

# Nitrate concentrations in Poole Harbour's rivers

## Introduction

Reducing nitrate (NO<sub>3</sub>-N) loads into Poole Harbour is a key goal to improve water and aquatic habitat quality. The majority (73%) of nitrate entering Poole Harbour has been attributed to riverine inputs, particularly from the Frome and Piddle rivers (Environment Agency and Natural England, 2013). The main contributors of nitrate into rivers within the Poole Harbour catchment are fertiliser from tillage land, manure from livestock, sewage treatment works (Environment Agency and Natural England, 2013) and private sewage systems (Kite & Natural England, Dorset, 2023).

Climate and rainfall have a significant effect on surface run off, soil drainage and leaching (the loss of soluble plant nutrients to groundwater). Run off and leaching are greatest during periods of heavy or intense rainfall and typically occur over the winter period when rainfall is more persistent. The amount, timing and intensity of rainfall events varies from year-to-year.

### What does Wessex Water measure?

Nitrate concentration monitors were installed on the Frome and Piddle rivers by the Wessex Water Catchment

Delivery Team in 2016. The monitors are situated alongside Environment Agency water level monitoring equipment which measures the amount of water flowing through each river location. With these two pieces of river data, riverine nitrate loads can be robustly estimated.

To gain a better understanding of climate and weather conditions and how they may influence nitrate loads, rainfall is also measured using rain gauges located across the Poole Harbour catchment.

## Historic Results

Historic nitrate data, collected by the Environment Agency (EA) and the Freshwater Biological Association, showed increasing nitrate concentration trends over five decades of sampling (Figure 1). This monitoring ceased in 2016.

After five decades of data collection showing an increasing trend in nitrate concentrations in the River Frome from approximately 2 mg N/l to just over 6 mg N/l, the last seven years of data indicate a plateauing effect with average annual concentrations remaining steady around 6 mg N/l (Figure 1). Maximum annual concentrations have shown a falling trend over the last seven years; however, it should be acknowledged this could be due to greater variation in the data prior to 2016.

### Nitrate concentrations in the River Frome

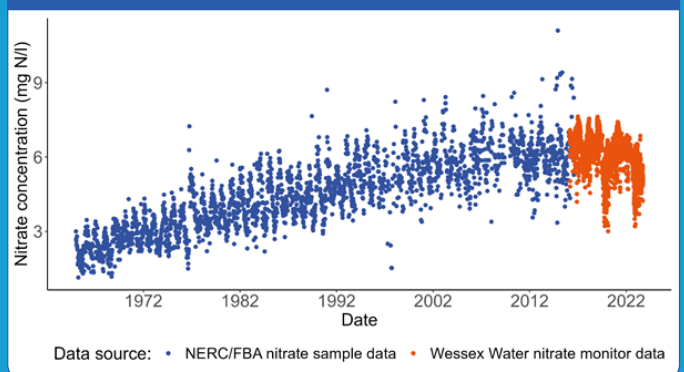


Figure 1 - River nitrate concentrations at East Stoke (River Frome) from 1965-2022. Data from 1965-2016 (blue) is data owned jointly by NERC - Centre for Ecology & Hydrology and the FBA (Freshwater Biological Association) *Bowes et al., 2011*. Average daily river flows supplied by the National River Flow Archive from data obtained from the Environment Agency. Data from 2016 onwards (orange) is owned by Wessex Water.

## Current Results

The rainfall data presented in Figure 2a represents the annual monthly rainfall across the Poole Harbour catchment. A seasonal trend is observed with drier months generally falling between April and August; however, high rainfall events in the summer can drive up averages over these months. October to March are typically wetter but there is a lot of annual variability present across the Poole Harbour catchment.

Data collected from the Frome and Piddle rivers over the last seven years indicates a strong seasonal trend with high river flows typically occurring between November to March (Figure 2b).

Peaks in nitrate concentrations also occur over the same period, leading to greatest nitrate loads being observed

during the wetter winter months (Figure 2c and Figure 2d, respectively).

Although the nitrate concentrations are seasonally variable, the concentration entering Poole Harbour from the Frome and Piddle rivers does not deviate much from the average over the course of a year. As such, the greatest influence on nitrate load into Poole Harbour can be attributed to the river flow.

**Data collected on the Frome and Piddle rivers over the last seven years indicates between November and March there are:**

- **Peaks in nitrate concentrations,**
- **Generally higher river flows, and**
- **Greatest nitrate loads.**



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## Poole Harbour rainfall, river flow and nitrate concentrations and loads

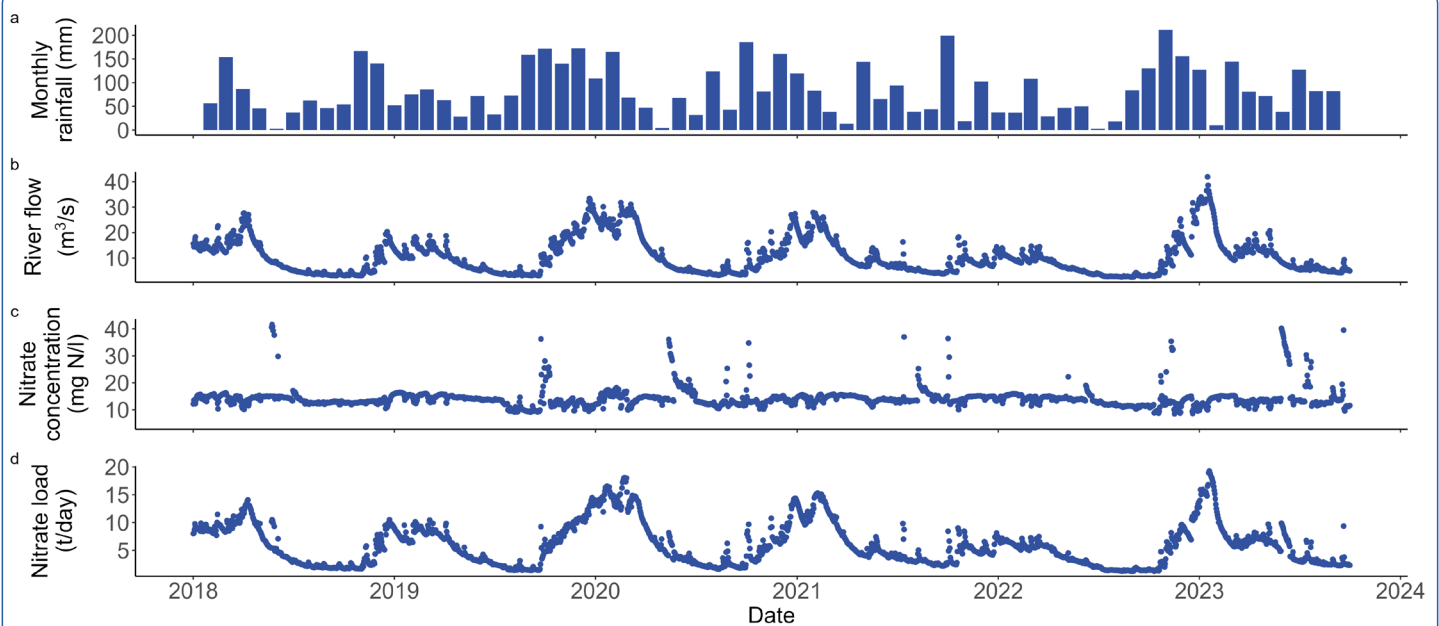


Figure 2 a) Monthly averaged rainfall across the Poole Harbour catchment, b) combined river flows entering Poole Harbour from the Frome and Piddle rivers, c) combined nitrate concentrations entering Poole Harbour from the Frome and Piddle rivers, and d) combined nitrate load entering Poole Harbour from the Frome and Piddle rivers. All data presented is from the period 2018-2023.

### Findings

Nitrate concentrations in the Frome and Piddle rivers are controlled by activities taking place within the river catchments (lag time must be acknowledged). Sources of nitrates can be diffuse, such as agriculture, or point sources, for instance public and private sewage systems. In the Frome and Piddle river catchments, the diffuse nitrate load is the largest component and is also the most variable.

The high concentrations observed over the winter period coincide with the wetter weather conditions. Nitrate residues in soils post-harvest are mobilised and enter into rivers and water bodies, through both surface water runoff and leaching into groundwater. The high nitrate concentrations observed over the winter are therefore greatly influenced by land management techniques. Rainfall also affects all other sources of nitrates entering the rivers.

A drier winter period (eg, 2022) will likely reduce the amount of nitrate entering the riverine system as there will

be less lost from the land to watercourses, while a wetter winter (eg, 2020) may result in increased river nitrate concentrations. As such, it is important to note that most nitrate sources are strongly influenced by the year-to-year weather conditions.

### Nitrate Sources

Nitrate load measurements have been analysed across the Frome and Piddle catchments for routinely-monitored point sources, and diffuse inputs. Water Recycling Centres (sewage treatment works) provide a consistent supply of nitrate to rivers throughout the year (128 tonnes; 9.7% of 1315 tonnes total annual N loading in the River Frome and 11 tonnes; 1.6% of the 707 tonnes total for the River Piddle based on data from 2016 to 2022), forming a stable baseline contribution. More detailed analysis is needed to disentangle the impact of legacy nitrate as a diffuse source to rivers.

### References

- Environment Agency and Natural England, 2013. Strategy for managing nitrogen in the Poole Harbour Catchment to 2035. [Online] Available at: [https://webarchive.nationalarchives.gov.uk/ukgwa/20140328091437/http://www.environment-agency.gov.uk/static/documents/Leisure/Strategy\\_for\\_Managing\\_Nitrogen\\_in\\_the\\_Poole\\_Harbour\\_Catchment\\_Final\\_06\\_06\\_13.pdf](https://webarchive.nationalarchives.gov.uk/ukgwa/20140328091437/http://www.environment-agency.gov.uk/static/documents/Leisure/Strategy_for_Managing_Nitrogen_in_the_Poole_Harbour_Catchment_Final_06_06_13.pdf)
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- Bowes, M. et al., 2011. Water chemistry data for the River Frome, Dorset, UK, from 1965-2009. NERC Environmental Information Data Centre. <https://doi.org/10.5285/aa82fa99-d38c-47a7-9405-f0773edcd7a8>



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