River Action Henley Monitoring Report – June 2024

Executive Summary

This report analyses water quality data collected at multiple sites around Henley on the River Thames. The report includes analysis of nitrate and phosphate concentrations collected throughout 2023 to June 2024 and Echerichia coli (E. coli) measurements taken in late May and June 2024.

Looking at all the samples collected throughout the year, the highest levels of phosphate and nitrate were in the summer, followed by spring. These levels were well above recommended limits, especially for phosphate. Phosphate and nitrate levels were lower in the autumn and winter, but nitrate still exceeded recommendations. Higher summer turbidity (cloudiness) might be linked to algae blooms.

The report didn't find any clear increase or decrease in E. coli levels in June. However, it did find very high levels of E. coli in one sample from Fawley Meadows in June. This could be an error, but it suggests the water quality there may be unsafe.

Overall, the water quality seems to be worst in the Upper Thames and Temple Island areas, with very high phosphate and nitrate levels. Monitoring should continue, and sources of nutrient pollution should be investigated, especially for these two areas.

Report

Sites monitored

There were 10 sites monitored with at least 5 measurement events using the Freshwater Watch (FWW) monitoring approach (Figure 1) in 2023 and 2024 (to June 2024).

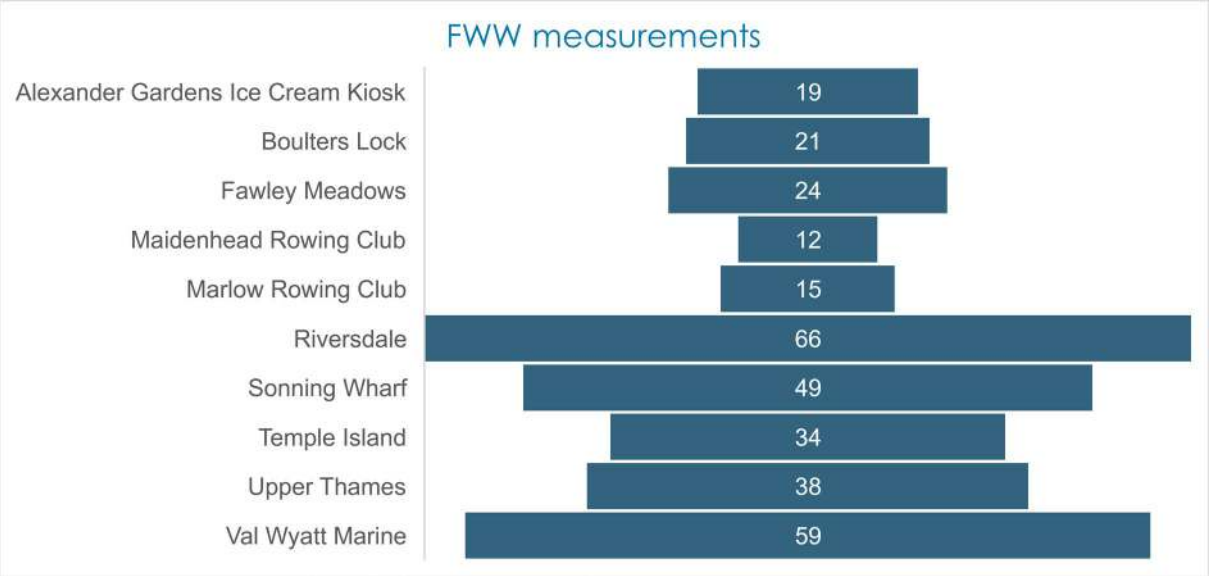

Figure 1 *Sites monitored using FWW*

For microbiological monitoring, there were 4 sites with at least 4 measurements of E. coli, measured in 2024 (Figure 2).

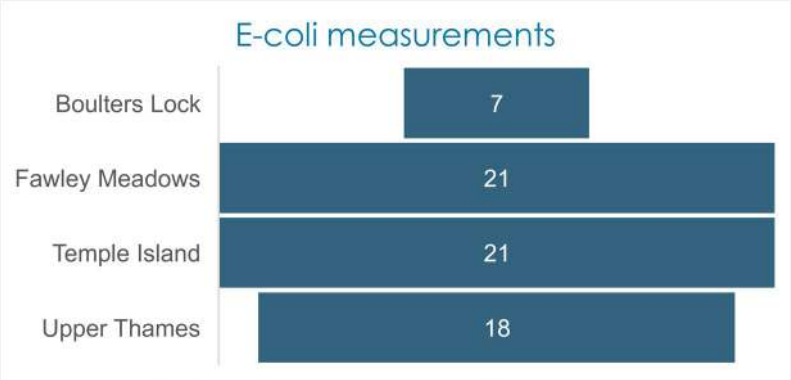

Figure 2 *Microbiological monitoring sites*

Nutrient pollution

Of the 10 sites monitored by citizen scientists using FWW, 60%, showed moderate or high concentrations of phosphate (above 0.1 mg/L), suggesting unacceptable water quality conditions (Figure 3). Upper Thames and Temple Island had medians that were particularly elevated. These conditions favour algal blooms, in particular cyanobacteria. They also suggest an upstream source of phosphate.

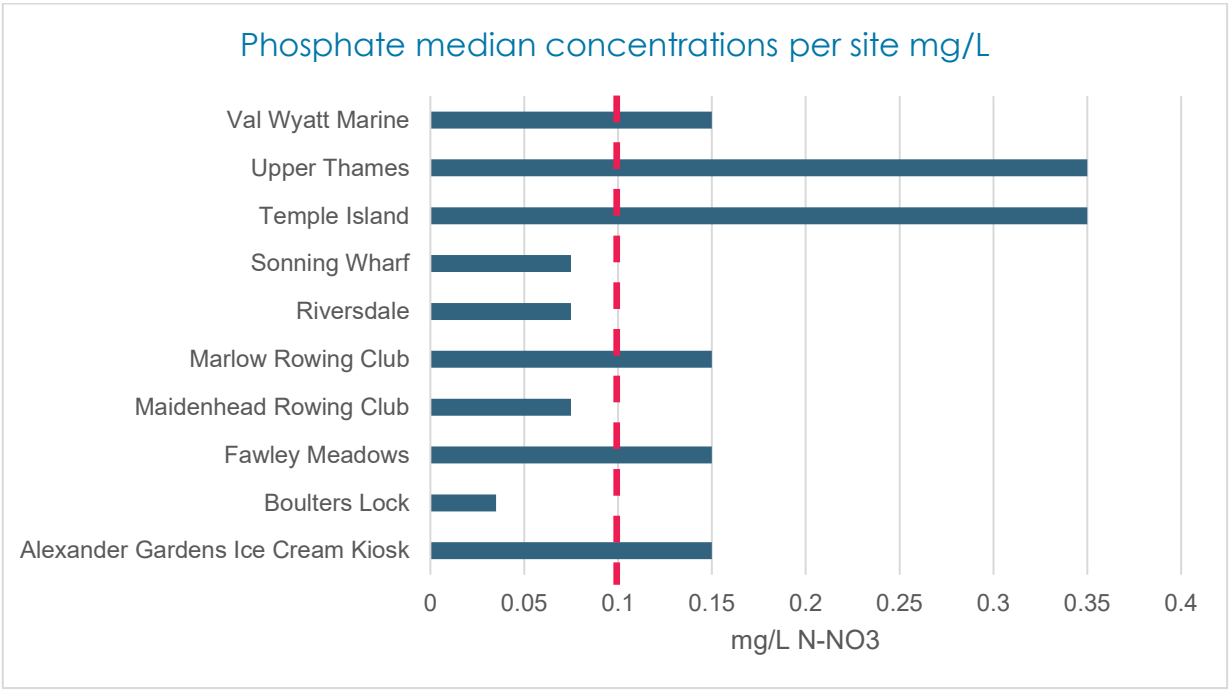

Figure 3 *Median phosphate concentrations per site*

With the exception of Boulders Lock, all other sites (90%) showed elevated nitrate conditions (Figure 4). Unfortunately, this is typical of the entire Thames catchment, and the result of inappropriate wastewater treatment and historically high fertilizer use for agricultural activities.

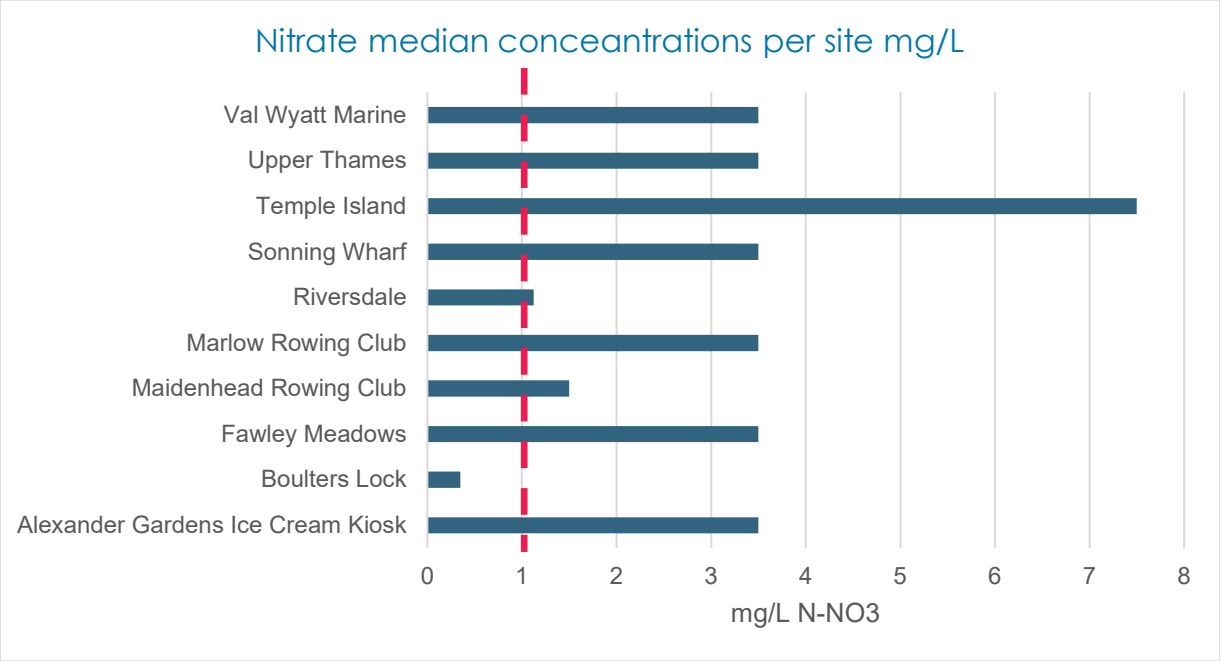

Figure 4 *Median nitrate concentrations per site*

Microbiological monitoring

E. coli concentrations were monitored in four locations, the distribution of the concentrations was non-gaussian with a positive skewness (skewness > 4, Shapiro-Wilk Test $p < 0.001$). A comparison of the medians shows medium to high concentrations only in the Fawley Meadows monitoring site (Figure 5). This site showed significantly higher concentrations ($p < 0.001$, Mann Whiney test) with respect to the other three. Temple Island, Upper Thames and Boulders Lock did not show differences between them.

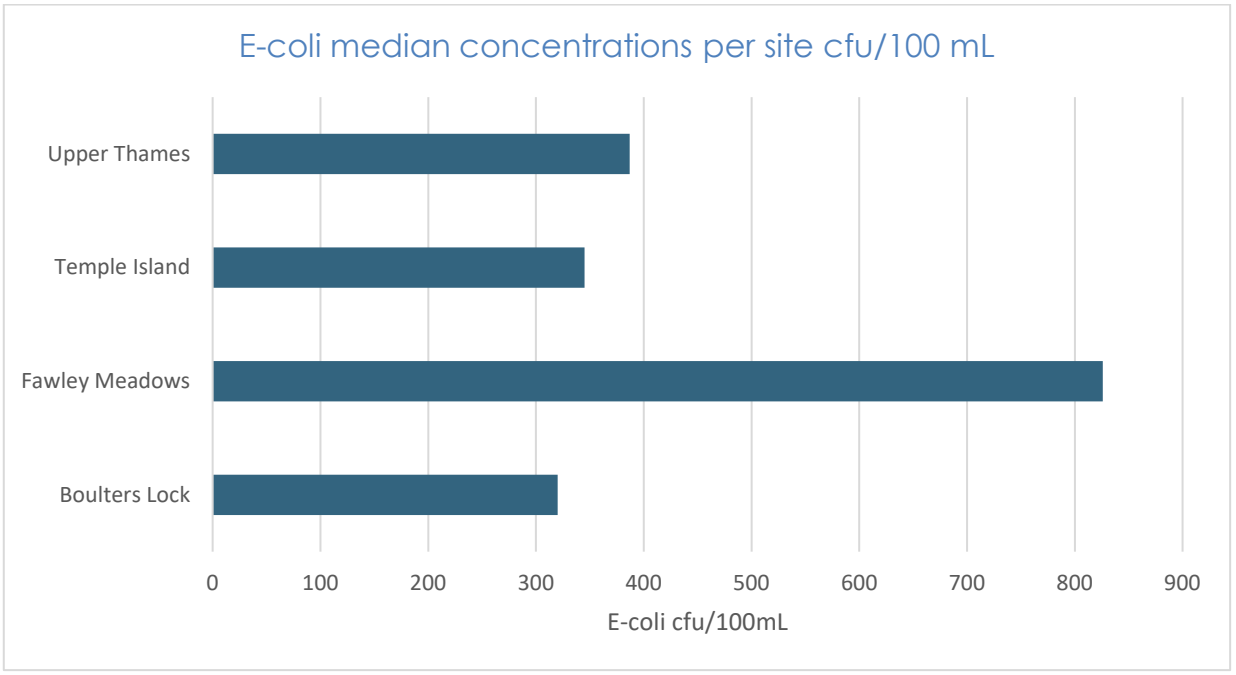

Figure 5 *Median E. coli concentrations across sites*

It is also possible to represent the different sites using their mean values (Figure 6), however, this does not represent their true centre concentrations, which will be skewed to the right (making them look larger). The resulting non normal distribution occurs with or without the potential outlier of 25000 cfu/100 mL.

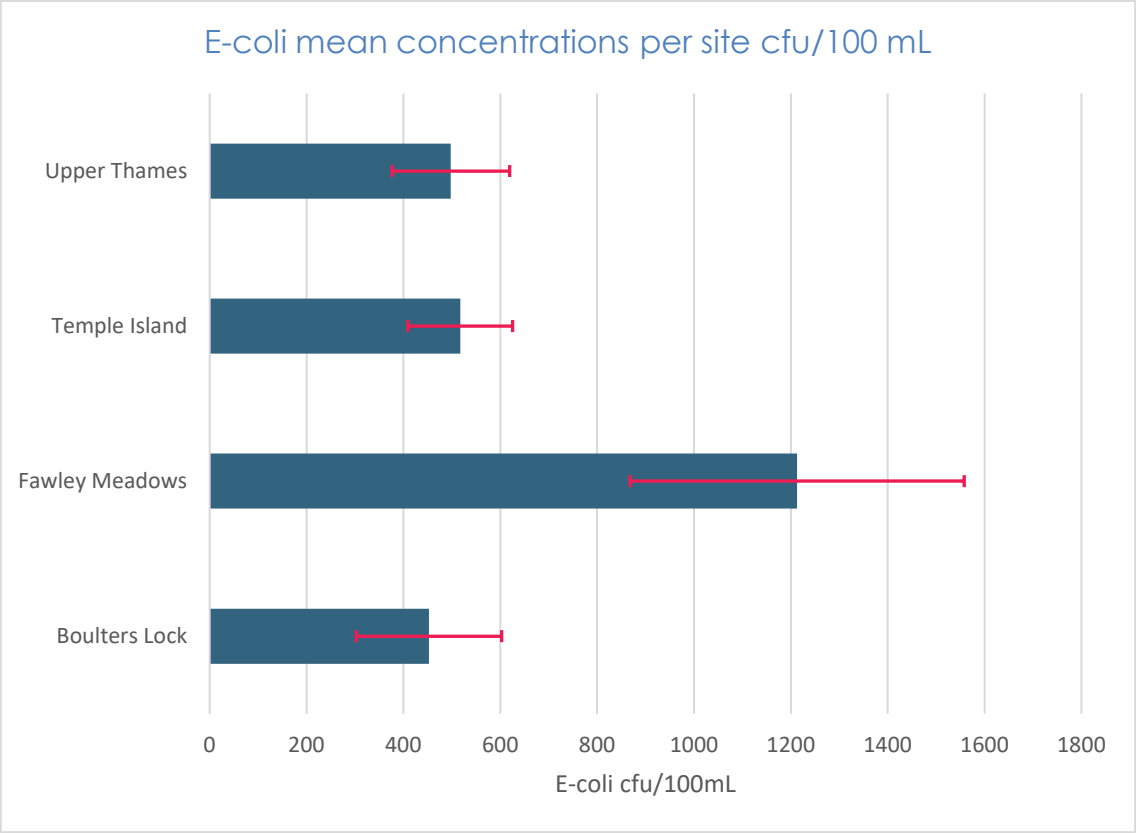

Figure 6 *Mean E. coli concentrations across sites with standard errors* ***(N.B. the potential outlier of 25000 cfu/100 mL was removed for this figure)***

The concentration of E. coli in the Fawley Meadows monitoring site from the 30th May to the 23rd of June can be seen in Figure 7 (potential outlier highlighted).

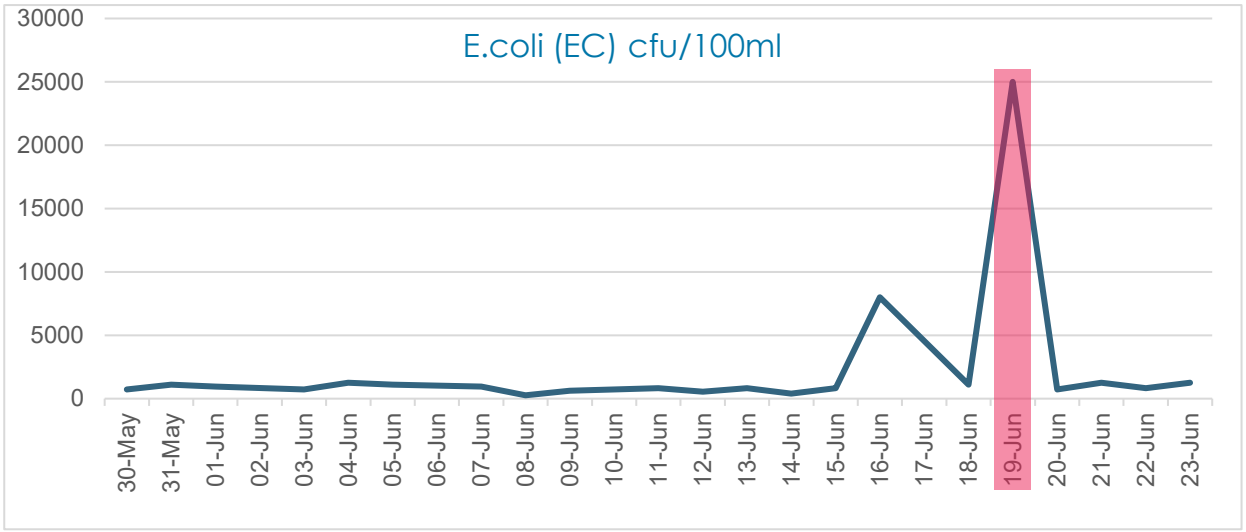

Figure 7 *E. coli concentration in Fawley Meadows over time*

Of the measurements taken in Fawley Meadows, 47% were above 900 cfu/100 mL; meaning that they do not meet the threshold for Sufficient water quality based on DEFRA's Inland bathing water standards. Almost 30% of measurements in Boulters Lock also failed to meet this threshold (Figure 8).

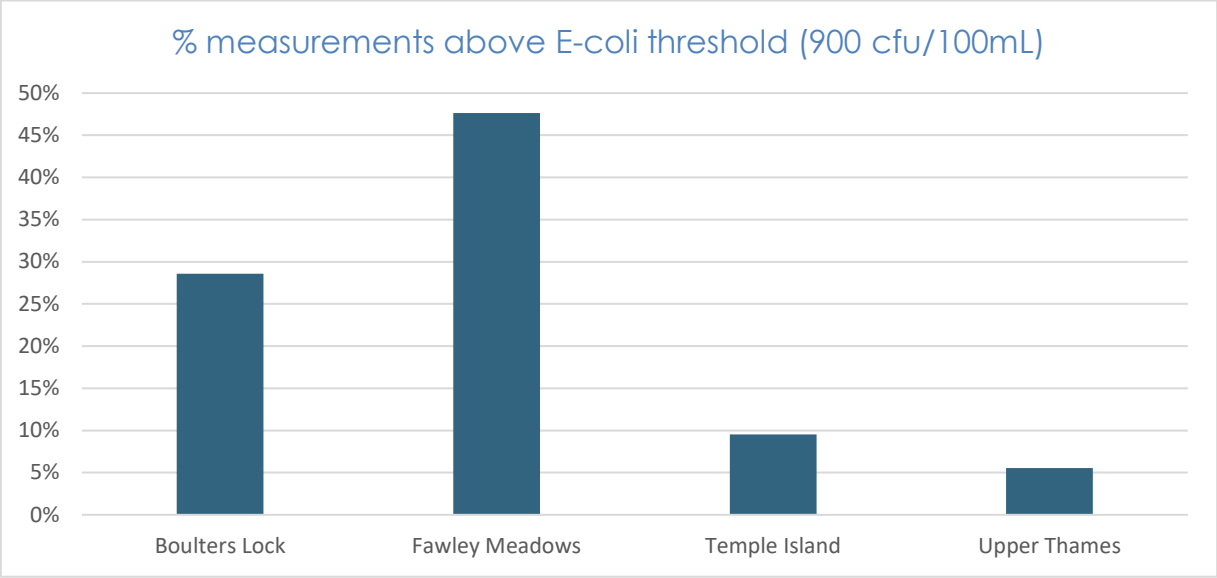

Figure 8 *Measurements above the E. coli threshold across sites*

Turbidity

Turbidity values were low in all 10 sites monitored (Figure 9).

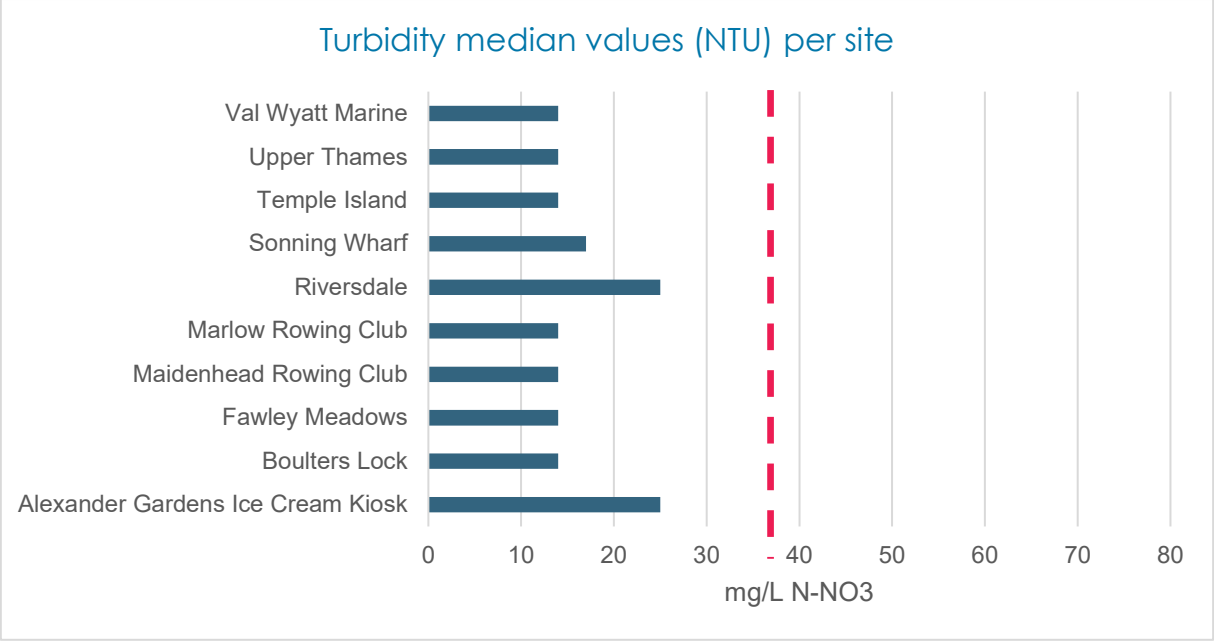

Figure 9 *Median turbidity values across sites*

Summary

From a temporal point of view, there were no clear trends in E. coli in June (not apparent and no significant) (Mann Kendall $p > 0.05$).

From a seasonal point of view, summer concentrations of phosphate and nitrate were the highest of all seasons, followed by the spring, with median concentrations of phosphate well above the suggested limit (0.1 mg/L). Concentrations of both phosphate and nitrate were lower in the autumn and winter, below the recommended values for phosphate. Nitrate concentrations, while lower in the autumn, remained above the recommended limit. Turbidity was highest in the summer and autumn, possibly related to algal blooms (citizen scientists reported a green water colour for 38% of the summer measurements and 27% of the autumn measurements (compared to 18% of the winter measurements).

One apparent E. coli outlier of 25000 cfu/100 ml was recorded in June in Fawley Meadows. This reading was verified by Fluidion (kit which is approved by the World Health Organisation); however, it is possible that this reading was a result of human error. All data analysis calculations were therefore performed both with and without this potential outlier. Overall results were not influenced by this elevated concentration value.

Conclusion

In conclusion, microbiological measurements, largely performed in May and June 2024, suggested that Fawley Meadows had unacceptably high concentrations of E. coli. The other sites Temple Island, Upper Thames and Boulders Lock had much better conditions. From the longer term monitoring performed, Upper Thames and Temple Island show the worst conditions, with extremely elevated phosphate and nitrate conditions, flowed by Val Wyatt Marine, Marlow Rowing Club, Fawley Meadows and the site near Alexander Gardens Ice Cream Kiosk. Monitoring should continue and a more detailed analysis of possible sources of microbiological and phosphate pollution should be made.

Methodology

Measurements
The FreshWater Watch (FWW) measurements of nitrate and phosphate are made colourimetrically in closed tubes using a standard plastic cuvette for a fixed volume of 1.5mL. Nitrate measurements are based on the Griess reaction, with a reduction reaction using zinc, which reduces the nitrate (NO_3^-) to nitrite (NO_2^-) and a colourimetric reaction for the determination of nitrite. PO_4 is detected using 4-amino-antipyrine with phosphatase enzyme to produce hydrogen peroxide, which then undergoes a colourimetric reaction. Both colours are compared to standard reference colour charts provided to the citizen scientists, assigning colour brightness to one of seven concentration intervals. Side-by-side measurements have shown an overall accuracy of 75% to 85% of the citizen scientist estimated PO_4 concentrations compared to concentrations measured at the same site and day by our FWW scientists using standard laboratory analysis.

Fluidion provides a quantified response in terms of bacteria/100 mL present in the sampled water and has been validated through numerous side-by-side studies with approved laboratories external to Earthwatch.

Data analysis
The concentrations of E. coli, phosphate, nitrate and turbidity all showed a non-normal distribution (Shapiro-Wilk Test $p < 0.001$), with positive skewness, in particular for the E. coli measurements (skewness > 4). Given such distributions, data analysis and quality control were performed using non-parametric methods, Kruskal-Wallis and Mann Whitney for single parameter comparisons,

Sheire Ray Hare for two factor comparisons. It should be noted that reporting central (typical) concentrations should be performed using median values and their interquartile range, rather than averages and standard deviations.

Within the datasets, there were several measurements of E. ecoli that could be considered as potential outliers, measurements that fall outside the distribution and may be related to analytical or transcription errors, contamination or sampling error, or simply an exceptional event. In fact, using Grubbs test, the measurement at Fawley Meadow on the 19th June of 25000 cfu /100 mL was determined to be an outlier (Grubbs and interquartile ranges). All calculations were therefore performed with and without this potential outlier. Overall results were not influenced by this elevated concentration value.

About Earthwatch

Earthwatch Europe is an environmental charity helping people to protect the nature around them. We build meaningful nature connections and give people the tools they need to fight for our planet. We are an Indipedent Research Organisation and we champions citizen science. Through our FreshWater Watch programme, we enable communities to gather real-time water quality data, which provides valuable insights that complement official monitoring efforts. We know that volunteers can gather extensive, accurate, and timely information on water conditions, ensuring transparency and accountability from polluters. Earthwath recently published it's Great UK WaterBlitz report, the result of a citizen science campaign measuring nutrient pollution in freshwater sytems across the UK.