



SOURCE TO STREAM

DELIVERING NUTRIENT REDUCTIONS IN UK RIVERS

JULY 2026

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This page: Old Bedford River, Norfolk, UK.

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More detailed information on the project's methodology or findings can be provided upon request.

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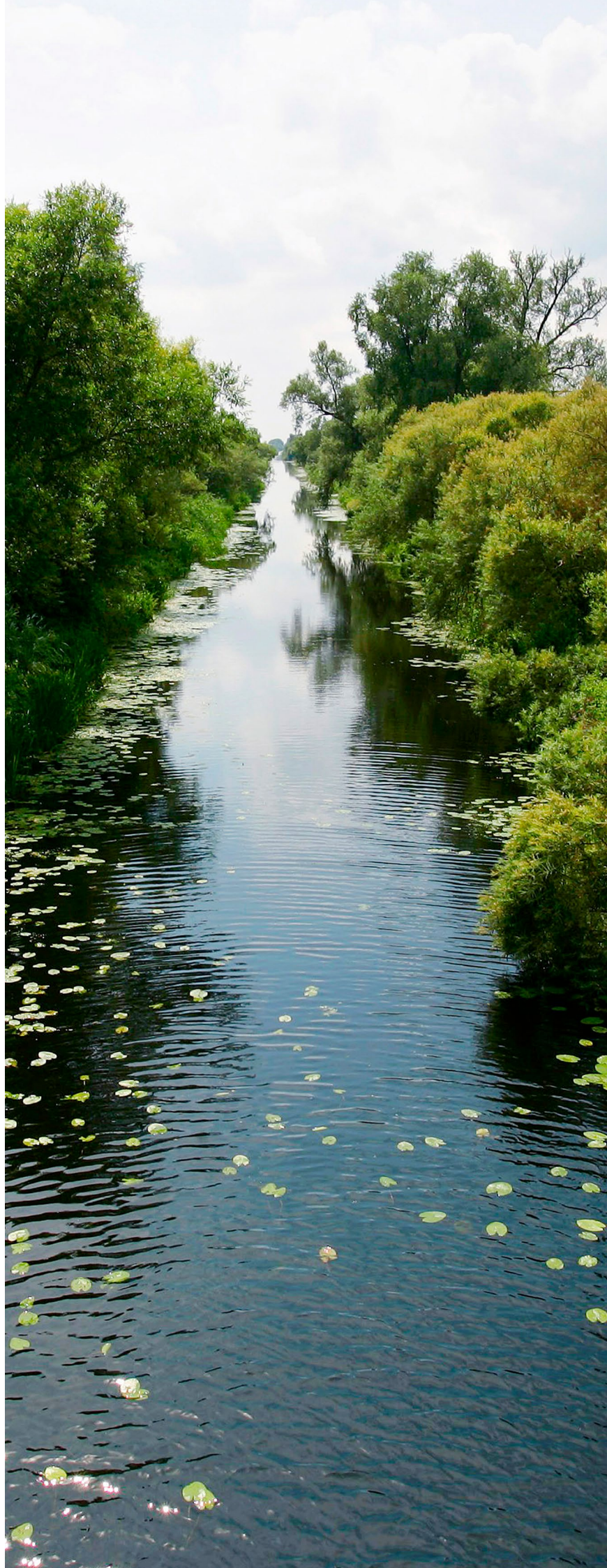
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SUMMARY AND RECOMMENDATIONS

The UK Government has committed, through the Environment Act and Environmental Improvement Plan, to improving water quality and reducing nutrient pollution in rivers. Nutrient pollution remains the primary reason rivers fail to achieve good ecological status, with only ~14% of rivers in England currently meeting this standard.

In its January 2026 white paper, *A New Vision for Water*, Government recognised agriculture as responsible for around 40% of river and groundwater pollution, but policy attention has remained disproportionately focused on water companies. While wastewater treatment is a major source of phosphorus pollution, agriculture is responsible for almost two-thirds of nitrogen losses into UK water systems, meaning farm pollution must be addressed if statutory targets are to be met.

This mini report draws on research commissioned by WWF-UK to provide policy recommendations for reducing both nitrogen and phosphorus pollution in rivers. It is intended to inform forthcoming freshwater policy, including the Clean Water Bill, agricultural regulation updates, and future Sustainable Farming Incentive (SFI) schemes.

The evidence suggests that the policy tools needed to deliver nutrient reductions already largely exist, including Farming Rules for Water (FRfW), Nitrate Pollution Prevention Regulations (NPPR), Silage, Slurry and Agricultural Fuel Oil (SSAFO) regulations, Asset Management Period 8 (AMP8)¹ phosphorus stripping, SFI schemes, Catchment Sensitive Farming advice, and Environment Agency monitoring systems.

The challenge is therefore not policy redesign, but improving implementation, targeting, compliance, and monitoring.

WWF-UK's research shows meaningful nutrient reductions are technically achievable. AMP8 wastewater improvements and stronger compliance could deliver significant phosphorus reductions in the near term, while agricultural measures could substantially reduce nitrate and overall nutrient loads. However, legacy nutrient stores in soils and groundwater, and long environmental residence times, mean reductions in nutrient inputs will not immediately translate into ecological recovery. Defra should therefore adopt catchment-specific nutrient planning rather than relying solely on generic uptake targets.

¹ AMP8 is the eighth Asset Management Period for the UK water industry, covering 2025–2030, and it is the regulatory cycle in which water companies plan and deliver major investment in infrastructure, environmental improvements, and compliance. It is overseen by Ofwat, with delivery involving water companies, the Environment Agency, and Defra.

RECOMMENDED ACTIONS TO DELIVER MEANINGFUL NUTRIENT REDUCTIONS

- 1 Strengthen compliance and enforcement:** Strengthen agricultural and water-company compliance, alongside regulatory reforms and delivery of AMP8 investments, accounting for legacy nutrient stores;
- 2 Expand effective farming measures:** Scale up proven farming measures by prioritising SFI actions with the strongest evidence for reducing nutrient pollution and protecting payment rates for these interventions;
- 3 Address both current and legacy nutrient pollution:** Adopt a dual approach that:
 - reduces current nutrient delivery to rivers through stronger compliance, targeted land-management measures, and pathway interruption; and
 - draws down legacy nutrient stores over time through tighter nutrient load control, mandatory farm-level nutrient budgeting in priority catchments, and catchment-scale accounting of soil phosphorus and groundwater nitrogen.
- 4 Introduce catchment-specific approaches:** Develop more targeted catchment-based approaches that reflect local ecological status, geology, nutrient sources, and legacy pollution profiles;
- 5 Rebuild and modernise water-quality monitoring:** Strengthen water-quality monitoring by halting Environment Agency station closures, modernising monitoring infrastructure, and rationalising monitoring sites;
- 6 Develop a nitrogen standard for rivers:** Develop a scientifically robust nitrogen standard for rivers to complement existing phosphorus standards; and
- 7 Integrate climate adaptation into nutrient policy:** Support measures such as riparian shading, wetlands, and baseflow protection that deliver both water-quality and climate-resilience benefits.

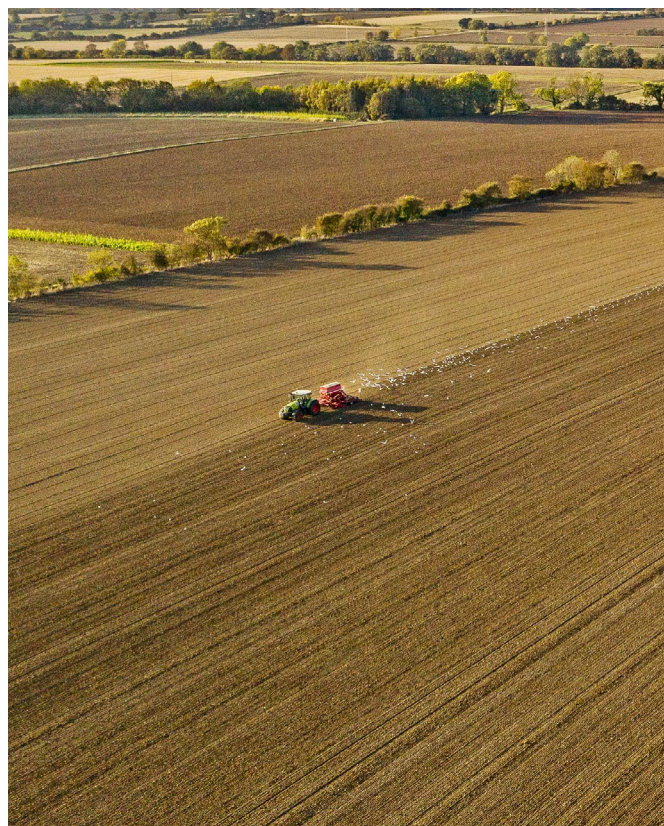
Achieving Environment Act nutrient targets will require a stronger focus on agricultural pollution, improved enforcement and monitoring, and more locally tailored, evidence-led catchment management.

BACKGROUND TO WWF-UK CATCHMENT MODELLING PROJECT

WWF-UK commissioned a research project into reducing diffuse nutrient pollution to provide evidence of the most effective actions across catchments and the scale of adoption needed to deliver against water quality targets. The project was comprised of two stages:

Literature review of evidence

Firstly, we assessed the peer-reviewed and grey-literature evidence base on the effectiveness of on-farm measures (such as buffer strips, cover crops, wetlands, nutrient management) at reducing diffuse nitrogen and phosphorus pollution. As part of this, we identified where evidence is strong, and where gaps remain.



Catchment modelling

To build a realistic representation of different actions, WWF-UK then commissioned Water Resource Associates (Prof. Paul Whitehead, Oxford) and Aquascope to build models of five UK catchments:² River Wye (England/Wales), East & West Cleddau (Wales), Stiffkey & Glaven (Norfolk).

These catchments were selected because they represent a range of scales, geologies and nutrient pressure profiles. The Wye is a large, mixed land-use river system crossing the England–Wales border; the East and West Cleddau are smaller, agriculturally intensive Welsh catchments with significant legacy nutrient challenges; and the Stiffkey and Glaven are lowland chalk streams in North Norfolk, representative of the wider chalk-stream environments under sustained farming pressure that have attracted significant parliamentary attention, including Pippa Heylings MP's Private Members' Bill on Chalk Streams and amendments tabled during the passage of the Planning and Infrastructure Act, and are focus areas for WWF-UK's engagement in landscape work.³ As agriculture policy is devolved, modelling rivers such as the Wye (which is cross-border) and the Cleddau, enabled us to analyse key contexts in England and Wales.

² This modelling was done using process-based INCA models (INCA-N, INCA-Peco) for each catchment. These simulate daily hydrology, nutrient transport and in-river chemistry, with strong calibration ($R^2 > 0.9$).

³ <https://www.wwf.org.uk/learn/wholescape>

As part of the project, six scenarios were designed by WWF-UK to assess potential nutrient management options:

1 Baseline: current practices;	4 Incentive high – 100% uptake of most effective SFI/SFS-type incentive schemes;⁴
2 Compliance: 100% compliance for water companies and farmers/ land managers with existing regulations in England and Wales as well as phosphorus stripping by the Water Companies and Welsh Water under the AMP8 cycle of investments over the next 5 years;	5 Voluntary low – Targeted advice (e.g. CSF) on 50% of farmed area, in addition to incentives;⁵
3 Incentive low: additional uptake of most effective SFI (England) and SFS (Wales) type measures to 75% of agricultural area;	6 Voluntary high – Targeted advice (e.g. CSF) on 75% of farmed area, in addition to incentives.



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⁴ These actions include for example direct drilling / precision equipment, hedgerow buffers, riparian buffer strips, field buffers, and improved grassland management.

⁵ Additional voluntary actions included, for example, maize suitable fields, poultry unit management, exporting manure, and livestock control.

WHAT HAS WWF-UK'S RESEARCH FOUND?

Compliance and wastewater investment are the most important near-term levers in reducing phosphate pollution, but extensive measures in agriculture needed for longer-term outcomes

The modelling tested a scenario of 100% compliance across relevant water company and agricultural regulations. For phosphorus, the modelling suggests that full compliance with existing regulatory requirements (across agriculture and planned AMP8 phosphorus stripping at sewage treatment works) delivers substantial near-term reductions in in-river soluble reactive phosphorus (SRP) at 15–35% in catchment outlets (Figure 1). The modelling suggests AMP8 delivery is the most important near-term lever for phosphorus.

For nitrogen, modelling suggests that agricultural compliance with regulations such as the Farming Rules for Water (FRfW) and Nitrate Pollution Prevention Regulations (NPPR) are effective in reducing nitrogen pollution. For catchments where regulation is not sufficient to deliver targets, additional incentives and voluntary measures can achieve significant further reductions in the short term, if delivered at scale. 100% compliance with farming regulations delivered approximately 9–27% reductions in in-river nitrate concentrations beyond the baseline across the five modelled catchments, with the largest responses in the Glaven (~27%) and Wye (~22%) and the smallest in the Stiffkey (~9%) where chalk-aquifer legacy nitrogen dominates (Figure 2).

On-farm actions are effective but create different results for nitrogen and phosphorus

When modelling the effect of the uptake of sustainable farming practices, such as SFI actions, we found different methods are needed to address on-farm nutrient loss for phosphorus and nitrogen. Overall, the modelling suggests on-farm actions are more effective at reducing nitrate than phosphate in the short term. In particular, rapid reductions in in-river soluble reactive phosphorus (SRP) from on-farm physical measures are limited and variable, and in catchments failing phosphate/SRP targets a longer-term route is to reduce the catchment nutrient budget through soil P drawdown (enabled by soil testing and nutrient budgeting).

Nitrate is more mobile as a nutrient and responds more quickly to changes in land management such as increasing buffer strips and constructed wetlands.

Many on-farm measures which intercept pollution pathways such as buffer strips and wetlands are better at reducing particulate or total phosphorus than the dissolved phosphorus (soluble reactive phosphorus or 'SRP').

Therefore, while sustainable farming scheme actions can prevent nitrogen loss into waterways, the most effective way of reducing phosphorus loss is preventing further application, such as through soil testing, nutrient budgeting, lower application rates, and better timing of applications.

However, physical on-farm actions are still important as they deliver co-benefits for sediment control, riparian shading, habitat and climate resilience, and they contribute to nitrate and total phosphorus load reduction. On a catchment-level, the modelling indicates that high uptake (i.e. approximately double current levels) is required to produce meaningful changes in in-stream concentrations in some catchments.

Legacy nutrients need addressing separately to rapid diffuse nutrient losses

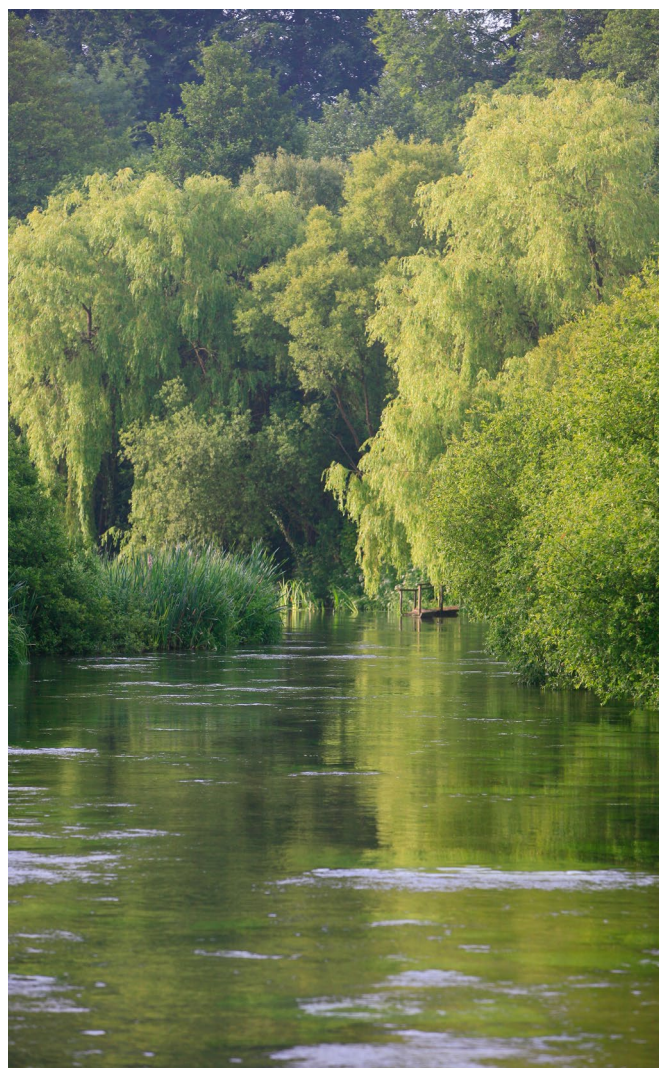
The modelling also suggests that across several catchments, especially chalk streams or streams with high historical nutrient loading, there is a substantial delay to river quality changes due to stores of nitrogen and phosphorus in soils, sediments and groundwater. For example, even under the most extensive intervention scenarios modelled (combining compliance, incentives and targeted advice), ecological thresholds may not be met. In the Stiffkey model, nitrate concentrations remained roughly 1.7× the ecological threshold (≈ 6.0 mg N/L vs a hypothetical 3.6 mg N/L 'Good/Moderate' boundary) even under the highest voluntary-uptake scenario, due to legacy stores in the chalk aquifer.

These results suggest that legacy stores represent a distinct problem requiring dedicated interventions in parallel with measures to reduce mobilisation and disrupt pathways, such as farm and catchment nutrient budgets. International evidence supports this two-track approach: Denmark's successive National Action Plans since the mid-1980s have delivered ~30–40% reductions in stream nitrogen concentrations and loads, demonstrating that sustained input controls do work, but with a 10–15 year groundwater lag (longer in chalk hydrogeology) before surface waters fully respond. The lesson for UK chalk catchments such as the Stiffkey is that input controls and dedicated legacy interventions need to run concurrently, not sequentially.

Catchment differences have a substantial impact on reductions in water quality

The modelling shows substantial variation between catchments. For example, the model suggests the East Cleddau already meets Good Ecological Status for phosphorus and meets our assumed ecological threshold for nitrate under baseline conditions. However, the Stiffkey has baseline nitrate concentrations more than double the ecological threshold and these levels continue to remain high even under the most extensive intervention scenario.

Variations in catchments are due to a range of factors such as nutrient sources (e.g. wastewater or agricultural pollution), their geology (e.g. chalk aquifers store large amounts of legacy nitrogen whereas clay catchments respond faster to surface measures), and the size the legacy stores already present in the water.



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PHOSPHORUS (P) — % CATCHMENT AREA MEETING GES FOR PHOSPHATE

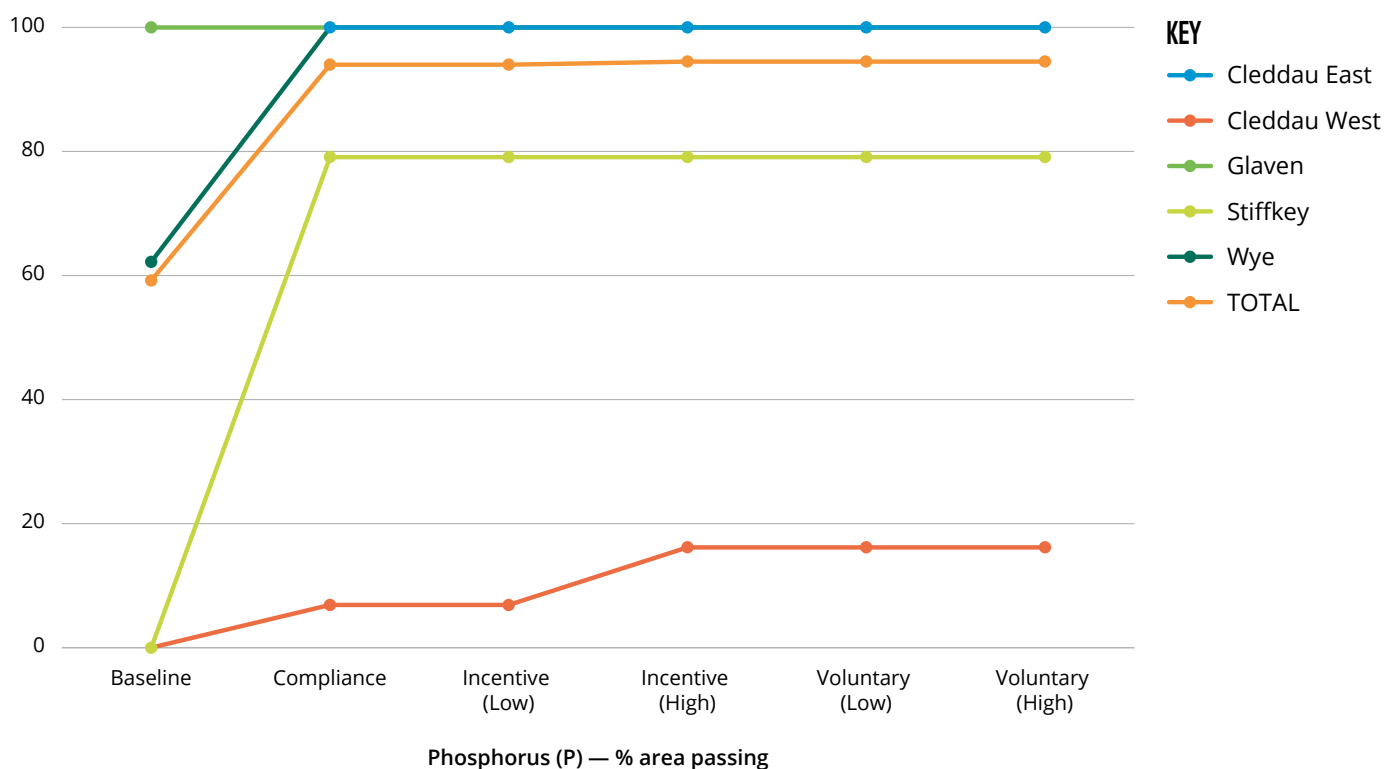


Figure 1: % of overall catchment area passing 'Good' status threshold for phosphate, under each policy scenario.

NITRATE (N) — % CATCHMENT AREA BELOW 3.6 MG/L - N

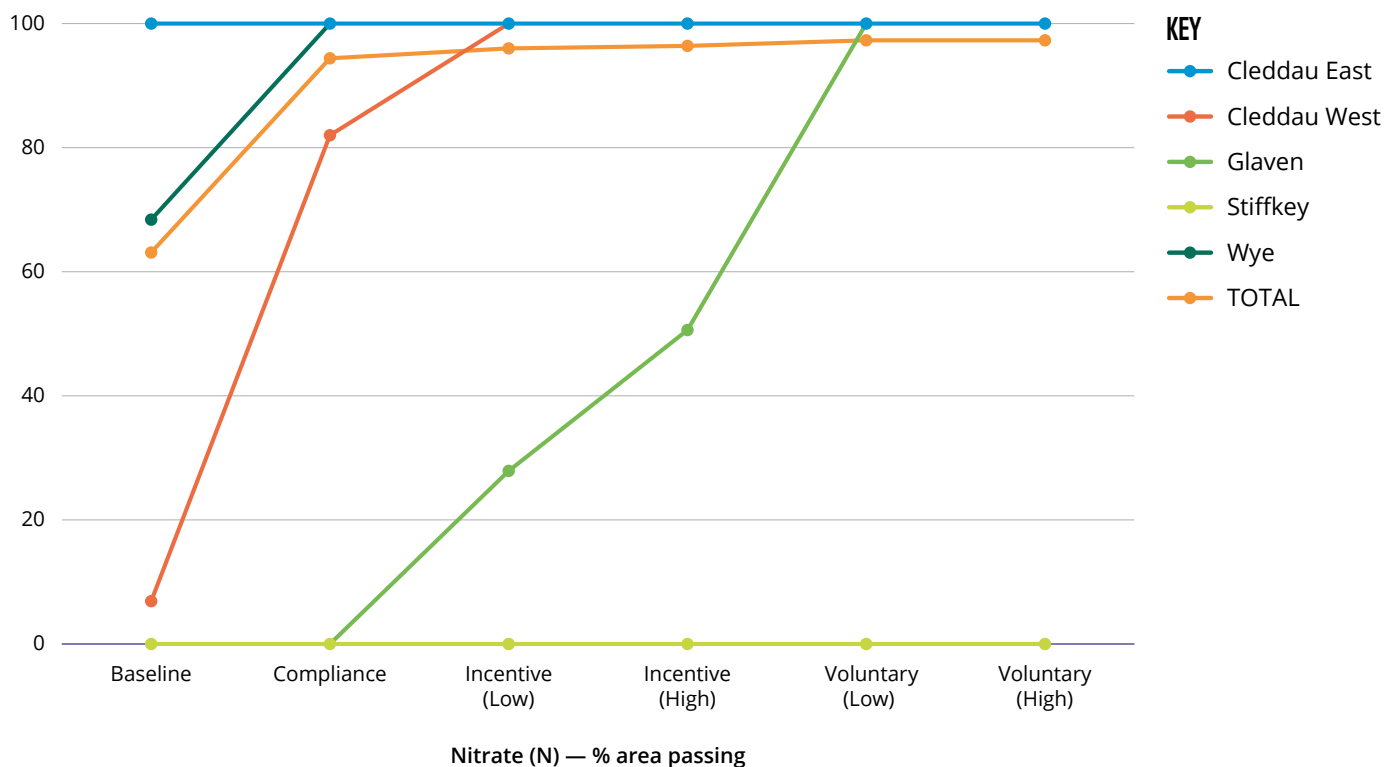


Figure 2: % of overall catchment that are below the assumed ecologically relevant nitrate threshold, under each policy scenario.

Reducing nutrient pollution requires joined-up action across multiple Defra teams and Ministerial portfolios

Responsibility for addressing freshwater pollution largely sits within the water Ministerial portfolio. However, with around 40% of freshwater pollution from agricultural sources, many of the most effective levers — AMP8, the FRfW, NPPR and SSAFO regulations, and sustainable farming schemes such as SFI — sit under farming policy and are regulated under separate legislation. A holistic approach across portfolios is needed to address all major sources of nutrient pollution and to avoid gaps where wastewater and agricultural levers are managed in isolation.

There is insufficient evidence to track progress against targets

Our research has found four significant gaps which prevent the successful monitoring of water quality and the assessment of policy progress:

Environment Agency sampling capacity has declined: There is limited real-time data on water quality, which makes it difficult to diagnose in-river issues or measure impact of interventions on waterways. Citizen science programmes provide valuable coverage but, on their own, are not yet consistent enough in methodology and quality assurance to substitute for statutory monitoring.

There is no formal nitrate standard in England or Wales under the WFD framework: nitrogen monitoring is driven by drinking water protection limits, which are not aligned with ecological thresholds. Without a meaningful nitrogen target, it is difficult to measure one of the main drivers of ecological status in UK waterways.

Livestock data — particularly for poultry — is inconsistent across sources: Defra national

figures, APHA records and local council planning data on poultry-unit numbers and bird stocking densities frequently disagree, particularly in catchments such as the Wye where intensive poultry is the dominant agricultural pressure. Without a reconciled, catchment-resolved livestock dataset, both modelling and targeted enforcement are weakened.

There is a tension between instream soluble reactive phosphorus (SRP) targets used for the Water Framework Directive (WFD) targets and load-based targets used within the EIP. Agricultural nutrient loads to rivers cannot be directly measured at national scale and will largely be estimated through modelling. There is a real risk that load-based targets are reported as met even where in-river concentrations remain high because of legacy stores, groundwater lags and catchment-specific hydrology. Defra should distinguish clearly between modelled load reductions and observed river condition and avoid presenting progress against agricultural load targets as equivalent to ecological recovery.

Climate change is now an important driver of nutrient-related ecological harm and must be treated as a finding, not a future risk

Our modelling, combined with a Cardiff University study (2024), found that elevated temperatures and reduced summer flows are key drivers of algal blooms in the Wye, and these pressures are already being amplified by climate change. Reduced dilution and warmer water mean that even unchanged nutrient loads will produce worsening ecological outcomes. Nutrient policy therefore needs to be designed to deliver ecological recovery under future climate conditions, not historic baselines, and to capture the co-benefits of measures that reduce both nutrient pressure and climate-driven ecological stress (riparian shading, floodplain reconnection, wetland creation where hydrologically appropriate, and measures that maintain summer baseflows).



POLICY RECOMMENDATIONS

In response to the above findings, WWF-UK recommends the UK Government should:

1 Strengthen compliance and enforcement

Recent funding for Environment Agency farm inspections is a step forward, but inspection capacity alone is unlikely to deliver compliance at the rates needed: current compliance is low across multiple measures, and inspection coverage even at the funded level reaches only a fraction of farms each year. Defra should pair enforcement with regulatory design that makes compliance straightforward by default — including the FRfW reforms currently under review through the ‘addressing freshwater pollution from agriculture’ programme — and use the Corry regulatory review as an opportunity to remove ambiguity in farming rules. Compliance baselines should also be re-examined, as some current baselines do not adequately address legacy nutrient stores or modern intensification levels.

As Defra reviews and streamlines the FRfW, NPPR, and SSAFO regulations as part of the ongoing ‘addressing freshwater pollution from agriculture’ programme, decision makers should retain or improve on FRfW baselines, while prioritising ease of compliance. This could be achieved by considering more prescriptive regulations, rather than outcomes-based regulations like the current FRfW drafting.

Our modelling suggests that closing the compliance gap across agriculture and water companies provides the largest and fastest nutrient reductions in many catchments and is an essential baseline for catchments requiring further actions to improve ecological status.

2 Expand effective farming measures

Within the SFI26 framework, and in any future iterations of the scheme, Defra should prioritise the actions with the strongest evidence of reducing nutrient pollution — wooded and scrub buffer zones, constructed and restored wetlands, cover crops, and the riparian-shading and habitat actions that deliver climate co-benefits — and protect their payment rates against further erosion. These actions should be targeted by nutrient type, pollution pathway and catchment risk rather than rolled out by generic uptake percentages, with design and implementation guidelines that ensure they deliver the intended water-quality outcome and not just headline area covered.

3 Address both current and legacy nutrient pollution

Defra should introduce a dual approach strategy to tackle different pathways of nutrient pollution. For example, addressing rapid diffuse nutrient losses from agricultural applications via recommendations 1 and 2 will have an effect in reducing total phosphorus and nitrogen pollution, but rapid reductions in in-river soluble reactive phosphorus (SRP) from on-farm physical measures are limited and variable. While more responsive to interventions, instream concentrations of nitrate will remain problematic in some catchments due to legacy stores. In catchments failing phosphate/SRP targets, or ecologically meaningful nitrate targets, longer-term improvements require reducing the catchment nutrient stores through soil/groundwater nutrient drawdown, enabled by soil testing, and farm and catchment nutrient budgeting.

However, addressing legacy nutrients in soils, sediments and aquifers requires a distinct workstream. Defra should mandate farm-level nutrient budgeting (linked to soil testing on a defined cycle) for holdings in priority catchments and develop catchment-scale nutrient budgets that quantify the legacy P pool and groundwater N store. Over time, this enables targeted soil-P drawdown in catchments failing soluble reactive phosphorus (SRP) targets and a credible recovery trajectory for chalk catchments where groundwater lag dominates. Without this, even successful policy focused on measures that address nutrient pathways only will not deliver ecological recovery in legacy-affected catchments on the timescales the Environment Act targets imply.

4 Introduce catchment-specific approaches

As compliance is not sufficient for some catchments to reach good ecological status, Defra should use spatial mapping to introduce targeted approaches which address the needs of specific catchments or sub-catchments. This could be achieved by targeted measures such as in those in the NPPR for at-risk catchments, enhanced payments for specific high-effect actions. This action could be backed up by non-regulatory interventions such as Catchment Sensitive Farming advice and catchment partnerships. As noted in our findings, different catchments may require bespoke actions to bring them into good ecological status depending on their geology and the type of nutrients.



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5 Rebuild and modernise water-quality monitoring

Discontinuation of monitoring at many Environment Agency stations in recent years represents a major erosion of the national capacity to understand the controls on water quality and the direction and magnitude of any changes occurring. Because detection of change relies on long-term records, every station closure compounds the problem: trends already underway become harder to identify, and the impact of new interventions becomes harder to attribute. Defra should commit to a multi-year investment programme to halt and reverse station closures and rebuild EA sampling networks, including high-frequency nutrient and continuous flow monitoring at catchment outlets and key sub-catchment nodes.

Investment should also modernise how monitoring is done, drawing on the range of technologies and methods now available (including remote sensing, real-time sensor networks, improved laboratory and molecular techniques, and accredited citizen science) so that the network is fit for future strategic delivery. Alongside expansion, Defra should rationalise the existing network, so resources are deployed where they best support understanding of status and trends, broaden the range of pollutants routinely monitored (including emerging contaminants and an ecologically meaningful nitrogen metric), and require inter-calibration whenever new sampling or analytical methods are introduced so long-term trend detection is preserved. Accredited citizen-science and partnership monitoring should be formalised as a complement to statutory data, and the divergent livestock datasets identified in Finding 2.5 reconciled so that pressures and responses can be matched. This recommendation pairs with Recommendation 6: monitoring without an ecologically meaningful nitrogen target risks measuring the wrong thing well.

6 Develop a nitrogen standard for rivers

Defra should develop an ecologically meaningful nitrogen standard for rivers, alongside existing phosphorus standards. Current targets reduce agricultural nitrogen loads, but do not define what level of in-river nitrate or total nitrogen is needed for ecological recovery. This is a significant gap: England does not currently have a nitrogen-based environmental quality standard for rivers, despite evidence that excess nitrogen contributes to eutrophication, algal growth and ecological degradation. The Wye is a clear case in point: a Cardiff University study commissioned by the Wye and Usk Foundation (2024) found that current phosphate levels in the Wye are mostly within Special Areas of Conservation targets, while elevated nitrogen concentrations are now also an important nutrient driver of algal blooms, although low flows, high water temperatures and light availability remain dominant factors overall. This implies a phosphate-only regulatory regime is no longer sufficient. WWF-UK's modelling shows that nitrate is responsive to agricultural interventions, but legacy nitrogen in groundwater means some catchments, especially chalk streams, may remain above ecological thresholds without a clear long-term recovery target.

7 Integrate climate adaptation into nutrient policy

Defra should prioritise measures that reduce both nutrient pressures and climate-driven ecological stress, including riparian shading, floodplain reconnection, wetland creation where hydrologically appropriate, and measures that maintain summer baseflows. Climate change will reduce dilution, increase water temperature and raise algal bloom risk, so nutrient policy should be designed to achieve ecological recovery under future conditions, not historic baselines.





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