Freshwater Habitats Trust

Headstart

Using headwater catchments to kickstart nature recovery

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Freshwater Habitats Trust

Freshwater Habitats Trust is the UK's leading charity for all freshwaters. As an evidence-based conservation organisation, we carry out scientific research and practical conservation work to protect life in freshwater. With our partners, we are building the Freshwater Network, a national network of wilder, wetter, cleaner and connected freshwater landscapes, to reverse the long decline of freshwater wildlife.

A headwater stream in the New Forest National Park

Summary

The Headstart approach aims to harness the power of headwater catchments to drive nature recovery across England and Wales. Focusing on smaller, upstream freshwater habitats, the project takes a targeted, cost-effective, scalable approach to improve water quality, rapidly restore biodiversity and strengthen ecosystem resilience.

The issue

Despite decades of investment, improvements in the water quality and biodiversity of river systems have stalled.

Traditional approaches, focusing on larger rivers, are struggling to make headway against pervasive pollution from multiple upstream sources.

Why headwaters?

Though they're individually small, headwater streams are ubiquitous, and together their catchments cover more than half of England and Wales. Restoring headwater catchments - including their networks of ponds and wetlands - will kickstart nature recovery across the river network and the wider landscape.

Headwater catchments are easier to restore, because their small catchments mean pollution sources are fewer, more identifiable and easier to manage.

Restored headwaters will be:

- **Sources of resilience** – networks of unpolluted headwater habitats can act as refuges for sensitive plants and animals, and a bridgehead for recolonisation of downstream reaches.
- **A visible success story** – because they're small and respond quickly to restoration, significant improvements can be seen within years rather than decades, demonstrating the effectiveness of well-targeted investment and rebuilding public trust.

Updating policy and practice

Water policy needs to evolve to reflect the importance of headwaters and other small freshwater habitats.

By altering regulatory drivers, upgrades to key small wastewater treatment works can be prioritised, alongside cross-catchment action to restore freshwater networks. These interventions will have disproportionate benefits for freshwater biodiversity.

What will Headstart achieve?

Headstart aims to kickstart nature recovery, and address urgent challenges for river systems, using the pragmatic, science-driven strategy of starting in the headwaters and working down.

Outsized biodiversity value of small freshwater habitats

Because of their small size, headwater catchments are particularly amenable to restoration. Headwater catchments can therefore be used to drive rapid progress against nature recovery goals.

Historically, the most important freshwaters were assumed to be larger rivers and lakes. Over the past two decades, mounting evidence has revealed that, in most places, smaller waters are the primary hotspots of freshwater biodiversity.

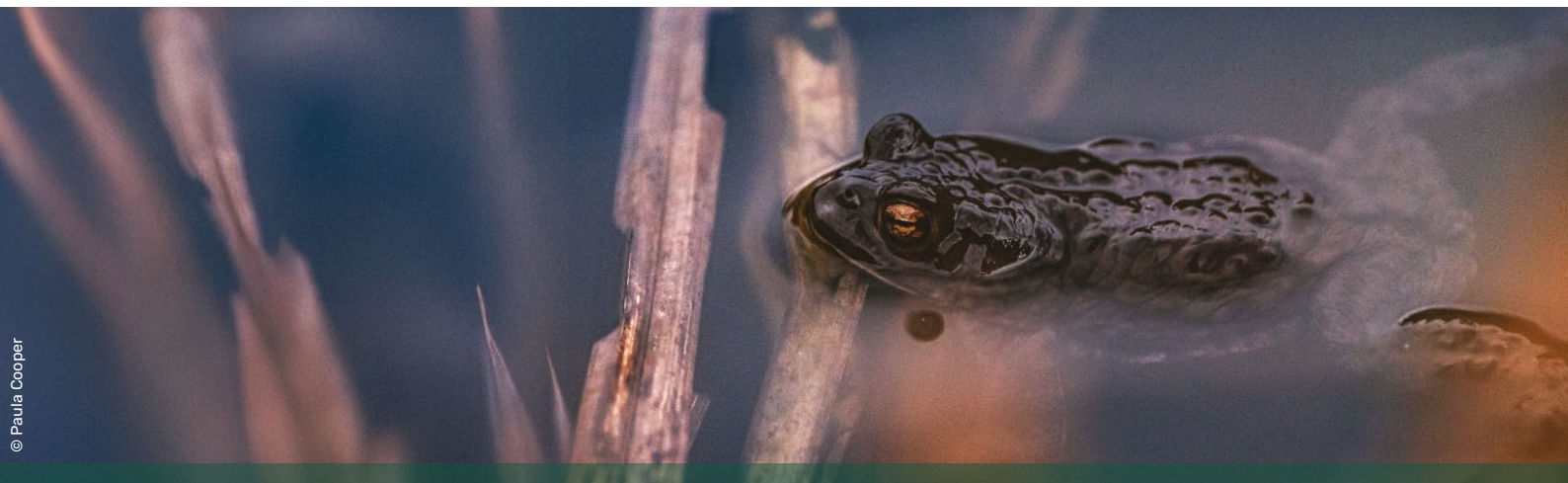
Objectives

- Significant biodiversity gains through the creation and restoration of clean water habitats.
- Persistent improvements in water quality and cross-catchment ecosystem resilience.
- Rapid progress towards nature recovery goals.

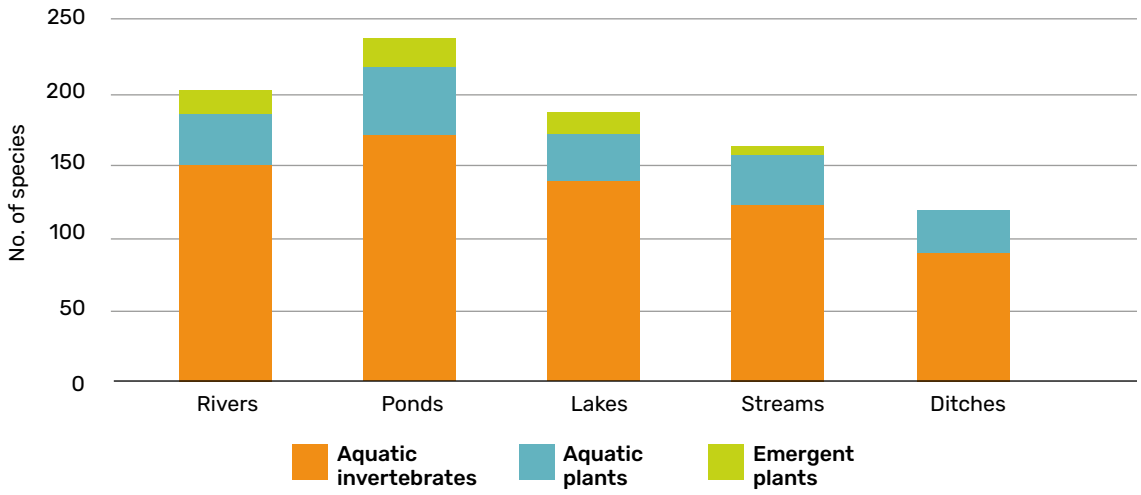
In most places, small waters (ponds, small streams, ditches) collectively support more biodiversity than larger waters (lakes, rivers).

Headwater streams make up more than 70% of Britain's river network by length, running for 150,000 km in England alone.[1–3] Headwaters often contain unique species, as well as most of the species present in downstream reaches of rivers. Healthy headwater streams provide vital spawning and nursery habitats for declining migratory salmonids.[4]

Ponds have become widely recognised as keystone habitats for freshwater biodiversity. They have repeatedly been found to support more freshwater plant and animal species at a landscape scale than rivers or large lakes, often including a high proportion of rare species.[5–8] In degraded landscapes, ponds can offer a clean water refuge, supporting pollution-sensitive species unable to survive in impacted rivers or lakes.[2]



Ponds are vital habitats for the declining Common Toad (*Bufo bufo*).



The number of aquatic plant, emergent plant and aquatic invertebrate species in all freshwater habitats (Gamma richness) across an 80 km² area of Oxfordshire/Wiltshire. Ponds support a surprisingly large number of species in the landscape. Adapted from Williams et al., 2004.

Headwater wetlands, such as springs and valleyhead fens, are the true sources of many of our rivers and streams, and among the most endangered habitats in Europe. England and Wales host a significant portion of Europe's surviving alkaline fens. Headwater wetlands support rich species assemblages, including specialists which are not found in other habitats.[10,11]

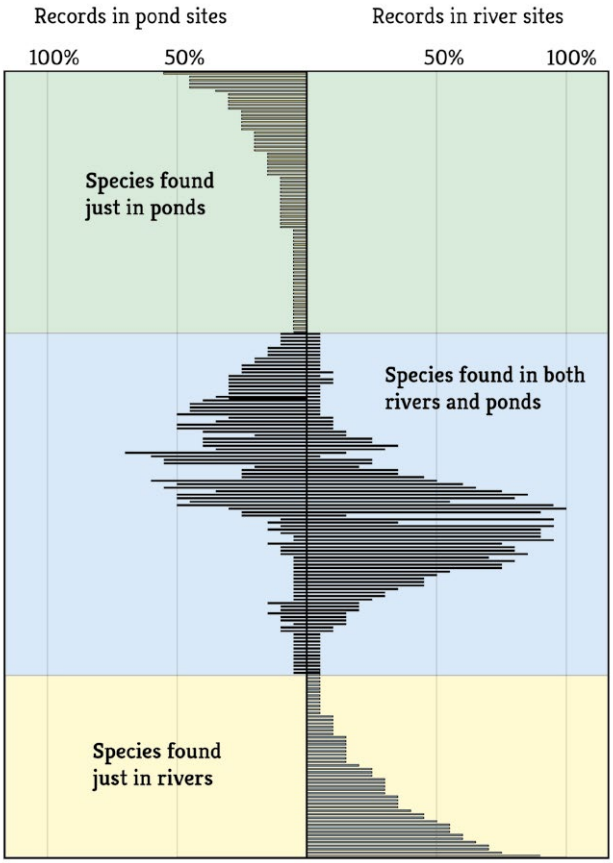
The role of small waters in ecological networks

As the science of freshwater ecology has developed, the interconnected nature of freshwater ecosystems - and the critical value of habitat networks - has become increasingly evident.

Although some freshwater species are habitat specialists, favouring a single habitat type, many are more catholic in their tastes, and are found in standing and running waters of multiple types. This includes the vast majority of freshwater plants, and almost half of all freshwater invertebrates.[2,12]

Metapopulations of freshwater species exist across inter-reliant networks of running waters, standing waters and wetlands. These connections allow species to spread between sites, recolonise after disturbances, and maintain genetic diversity.[13,14] This interconnectedness underpins the resilience of freshwater ecosystems in the face of pressures including pollution and climate change.[14,15]

Freshwater ecosystems function across interdependent networks of running and standing waters. Small waters are vital in maintaining connectivity and resilience across these networks.



Aquatic invertebrate species' occurrence in pond and river sites across an 80 km² area of Oxfordshire/Wiltshire. Most invertebrates live in both still and running waters. Data from Williams et al., 2004.

A lesser diving beetle (*Acilius sulcatus*), a common inhabitant of ponds, lakes and slow-flowing running waters.

Headwaters are, of course, the starting point of our rivers. Improvements to headwater health therefore cascade to downstream reaches, including through reduced transport of pollutants and increased supply of colonist plants and animals, facilitating faster recovery across the river network.[16,17] Like all freshwater habitats, headwater streams are connected indirectly to ponds and other 'offline' waters, which link running waters across catchments, as well as themselves contributing greatly to catchment-level freshwater biodiversity.[2,5,6,15]

Advantages of working in small catchments

Because of their position at the top of the river network, headwaters have small catchments – often as little as 100 hectares in area. By contrast, large rivers generally have catchments of many thousands of hectares.[18] This small catchment size means that restoration measures, applied over a relatively small land area, can deliver rapid environmental benefits.

A headwater catchment will almost invariably contain far fewer land holdings than a river catchment. This means that the impacts of diffuse agricultural pollution on freshwater can feasibly be fully addressed through catchment measures - unlike in large downstream catchments.[19]

Similarly, there are likely to be fewer point sources of pollution (such as wastewater treatment works), and those present are readily identifiable, so their impacts can be more easily resolved.

Because of their small catchments, small waters are more likely to be protected from pollution, and easier to clean up if they're polluted.

The Headstart approach

Headstart focuses on re-establishing pristine networks of freshwater habitats within headwater catchments, by mitigating wastewater and agricultural pressures, restoring headwater streams and wetlands, and creating clean water ponds.

By applying this set of well-tested measures in appropriate catchments across England and Wales, we can create pockets of unpolluted freshwater, as refuges for sensitive freshwater species and engines for nature recovery in the wider landscape.

The Headstart approach is less about the 'what' and more about the 'where'. The measures which comprise the Headstart approach are well-understood, and have been widely trialled, with good evidence for their efficacy. The unique advantage of the Headstart approach comes from bundling these measures together, and focusing them on small headwater catchments, where collectively they will transform the water environment.

Upgrading small wastewater treatment works

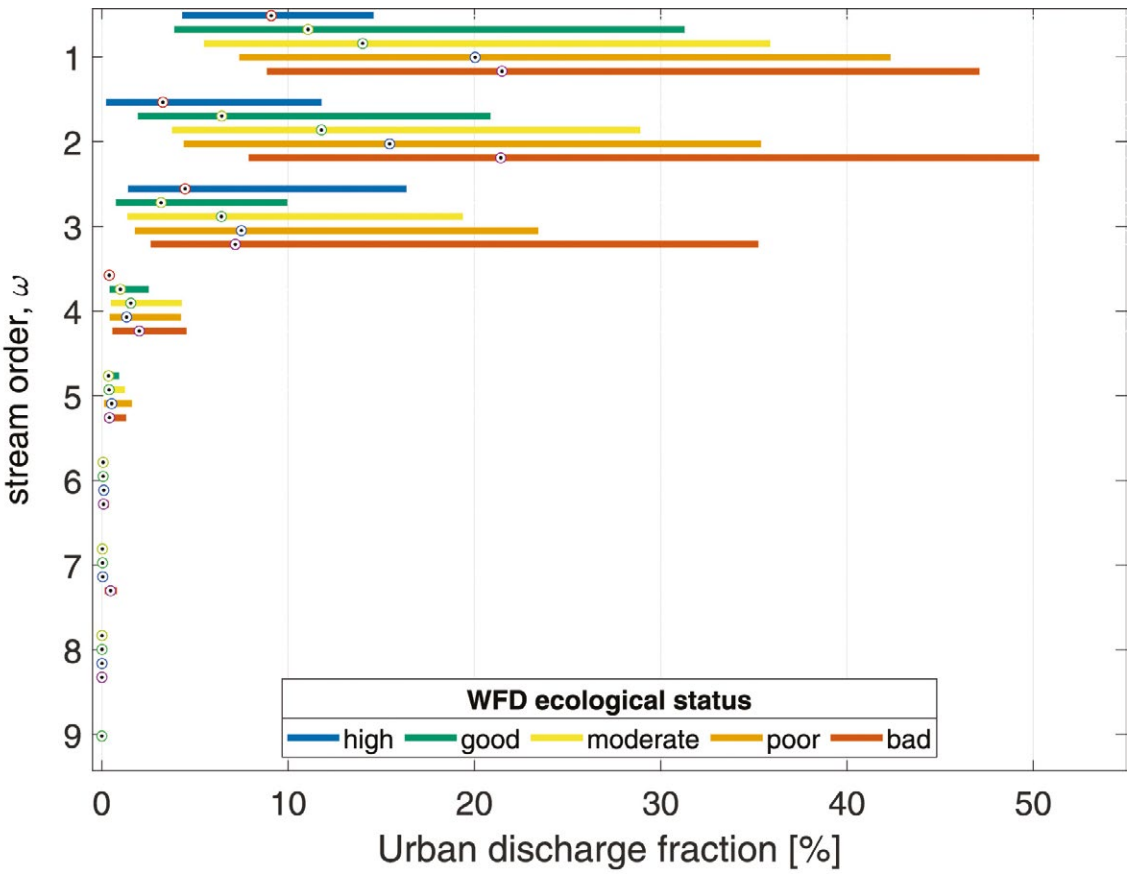
Wastewater can have a destructive impact on headwater streams, which have limited capacity to dilute effluent. The percentage of stream water originating from wastewater treatment works can be used as a simple proxy for sewage impacts, allowing headwaters to be rapidly screened and prioritised for investment.

Sewage in headwater streams – a problem and a solution

Though the total volume of effluent discharged into headwater streams is generally lower than in downstream waters, sewage entering headwater streams often causes more damage.[20] This is because headwater streams are small, and so effluent can make up a large proportion of total stream volume.

Regulatory drivers have overwhelmingly steered water company investment towards larger works in larger rivers. As a result, headwater streams seem to have benefitted less from improvements to river water quality during the 1990s and 2000s, following widespread sewage infrastructure upgrades.[21,22]

A recent pan-European study found that headwater stream ecological status declined consistently with increasing percentage of effluent, and that streams exceeding 6.5% effluent are unlikely to achieve high or good ecological status. In larger rivers (>3rd order), this relationship broke down, likely due to improved wastewater treatment, or the cumulative impact of other pressures - indicating that upgrades to sewage works in headwater streams could deliver greater ecological benefits.[23]



Water Framework Directive waterbodies' ecological status, split by stream order, with corresponding 'urban discharge fraction' – the percentage of water in the river which originates from wastewater treatment works. Smaller streams declined consistently with increasing effluent. From Buttner et al., 2022. Licensed under CC BY 4.0 (https://creativecommons.org/licenses/by/4.0/)

An opportunity to kickstart nature recovery by upgrading headwater sewage works

Upgrading small works in headwater streams could kickstart progress on improving river health. Because of their position in the river network, headwater streams are not affected by cumulative upstream pressures in the same way as larger rivers, meaning upgrading a single problematic wastewater treatment works can sometimes represent a silver bullet solution to water pollution in the stream.[23]

There's no default prescription here: investment could fund a mixture of conventional, nature-based and hybrid solutions. New technologies – both green and grey – offer the potential to overcome technical challenges of upgrading smaller works. Where upgrades cannot deliver adequate improvements to effluent quality, relocation of effluent discharge points can be explored.

Focusing catchment-based pollution mitigation measures

Most attempts to reduce diffuse pollution from agriculture have failed to measurably improve freshwater ecosystems, because they've been poorly targeted over a large area. Focusing the same measures on headwater catchments would deliver greater water quality improvements.

Agricultural pollution affects many headwater streams.[20] To get the excellent water quality needed to drive freshwater recovery requires partnership working: engaging the agricultural sector to reduce pollutant emissions from farmland.

Past government and third-sector schemes to address agricultural pollution have delivered very limited results. For example, the Defra-administered Catchment Sensitive Farming (CSF) programme was able to achieve on-farm reductions in pollutant emissions of up to 40%, but this translated to negligible improvements in river water quality (1-6%) and no measurable ecological improvements.[19]

This contrast, of failure at the catchment level despite demonstrable on-farm success, indicates that existing CSF-style approaches are likely to be more effective if applied in a targeted manner – such as in headwater catchments.

As noted by the Office for Environmental Protection (OEP) in their 2023/24 assessment of Environmental Improvement Plan progress, *'a practical intermediate step could be to focus interventions on smaller upper catchments, where larger proportions of catchments could be de-intensified with greater ecological benefits'*.[24]

Restoring networks of clean freshwater through habitat creation and restoration

Creating and restoring ponds, small wetlands and headwater streams can rapidly increase the integrity and resilience of headwater ecosystems.

Since the beginning of the 20th century, half of all ponds have been lost from the landscapes of England and Wales.[2,25] Small wetlands have been similarly affected: for example, approximately 95-98% of the UK's lowland fens have disappeared since 1940.[10] Headwater streams are harder to destroy entirely, but many stream habitats have been extensively lost through channel modification, culverting (piping underground) and disconnection from floodplains.[3]

Whilst upgrading wastewater treatment works and addressing agricultural pollution can mitigate the degradation of existing habitats, it cannot return these lost freshwater habitats.

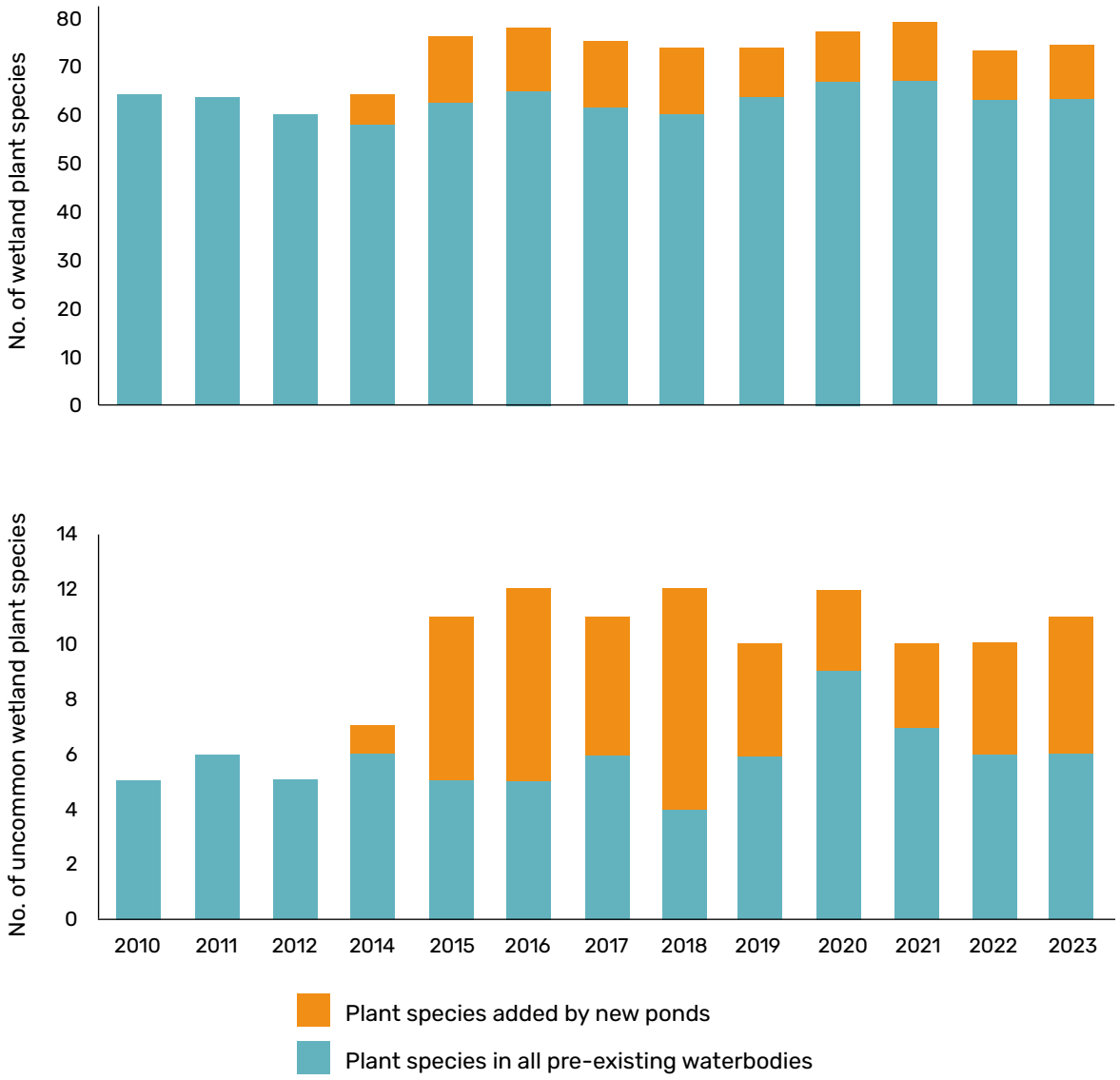
As outlined above, small freshwater habitats play a vital role in supporting freshwater ecosystems as a whole. By returning these habitats to the landscape, we can begin to reverse the long-running degradation of our freshwaters, and increase the resilience of freshwater ecosystems to future pressures.

A pond at Pinkhill Meadow, Oxfordshire. This floodplain wetland mosaic, created in 1990 by Thames Water, the Environment Agency and Freshwater Habitats Trust, is particularly rich, supporting around 20% of all the UK's freshwater plant and larger invertebrate species.

Creating and restoring ponds

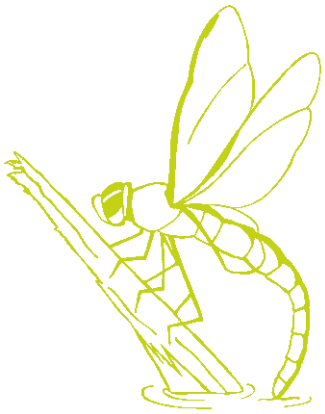
Though outside of the current operational protocol of the water sector, the creation and restoration of ponds has arguably the strongest evidence base of any freshwater conservation measure.[5,26–29]

The restorative power of ponds	
Rapid biodiversity gains	Newly created clean water ponds quickly support a diverse range of freshwater plants, invertebrates, amphibians, and other species. International evidence shows consistent positive effects on biodiversity following pond creation.[27,29,30]
Refugia for sensitive species	Ponds provide pollution-free habitats for species that cannot survive in degraded rivers or lakes, acting as 'lifeboats' for freshwater biodiversity.[2,28]
Stepping stones for connectivity	Ponds and small wetlands in headwater catchments create interconnected habitat networks, enabling species to move across landscapes and recover from local disturbances.[13,14]
Supporting entire freshwater systems	Clean water ponds in headwaters not only benefit species living within them, but also enhance downstream biodiversity by increasing connectivity and acting as refugia, permitting recolonisation of downstream habitats following disturbance.[14] This strengthens the ecological integrity of the entire freshwater system.
Co-benefits for terrestrial ecosystems	Ponds provide essential aquatic-terrestrial subsidies, such as emerging insects that feed birds, bats, and other wildlife. Riparian habitats around ponds further support terrestrial plants and pollinators.[28,31]



Increase in whole-landscape (gamma) wetland plant diversity across a 10 km² area of Leciestershire following the creation of 20 clean water ponds (total surface area <3 ha). Data from Water Friendly Farming project.

Evidence from the Water Friendly Farming project demonstrates the power of pond creation within small catchments. To double existing pond densities, 20 ponds were created across a 10 km² area of Leicestershire farmland, collectively covering less than 3 hectares. The ponds were sited to avoid pollution sources. Over 10 years, the creation of these ponds increased the whole landscape species diversity of wetland plants (i.e. looking at the total of species in all freshwater habitats) across the 10 km² project area by 16%. The number of regionally rare plants increased by 80%.[32]



A headwater stream in the New Forest. This complex, diverse morphology, typical of natural headwater streams, has been widely lost through physical modification.

Restoring headwater wetlands

Because of their hydrological requirements, headwater wetlands are confined to very specific parts of the landscape, and cannot easily be created. The restoration of these habitats is therefore critical to support their unique value as habitats for rare and specialist species.[10]

One of the main threats to surviving headwater wetlands is neglect. By reducing nutrient pollution and reestablishing traditional management, such as grazing or cutting, these special habitats can be brought back to life.

Restoring headwater stream morphology

Even more than larger rivers, many headwater streams have been transformed by extensive physical modification, including channel modification and straightening.[3]

However, headwaters are also far easier to restore successfully, not least because water quality can be improved in tandem with physical restoration – something usually unachievable for larger streams and rivers.

For rapid recovery and the most cost-effective results, physical restoration – including via 'ecosystem engineers' like Beavers (*Castor fiber*) – should be initially targeted at headwater streams where water quality is high, and should focus on increasing habitat heterogeneity both within-channel and across the floodplain.[33]

Updating water policy to drive the Headstart approach

Water Environment (Water Framework Directive) Regulations

WFDR overlooks standing waters <50 hectares, and bundles headwater streams with downstream waterbodies. If WFDR were amended, it could be used to drive progress across the whole water environment.

The Water Framework Directive (WFD – now WFDR) was ratified in 2000, prior to widespread understanding of the primary importance of smaller waters.[5,6] Consequently, as currently implemented, WFDR excludes standing waters of less than 50 hectares*, whilst headwater streams are generally either bundled with downstream waters or omitted from waterbody maps. As the OEP note in their 2023/24 assessment of Environmental Improvement Plan progress, this has meant that '*trends in small waters… are poorly understood*'.[24] In effect, the strongest statutory driver for improvement of freshwater ecosystems overlooks the majority of freshwaters.

The approach to water monitoring and management enshrined in the Water Framework Directive has failed to stem declines in whole landscape freshwater biodiversity.[32,34] Moreover, it has resulted in a significant missed opportunity, by failing to promote the restoration of resilient freshwater networks using the power of ponds and other small waters.

Amending the current approach – which is possible using options already available within WFDR - would go a considerable way to promoting uptake of the Headstart approach.

WFDR recommendations

- Incorporate standing waters <50 hectares into monitoring and management, enabling management of ponds and other small freshwater habitats as networks, through an existing WFDR mechanism known as 'System B'.
- Mandate stratified monitoring of headwater reaches within existing waterbodies, identify headwater-specific pressures, and set headwater restoration actions within River Basin Management Plans.
- Give catchment partnerships a clear role in management of the entire network of freshwaters, including restoration/creation of standing waters and wetlands.

* Except where these waterbodies are designated within protected nature sites (SSSIs, SPAs, SACs), or are used for drinking water

The Environment Act

Targets arising from the Environment Act inadvertently deprioritise work on smaller waters. Instating outcome-focused freshwater targets could deliver greater benefits for the freshwater environment.

The Environment Act introduced ambitious statutory targets for biodiversity and water. Regrettably, these targets currently constitute a barrier to effective management of the water environment. The targets' problems arise from a focus on input-driven measures (area affected/volume treated), as opposed to biodiversity improvement itself. The Environment Act wastewater target (set in the Environmental Targets (Water) (England) Regulations 2022) aims to reduce the load of phosphorus (P) discharged to freshwaters in treated wastewater by 80%, relative to a 2020 baseline. Because this target focuses solely on the gross volume of P emitted, it directs the overwhelming majority of water sector investment towards large rivers.

This is because the total load of P entering lower reaches is relatively high, and is generally discharged from larger sewage treatment works, so it costs less to achieve a given reduction in total P emitted. In headwater streams, investment is deprioritised because the total volume of effluent emitted is low, making improvements unattractive in terms of achievement of the P target, even at works which are causing significant damage to recipient ecosystems.

The Environment Act also provides for biodiversity targets (set in the Environmental Targets (Biodiversity) (England) Regulations 2023), covering species abundance, species extinction and the creation of wildlife-rich habitat outside protected areas.

Small freshwater creation and restoration is indirectly supported by the Environment Act species abundance target, because all freshwater plants, more than 90% of the freshwater invertebrates and a third of fish listed in the species abundance indicator can be found in small waters.[35] Similarly, the species extinction target could promote the conservation of small freshwaters, because many freshwater species threatened with extinction (Red-Listed) in England are supported by these habitats.

However, no Environment Act target directly supports the creation and restoration of small freshwater habitats. The wildlife-rich habitat target is purely area-based and very high-level, with no broken-down prescription for the quantity of each habitat type that should be created. This has the effect of disincentivising the creation or restoration of freshwater habitats, and particularly small waters, because these interventions are generally expensive relative to area – but not relative to biodiversity benefits.

In their 2023/24 assessment of Environmental Improvement Plan progress, the OEP recommend that an interim target be set to *'create or restore wildlife-rich open-water and river habitats'*.[24] This amendment, along with the introduction of a more impact-focused wastewater target, would further the implementation of the Headstart approach.

Environment Act recommendations

- Establish an interim target (as recommended by the OEP) to '*create or restore wildlife-rich open water and river habitats*'.
- Amend the wastewater target to focus on impacts of sewage pollution, rather than (solely) the gross volume of pollution emitted.

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The Fen Raft Spider (*Dolomedes plantarius*), a Red-Listed (Vulnerable) species which is reliant on wetland habitats.

Water sector regulatory framework

Non-legislative amendments to water sector regulation could promote uptake of the Headstart approach.

A growing portion of water sector investment (more than £20 billion in AMP8) is directed towards environmental improvement, the majority of which is spent on direct mitigation of wastewater pressures in large rivers and lakes.

These large waterbodies are often heavily impacted by multiple pressures, including many which are caused by other sectors – particularly agriculture. Although catchment-based measures have enabled the water sector to take on some of these other pressures, environmental benefits are constrained by the requirement to deliver reductions in pollution emissions to the river channel itself.

Greater environmental benefits could be secured if a portion of water industry investment were freed up for catchment-based interventions away from heavily impacted large waters, and spent on restoring and creating truly unpolluted freshwater habitats of all kinds - which would strengthen the resilience, connectivity and integrity of freshwater ecosystems as a whole.

There is sufficient flexibility in existing regulations to drive a significant portion of this work without waiting for legislative change. Non-legislative amendment to water sector regulations could incentivise greater investment in headwater catchments, and facilitate the development of the Headstart approach.

Water sector regulation recommendations

- Direct greater water sector investment towards headwater catchments. This could be achieved by (e.g.) Government issuing new strategic priorities to Ofwat, or by Ofwat issuing a new Performance Commitment.
- Extend the scope of catchment-based measures to encompass mitigation of pollution emissions to freshwaters across the whole catchment, and recognise clean water pond creation as a solution to cross-catchment water pollution issues.
- Establish a demonstration programme in headwater catchments across England and Wales, trialling the Headstart approach in advance of wider implementation.

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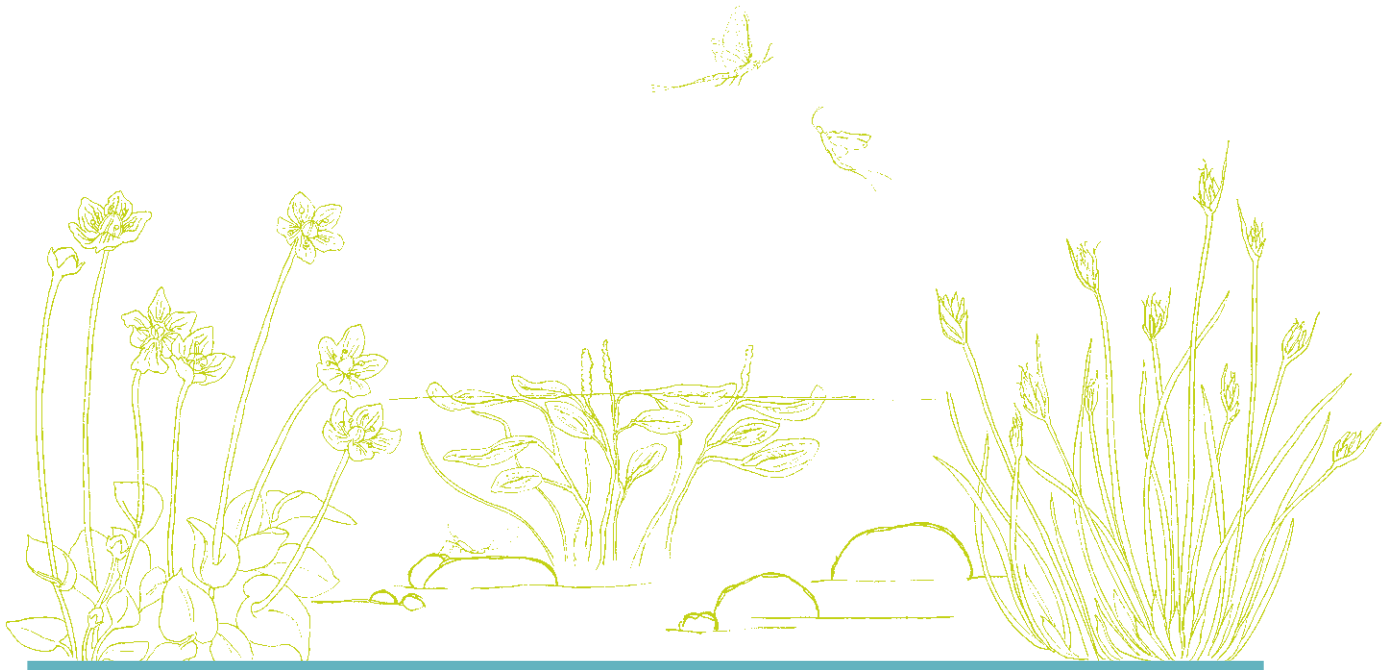

Background

During 2024, Freshwater Habitats Trust was commissioned by Anglian Water to conduct an evidence review examining the regulatory framework for smaller waters, and the policy, social, technological and environmental context in which the framework exists, as part of the Catchment Systems Thinking Cooperative (CaSTCo) project. The evidence review drew on existing literature, and a roundtable workshop with experts from academia, regulatory bodies, eNGOs and the water industry. The above is informed by the resulting report's key findings, by feedback from subsequent stakeholder engagement, and by further examination of available evidence.

The ideas presented here comprise one application of Freshwater Habitats Trust's Freshwater Network strategy, aiming to create a national network of wilder, wetter, cleaner, connected freshwaters.

Freshwater Habitats Trust

www.freshwaterhabitats.org.uk

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