living amongst the riverbed stones and gravels and they quickly recolonise after a kick sample has been taken. However, it is possible that daily and repeated disturbance by recreation or cattle at both the Dedham sites in summer does not give the invertebrates time to recolonise fully and this in itself could depress the ARMI Riverfly Scores.

One driver of our investigations was to determine the impact of the Dedham Sewage Works. In this respect, if the outfall from the Dedham Sewage Works was polluting the River Stour, we would expect the ARMI Riverfly Total Score below the Sewage Works to be lower than the ARMI Riverfly Total Score above the Sewage Works. This is not the case. We do not have evidence, therefore, that the Dedham Sewage works is lowering the water quality of the River Stour.

Low ARMI Riverfly Scores such as those at the Dedham sites give indications of the water quality relating to the general ecology and its suitability for wildlife: they do not give indications of the water quality in terms of its suitability for water recreation, nor do they reflect anything about human pathogens such as *E. coli*. This point is covered in our recommendations.

Following this year's work we have the recommendations as set out below

6. Our Recommendations

1. We will aim to locate new sampling sites above and below the Dedham Sewage Treatment Works which do not suffer such major disturbance from tourists, dogs and cattle. If we can find these sampling sites this will disconnect the impact of disturbance so that the ARMI Riverfly method can better investigate whether there is any impact of the Sewage Treatment Works on the invertebrates and hence the ARMI Riverfly Scores. To locate these new sampling sites, we will walk the course of the River Stour both upstream and downstream from the Sewage Treatment Works.
2. If we can find these better sampling sites, we will continue ARMI Riverfly sampling at these sites and at the Langham Low Lift site on the River Stour and Higham Bridge on the River Brett.
If we do not find better sampling sites, then we will review whether or not we wish to continue with water quality sampling on the Stour/Brett
3. We will expand the water chemistry measurements at the sampling sites by measuring the amount of phosphate in the river water – phosphate is often the most significant chemical determining the rate of growth of river plants and algae.
4. We will improve the River Condition measurements by taking depth readings at standard positions at each of sampling sites. This will give a better summary of the state of the river than a word description.
5. We will arrange with Jamie Szajewski of Anglian Water for a visit to the Dedham Sewage Treatment Works with their staff to understand their operation. (He kindly arranged for a visit to the Hadleigh Sewage Treatment Works which is on the banks of the River Brett below Hadleigh and this was a very informative visit).
6. We will consider investigating pathogens at all sampling sites by taking *E. coli* cultures at each sampling date. This would advise whether there are issues associated with people using the river for recreational activities.

7. Acknowledgements.

Thanks to the key volunteers from PACE Manningtree who were trained in the ARMI Riverfly method and water chemistry and helped with the samples: Bob Rowles, Judy Wakeling, Caroline Hall, Anna Helm Baxter, Rachael Hurst, Natalie Singleton, Heather McCollin, Sarah Smith, Kelly Lench, Jim Sumberg, John Hall. This enabled the regular monthly samples to be taken.

Thanks to Ian Hawkins and Dan Mills from the Environment Agency who enabled the training of the first 9 PACE volunteers and to John Findlay from the Environment Agency who has continued the support and training for 6 new PACE volunteers: Tom Hancock, Trudi Needham, Iris Marr, Steve Marr, Arnrud Wood and Philip Bohannon.

Thanks to the Dedham Vale Area of Outstanding Natural Beauty Sustainable Development Fund which part funded this Water Quality Project by supporting the purchase of the sampling equipment and water chemistry meters.

Thanks to the support of Paul Hogger and the team of volunteers from HEAT (Hadleigh Environment Action Team) who have run a similar ARMI Riverfly Sampling programme on the higher sections of the River Brett.

Thanks to Trine Bregstein, Riverfly Partnership National Co-ordinator and Kirsty Hadwin from the Freshwater Biological Association for their support from the Riverfly Partnership.

Thanks to the landowners for access to the river including Carol and Elizabeth Gurney, Essex and Suffolk Water, Colchester Piscatorial Society.

8. References.

The Riverfly Partnership <https://www.riverflies.org>

Anglers Riverfly Monitoring Initiative ARMI <https://www.riverflies.org/anglers-riverfly-monitoring-initiative-armi>

PACE Manningtree (Practical Actions for Climate and the Environment)
www.pacemanningtree.org.uk

9. Appendices

Appendix 1 Spreadsheets showing the original ARMI records for 1 site on the River Brett and 3 Sites on the River Stour between July 2022 and June 2023. See attachment to this report.

End of Report.