

Nitrate in Poole Harbour's rivers

2023 to 2024 hydrological year update

Introduction

Reducing nitrate loads into Poole Harbour is key to improve water quality and aquatic habitat. The majority (73%) of nitrate delivery into Poole Harbour has been attributed to riverine inputs, particularly from the Frome and Piddle rivers (Environment Agency and Natural England, 2013). The main sources of nitrate 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 typically greatest during the winter period when rainfall is more persistent and soils become saturated. The amount, timing and intensity of rainfall events varies from year to year, and is becoming increasingly altered by climate change.

What does Wessex Water measure?

The Wessex Water Catchment Delivery Team installed nitrate concentration monitors on the River Frome in 2016 and the River Piddle in 2017. The monitors are situated alongside Environment Agency river flow monitoring equipment that measure the amount of water passing through each location. With these two pieces of data, riverine nitrate loads can be robustly estimated.

To gain better understanding of climate and weather influences on river nitrate loads, rainfall is also measured at strategic locations across the Poole Harbour catchment.

Long-term nitrate concentration and load trend on the River Frome

Historic nitrate concentration data, collected by the Environment Agency (EA) and the Freshwater Biological Association at East Stoke (River Frome), show concentrations steadily increasing over five decades of sampling from approximately 2 mg N/L in 1965 to 6.5 mg N/L in 2016, when their monitoring ceased and nitrate concentrations appear to have peaked (Figure 1).

Data collected over the last eight years shows a flattening of the nitrate trend. Mean nitrate concentration over the last eight years of continuous monitoring is 6.10 mg N/L, similar to the preceding eight years (2008 to 2016) where mean concentration was also 6.10 mg N/L. Recently, the data suggests that annual mean concentrations are starting to decline.

We will continue to monitor the direction of this trend as subsequent years of data become available.

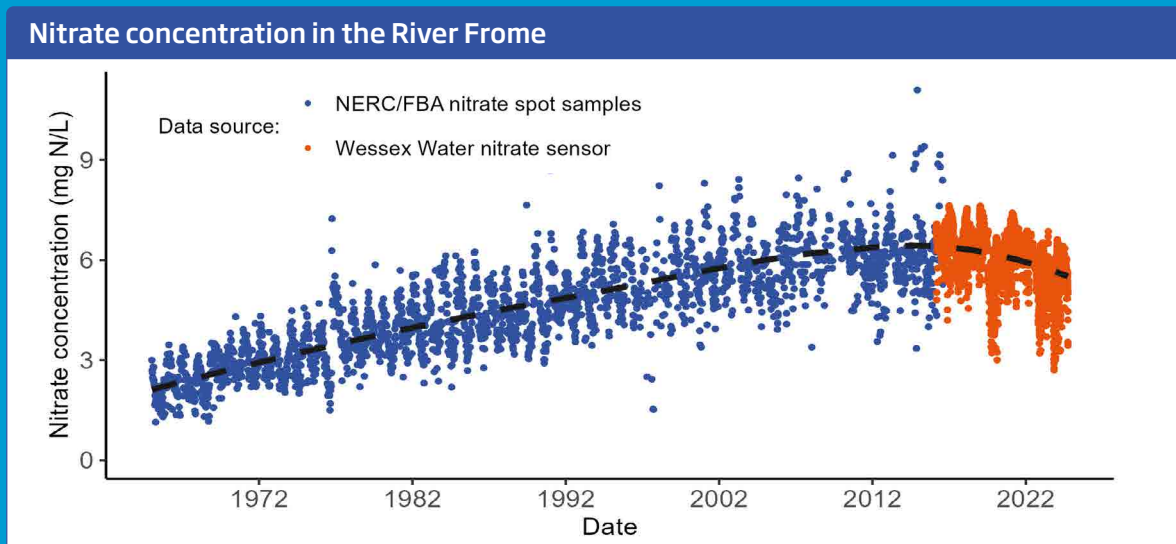


Figure 1. Daily mean river nitrate concentration at East Stoke (River Frome) from 1965 to 2024 with fitted trend line (dashed line). Data from 1965 to 2016 (blue) are jointly owned by NERC - Centre for Ecology & Hydrology and the Freshwater Biological Association (FBA). Data from 2016 onwards (orange) are owned by Wessex Water Services Ltd.



Long-term nitrate concentration and load trend on the River Frome (continued)

Figure 2 shows historical nitrate loads at East Stoke along with historical catchment rainfall during the drainage season (October - April). Loads have also shown an increasing trend during the approximate period from 1965 to 2016, in agreement with the increasing concentration trend. The red dashed line indicates the estimated maximum nitrate load limit (tonnes/yr) for the River Frome to achieve acceptable macroalgal cover in Poole Harbour (Environment Agency/Natural England, 2013). Riverine load shows much greater inter-annual variability compared to concentration because loads are strongly correlated with winter rainfall. Therefore, despite the recent decline in riverine concentrations, loads have remained high and spiked last year, driven primarily by more intense winter rainfall.

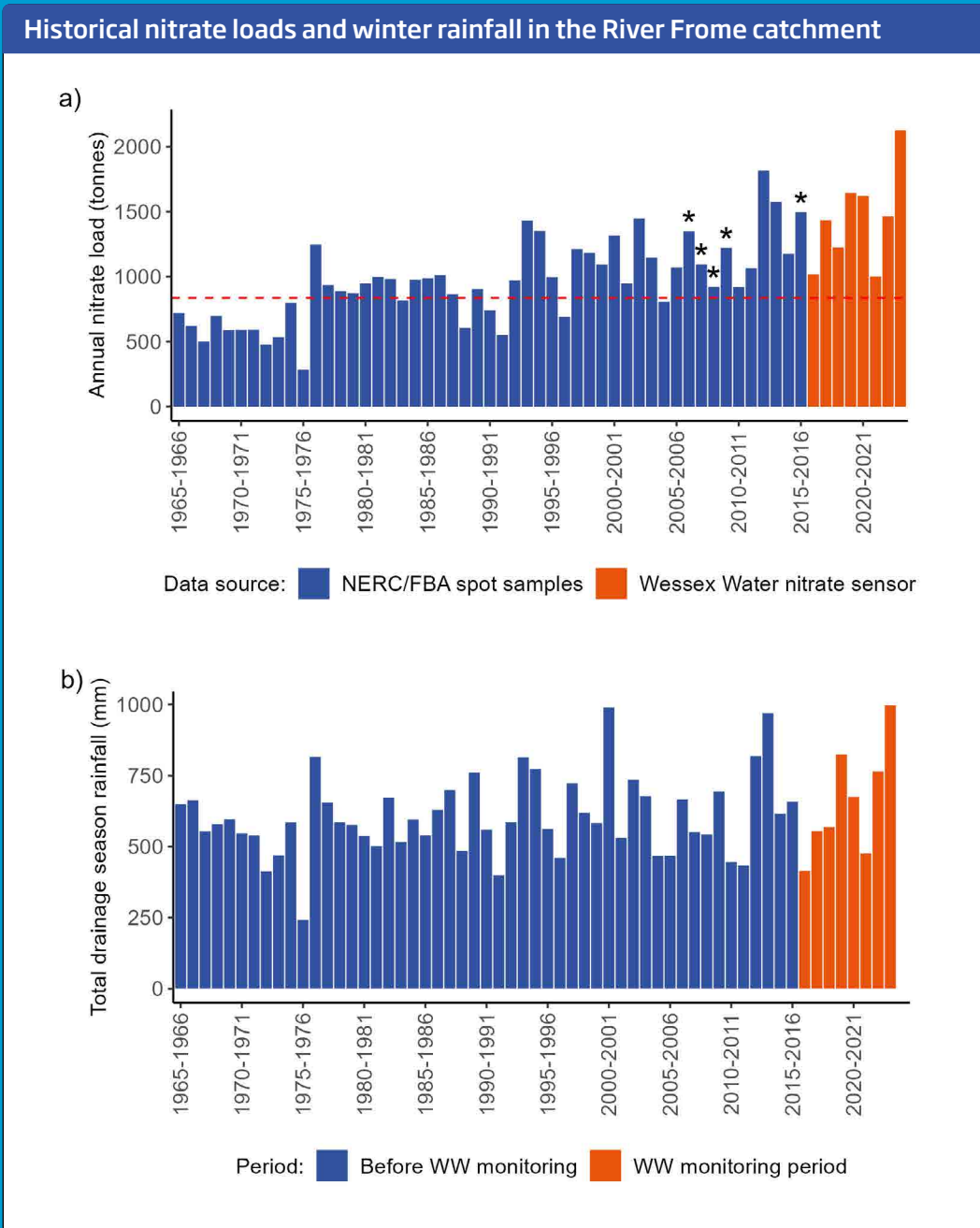


Figure 2. a) Annual nitrate load by hydrological year from CEH/FBA (blue) and Wessex Water (orange) monitoring. Note: CEH/FBA loads calculated from monthly grab samples. * indicates some data missing from year. Red dashed line is recommended maximum load limit from River Frome to avoid gross macroalgal growth in Poole Harbour (Environment Agency/Natural England, 2013). b) Poole Harbour total drainage season (October to April) catchment rainfall (mm) by hydrological year.

Rainfall, flow, concentration and load patterns from 2018 to 2024

Figure 3a shows the monthly rainfall across the Poole Harbour catchment. Rainfall patterns are broadly seasonal with drier months generally falling between April and August and greatest rainfall occurring in the winter months.

Greater winter rainfall, combined with lower evapotranspiration, drive the higher river flows between November to March (3b). River flows then recede throughout the summer months, in unison with groundwater levels, as rainfall declines and evapotranspiration rates significantly increase. Minimum river flows typically occur between August and September.

Elevated nitrate concentrations also occur during the wetter winter period leading to greater nitrate load exports during these months (3c and 3d, respectively).

Although nitrate concentrations are elevated in winter, seasonal variability is relatively modest due to stable groundwater inputs from a large legacy store of nitrate in the Chalk aquifer. Therefore, variability in nitrate load is mainly driven by rainfall and hence river flow.

Combined, the River Frome and River Piddle have averagely exported 2080 tonnes of nitrate per year into Poole Harbour since 2018. Last hydrological year (October 2023 to September 2024), combined exported load was 3,126 tonnes (37% above the mean), driven by a very wet year (total rainfall was 57% higher than the preceding seven year mean and total river flow at East Stoke and Baggs Mills were the highest recorded) (Wessex Water Services Ltd, 2025).

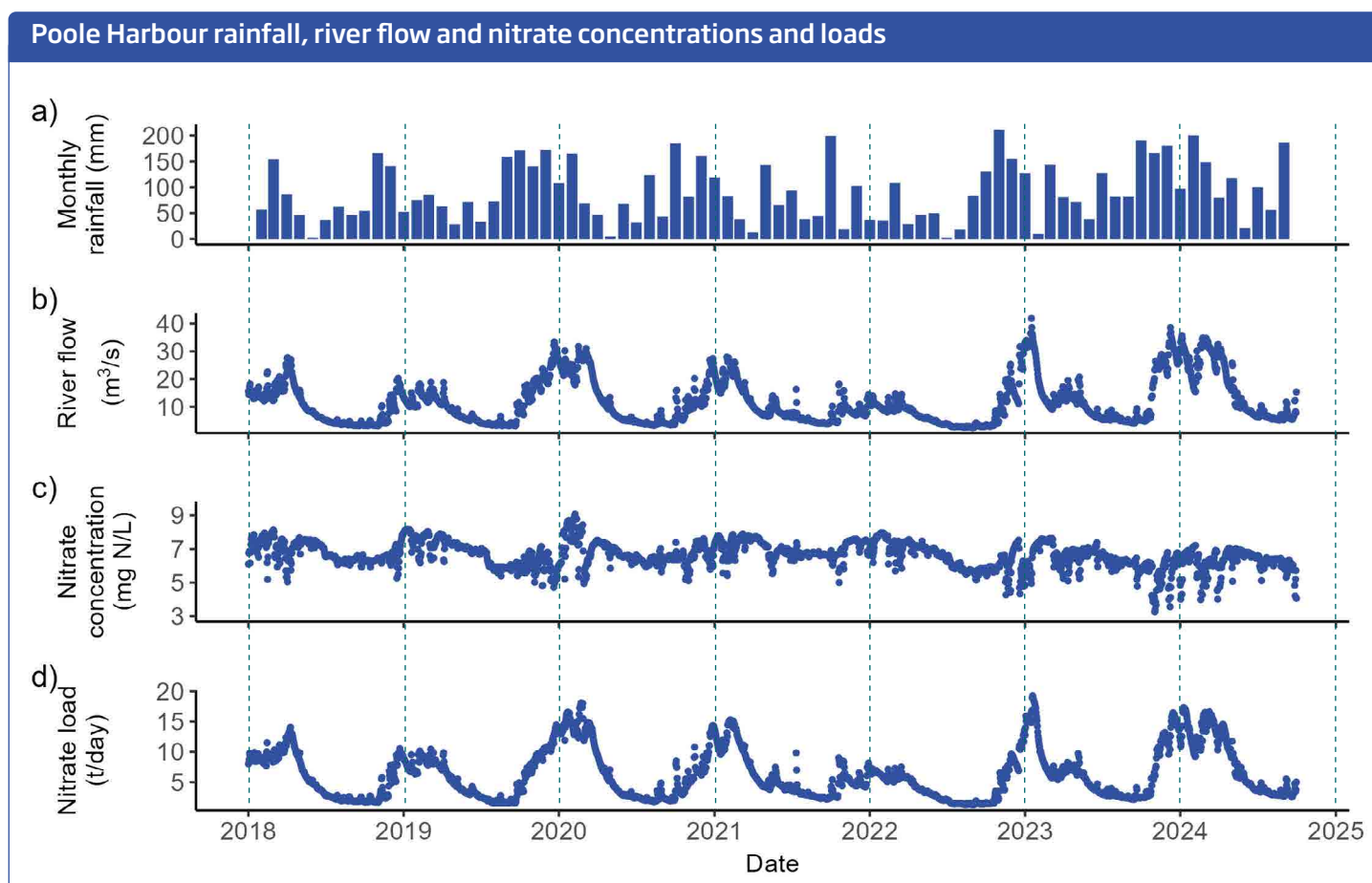


Figure 3. a) Average monthly rainfall across the Poole Harbour catchment, b) combined river flow entering Poole Harbour from the Frome and Piddle rivers, c) combined nitrate concentration entering Poole Harbour from the Frome and Piddle rivers, and d) combined nitrate load entering Poole Harbour from the Frome and Piddle rivers. Data span the period from 2018 to 2024 as River Piddle monitor installed in late 2017.



Nitrate sources and pathways

Nitrate export to Poole Harbour from the Frome and Piddle rivers are heavily influenced by human activities occurring within the catchment area (although changes in river concentration signal can be lagged by up to 30+ years due to slow transport through the Chalk aquifer). Nitrate can be diffuse-source (eg, from agriculture) or point-source (eg, public and private sewage systems). In the Frome and Piddle river catchments, the diffuse nitrate load is the largest component (approximately 90%) (Environment Agency and Natural England, 2013; Wessex Water Services Ltd, 2025).

Elevated winter nitrate concentrations coincide with the wetter conditions. Post-harvest soil nitrate residues are mobilised in rainfall and enter rivers and water bodies through both surface runoff and leaching into groundwater. Therefore, nitrate export is greatly influenced by both land management practices and winter rainfall.

A drier winter period (eg, 2021-2022) will reduce riverine nitrate loads due to fewer losses from the land, while a wetter winter (eg, 2019-2020 and 2023-2024) will result in increased nitrate mobilisation and higher nitrate loads, as we have seen this year.

Wessex Water routinely monitors nitrate and flow at its Water Recycling Centres (treated sewage discharges). Load contributions from these point sources are annually consistent, averaging 134 tonnes in the River Frome (9.8% of annual riverine N exports) and 11.3 tonnes in the River Piddle (1.7% of annual riverine N export), based on data from 2016 to 2024 (Wessex Water Services Ltd, 2025).

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

Kite, D. & Natural England, Dorset, 2023. River Frome, Dorset SSSI condition assessment. [Online] Available at: <https://www.dorsetcatchments.co.uk/media/hnzijzjm/2023-ne-full-report-river-frome-sssi-condition-assessment.pdf>

Wessex Water Services Ltd, 2025. Quantifying riverine nitrate loads in the Frome and Piddle Catchments. Internal technical note.

