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By Eleanor Absalom,
Oliver Bennett MBE
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Freshwater habitat restoration

Overview

- Freshwater habitats, such as rivers and wetlands, provide major benefits to society through services such as flood risk reduction. However, many of these habitats are in a poor condition due to human activities including physical modification and pollution.
- Restoration of freshwater habitats can be achieved by addressing the causes of degradation and by enhancing or extending habitats. There is good evidence on the benefits of restoration, although certain freshwater habitats, species and restoration measures are less well-studied.
- There are numerous national and international targets for the restoration of freshwater habitats. Some stakeholders believe that these commitments will not be met under current plans in England.
- There have been calls for increased long-term funding to deliver larger-scale projects, alongside changes to policy and legislation to deliver more joined-up decision making and include small water bodies and headwaters.
- Stakeholders also argue that restoration must happen alongside prevention of further degradation, including better enforcement of existing legislation and the removal of barriers to nature-based solutions.
- Policy in this area is devolved. For England, the Government published a Plan for Water in 2023 that contained new actions to help improve the condition of freshwater habitats. The Office for Environmental Protection will publish an assessment of the Government's approach in 2024.

Background

Healthy freshwater habitats, such as rivers and wetlands[a], offer numerous economic, environmental and societal benefits including:

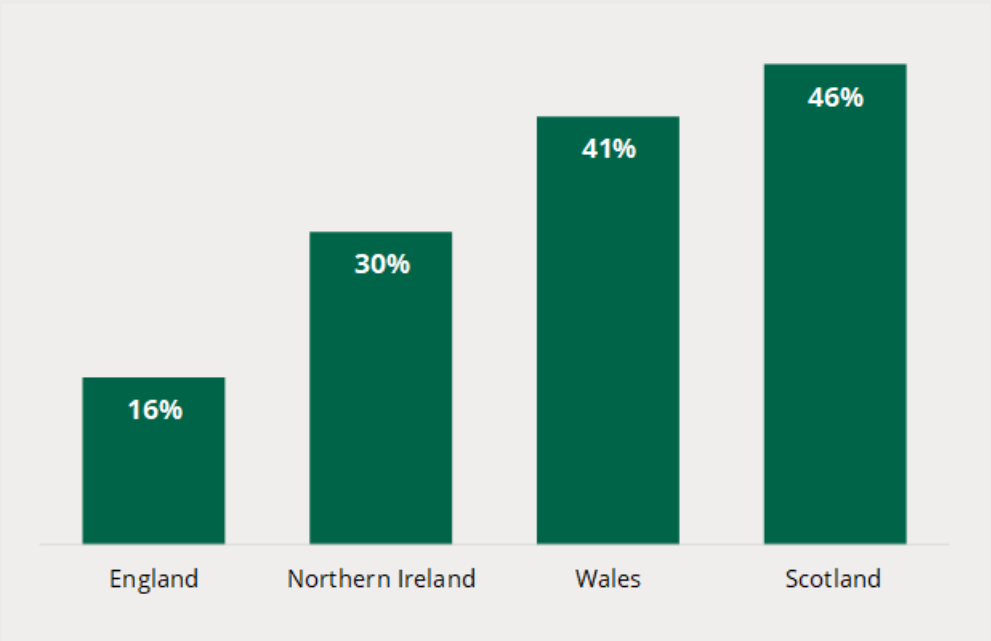
- providing clean water for agriculture, industry and human consumption
- supporting recreation and tourism, with the total benefits of England's freshwater fisheries valued over £1.7 billion[3]
- preserving and restoring biodiversity by sustaining a wide variety of aquatic and terrestrial plants and animals, including threatened and highly specialised species[4]
- improving physical and mental health.[5] In 2020, 2.2 million people in the UK gained health benefits from exposure to freshwater habitats, worth an estimated £739 million in avoided healthcare costs[6]
- mitigating and adapting to the impacts of climate change[7,8]

However, freshwater habitats across the UK are under pressure. Populations of many freshwater species are declining, with over 10% threatened with extinction.[9] An estimated 90% of wetlands, including 75% of ponds, have been lost over the last century,[9,10] while most rivers and lakes are not considered to be close to their natural state in any part of the UK (Figure 1).[11–14]

Policy in this area is devolved. This briefing focuses on England, but also includes evidence from Northern Ireland, Scotland and Wales.

[a] This POSTnote does not explicitly consider peatlands, although these are an important freshwater wetland habitat, as the issues and restoration targets for peatlands can be different to other freshwater habitats and are generally well documented elsewhere. For further detail please see PN668 'Reducing peatland emissions'[1] and PB48 'Restoration and creation of semi-natural habitats'.[2]

Figure 1: The proportion of assessed rivers and lakes achieving good or better ecological status in each part of the UK.



Notes: The proportion of assessed rivers and lakes considered to be close to their natural state, or achieving good or better ecological status, under the Water Framework Directive Regulations (as transposed into UK law) in each part of the UK. Ecological status assesses the overall quality of surface water bodies by combining elements, for example the abundance of plant and animal species and continuity of water flow, that can be affected by pressures such as pollution and physical modification. Ecological status has five levels (high to bad), with the final level for a water body based on the lowest scoring element. Source: Environment Agency, Northern Ireland Environment Agency, Senedd Research, Scottish Environment Protection Agency

Pressures on UK freshwater habitats

The main pressures are:

- **Physical modification**, such as from land use change, channelisation and poor riparian[b] management, which can cause the loss, degradation and fragmentation of habitat.[c] Physical modification is the leading pressure on rivers and many wetland habitats, such as floodplains, across the UK.[12,13,15,16]

[b] Riparian refers to the area alongside watercourses, including all habitats, such as scrub, woodland and wetland, which occur along this terrestrial to aquatic transition zone.

[c] Fragmentation of habitat can disrupt the movement of organisms, including animals and seeds, and matter, such as nutrients and sediment, within and between freshwater habitats. This can have negative environmental consequences, such as preventing species migration or increasing the build-up of pollutants in a certain area.

- **Chemical and physical pollution**, including fertilisers, pesticides and animal waste from agriculture (PN661) and sewage and 'forever chemicals'[d] from wastewater (PN579). Pollution is a key pressure on lakes and ponds in the UK and the second leading cause for poor status of rivers, although there is significant localised variation.[11,13,17–20]

- **Disruption to natural flows** due to water abstraction (removal for human use) and discharges (PB40). These activities can severely affect flow volume, velocity, and variability. Although the majority of the UK's waters achieve good quantitative status,[e] certain habitats and regions are worse affected, particularly chalk streams in the east and south-east of England.[11–13,17,21,22]

- **Invasive non-native species** (INNS)[f] (PN673) can compete with native species, increase predation, spread disease, damage infrastructure, disrupt water supply and navigation, and cause eutrophication.[g] [23] INNS in freshwater systems doubled in Great Britain between 1960-2019.[24] Around 20% of rivers and lakes are impacted by invasive species in England, with 3% affected in Scotland.[13,16]

In addition**,** climate change and population growth are projected to exacerbate these pressures while also making freshwater systems more vulnerable to their impacts.[7,25–27]

Legislation and policy

The UK has numerous legislative and policy objectives for restoration, under international and national frameworks, including that restoration must be underway or completed on at least 30% of degraded UK inland waters by 2030 (Convention on Biological Diversity (CBD) Kunming-Montreal Global Biodiversity Framework).

Most legislation and policy for freshwater restoration is devolved. Table 1 outlines bodies responsible for the delivery of freshwater policy in each part of the UK.

[d] These are a group of pollutants called PFAS (poly and per-fluoroalkyl substances) that do not break down in the environment, can accumulate in the body and become toxic to humans, livestock, pets and wildlife.

[e] Considers the amount and condition of groundwater resource available. Good status is achieved by ensuring groundwaters and dependent surface waters are not impacted by over-abstraction.

[f] Plants, animals or microorganisms introduced, intentionally or accidentally, outside of their natural geographic range, causing severe negative environmental and socioeconomic impacts.

[g] This is when excessive nutrients, such as nitrate or phosphorus, in a water body lead to over-growth of algae and some plants. This can deplete the water of oxygen, harming other aquatic life such as fish. Invasive non-native species can increase eutrophication by disrupting water and nutrient flows and increasing polluting run-off from land.

Much legislation relevant to freshwater management and restoration is derived from EU law, such as the Birds Directive, Habitats Directive, Urban Wastewater Treatment Directive, and the Water Framework Directive (WFD), as transposed into UK law.[h]

In particular, the WFD regulations require nations to achieve good ecological status in inland and coastal waters by 2027 where reasonably feasible.[i] [28] They take a catchment approach, requiring environmental regulators in each part of the UK (Table 1) to produce River Basin Management Plans setting out measures to achieve this overarching target in all assessed water bodies (PN320).[j] In England, this approach is also supported by collaborative Catchment Partnerships.[k] These voluntary groups aim to engage all stakeholders in a catchment – including water companies, local authorities and environmental NGOs – in the delivery of integrated freshwater management and restoration.

There is further legislation across the UK to support this system, including water and sewerage industry regulation; agricultural management and waste disposal rules; planning laws; chemical controls; and legislation for the designation of protected freshwater sites, such as the Ramsar Convention for wetlands of international importance and the Wildlife and Countryside Act 1981 for Areas/Sites of Special Scientific Interest (A/SSSIs).

[h] For example, the Water Framework Directive was transposed as the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, and the equivalent regulations in Northern Ireland and Scotland.

[i] Exemptions include water bodies impacted by certain chemicals that can remain in the water environment for many years after actions to reduce or eliminate their use. These are known as ubiquitous persistent, bioaccumulative and toxic substances (uPBTs).

[j] River basins, or drainage basins, are the area of land around a river that is drained by the river and its tributaries. A river basin district may contain one or more river basins. River Basin Management Plans cover all 15 river basin districts in the UK. They set out measures to achieve environmental objectives for all ground and surface waters above a minimum size (over 50 hectares for surface waters, or 0.5 hectares for surface water bodies in protected areas) within these districts. RBMPs are subject to public consultation before being finalised and must be updated every six years (the most recent covering 2021-2027). They are used by environmental regulators to inform water regulation, including determining permits for water abstraction, engineering, and discharges of polluted water. Local authorities must also have regard to the plans when making planning decisions.

[k] Catchment Partnerships were set up by Defra under the Catchment-based Approach in 2013. This polycentric style governance approach was found by the Dasgupta review in 2021 to be more effective in implementing water policy.[29] There are around 100 catchment partnerships in England and cross-border with Wales.

Table 1 Bodies responsible for the delivery of freshwater policy in the UK		
Nation	Body	Main role
UK	Joint Nature Conservation Committee (JNCC)	Statutory nature conservation advisor
England	Environment Agency	Environmental regulator, advisor, planner
	Natural England	Statutory nature conservation advisor, Environmental regulator
Wales	Natural Resources Wales (NRW)	Environmental regulator, Statutory nature conservation advisor
Scotland	Scottish Environment Protection Agency (SEPA)	Environmental regulator, advisor, planner
	NatureScot	Statutory nature conservation advisor
Northern Ireland	Northern Ireland Environment Agency (NIEA)	Environmental regulator, advisor, planner; Statutory nature conservation advisor

Source: JNCC, Environment Agency, Natural England, NRW, SEPA, NatureScot, NIEA

Freshwater restoration policy and legislative changes in England introduced after the transposition of relevant EU directives include:

- targets for the reduction of water use and some pollutants from key sectors, including a 40% reduction in nitrogen, phosphorus and sediment pollution from agriculture and an 80% reduction in phosphorus from wastewater discharges by 2038 against a 2018 baseline (Environment Act 2021)
- to improve at least 75% of waters[l] to close to their natural state[m] as soon as is practicable and to create or restore 500,000ha of wildlife-rich habitat by 2042, along with other protected sites, species and habitat targets set out in the Environmental Improvement Plan 2023
- new developments must deliver at least a 10% biodiversity net gain[n] (Environment Act 2021)

[l] Including freshwater and marine habitats

[m] Or good ecological status under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 and Water Environment and Water Services (Scotland) Act 2003.

[n] In England, biodiversity net gain (BNG) is becoming mandatory under Schedule 7A of the Town and Country Planning Act 1990 (as inserted by Schedule 14 of the Environment Act 2021). Planning and

Other approaches are being taken in the devolved parts of the UK:

- In Scotland, the Biodiversity Strategy 2045 aims to increase the extent of restored catchments[o] and riparian woodland, and to restore rivers, lochs and wetlands to good condition.[32] Statutory targets related to the strategy will be introduced via the upcoming Natural Environment Bill (Scotland).[33]
- In Wales, the Nature Recovery Plan 2020 aims to "increase the resilience of our natural environment by restoring degraded habitats and habitat creation."[34,35] It does not set any legally binding targets, although the Welsh Government committed to developing the necessary legislation 'as early as possible' following recommendations from an expert commission on biodiversity.[36]
- In Northern Ireland the Environment Strategy sets several objectives over the next ~30 years, including to restore 112,500 hectares of terrestrial and freshwater protected sites to favourable condition.[37]

UK Government policy

The UK Government has produced several environmental strategies for England.[p] [38] In January 2023 it set out its overarching policy in the Environmental Improvement Plan (EIP23), followed by a Plan for Water that contained new actions aiming to "transform our management of the water system, deliver cleaner water for nature and people, and secure a plentiful water supply."[39] Key parts include:

- more funding for catchment groups and catchment-scale partnerships that coordinate action and investment[q]
- reforms to update the policy and legal framework
- improvements to Environment Agency regulatory oversight

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infrastructure proposals are required to demonstrate in plans how they will deliver a minimum 10% gain in biodiversity 'units' from what is initially present at the development site.[30] This is calculated using a metric that assesses the quantity and quality of UKhab classified vegetation types, including watercourse habitats.[31]

[o] A catchment is the area of land through which water from any form of precipitation - such as rain, melting snow or ice - drains into a body of water, such as a river, lake or underground water supply ('groundwater'). Catchments vary in size depending on the topography, climate and number and type water bodies present. There are around 100 principal catchments in England and Wales.

[p] Please refer to the House of Commons Library briefing 'Climate Change and Biodiversity.'

[q] In England, each river basin district identified under the WFD Regulations is divided into management catchments, based on those used for managing flood risk and water resources. These can be large areas, with many, often interconnected, water bodies. Each management catchment has an associated catchment partnership made up of all stakeholders involved in water and land management in the area, such as water companies, environmental groups, businesses, and landowners/managers. There are over 100 catchments and associated catchment partnerships in England and cross-border with Wales.

- the creation of a Water Restoration Fund for projects using money from water company fines and penalties

The Government is also aiming for private finance to fund environmental restoration.[40] It is seeking to build confidence in new markets for tradeable credits through which businesses pay land managers to deliver restoration. Examples include nutrient mitigation schemes,[r] [41] and Landscape Enterprise Networks.[s]

Are restoration targets being met?

In 2023 the Office for Environmental Protection (OEP) indicated that England was significantly off track in meeting targets across several environmental indicators.[42] The OEP will publish an update on progress, considering the new EIP23 and Plan for Water, in early 2024.[43]

There has been little change in the proportion of UK surface water bodies achieving good or better ecological status since 2009,[t] remaining at around 36%.[44] There has been more progress in Wales and Scotland than in England and Northern Ireland.[u] However, all parts of the UK failed to achieve most of the 2021 River Basin Management Plan targets for water status improvements.[13,15,16,18] This trend is replicated across Europe.[45]

Monitoring of freshwater indicator species gives a more nuanced picture.[v] For example, while the diversity of river insects in England and Wales increased during the 1990s after changes to water treatment legislation, there has been little improvement in the past decade.[47–49] In contrast, aquatic plant, salmon and wetland bird populations have declined overall across the UK since records started.[24]

On protected area restoration, there was a small decrease in the proportion of UK Areas/Sites of Special Scientific Interest (A/SSSIs), including but not limited to freshwaters, in a favourable or 'recovering' condition[w] in 2023, with little overall

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[r] Under the Habitats Regulations, nutrient neutrality requires new developments near protected areas already in 'unfavourable condition' due to nutrient pollution to mitigate more nutrients entering the water system. There are currently 27 protected habitats sites in 'unfavourable condition' in England, affecting 74 local planning authorities.

[s] Developed by 3keel, Landscape Enterprise Networks are a regionally focussed approach to restoration. They operate by co-procuring investment from groups of local businesses with common business and environmental restoration goals, and enabling restoration providers, such as farmers, to define and cost actions to deliver these.

[t] When the WFD was first implemented.

[u] There have been changes to monitoring approach under WFD Regulations between parts of the UK during this time, meaning data from 2014 onwards are not directly comparable.

[v] A report published in 2022 by the Environmental Audit Committee on English river water quality stated that, 'A 'chemical cocktail' of sewage, agricultural waste, plastic and persistent chemicals is polluting rivers. River water quality has improved by some measures in recent decades, but in others it appears to be getting worse.'[46]

[w] This classification identifies the proportion of important biological or geological features in protected areas that are in a desired state with good prospects to continue to be so (favourable), or that have

change since 2011.[51,52] The condition of freshwater habitats designated as Special Areas of Conservation has also declined since 2013, with all but one classed as unfavourable in 2019.[x] [53]

Restoration techniques and benefits

Historically, research and practice for freshwater restoration in the UK has focused on measures in lowland rivers and large lakes, primarily to increase fish populations.[54–58] In recent decades, a growing body of research has supported a move towards nature-based solutions to restore physical, chemical and biological processes that sustain freshwater habitats and their hydrological functions across whole catchments.[59]. Some common nature-based restoration techniques and their benefits are listed in Table 2.

However, evaluation of the benefits of restoration can be challenging due to a lack of long-term monitoring and lag times in natural processes that can delay response to intervention.[60–62] Some techniques developed overseas, such as Stage Zero river restoration,[y] require further research to determine their applicability in the UK.[56,63,64]

appropriate management but are yet to have regained their favourable status (unfavourable-recovering).[50]

[x] Special Areas of Conservation are designated under legislation derived from the EU Habitats Directive (under Article 17) – as transposed these are: Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales, the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) in Scotland, and the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland. The last time a report on the implementation of these regulations was submitted was in 2019 when the UK was still an EU Member State.

[y] Like re-meandering, stage zero restoration aims to improve river structure, however this approach generally gives rivers more freedom to follow natural flow paths and re-connect to their floodplains. 'Stage zero' refers to the earliest undisturbed state in a river's development.

Table 2 Common nature-based solutions for freshwater restoration

Where	Solution	Purpose	Benefits
Catchment-wide	Good soil management, increase vegetation cover, re-establish wetlands	Restore hydrological function[z], habitat and species connectivity and resilience	Economic crop, drought resilience, flood management, water quality, carbon sequestration, biodiversity
Headwaters	Rehydrate soils, undo/block drainage, re-establish upland habitats, such as by re-wetting peatland	Restore hydrology and wetlands, springs, headwater streams	Biodiversity, drought resilience, carbon sequestration, flood management, water quality, fisheries, economic crop, well-being, pollination
Headwaters, rivers, lakes and ponds	Re-establish appropriate riparian and water edge vegetation, remove scrub and sediment where needed (e.g. via excavation)	Restore rivers, lakes and ponds (e.g. in-filled 'ghost' ponds)	
Headwaters, rivers and floodplains	Remove embankments, reconnect floodplains, 'Stage Zero'	Restore rivers and floodplain wetlands, meadows and woodland	
Headwaters, rivers	Channel narrowing, remove obsolete structures e.g. weirs, replace large woody material	Restore river habitat	Biodiversity, drought resilience, fisheries, well-being
Headwaters, rivers and floodplains, lakes and wetlands	Species re-establishment e.g. beaver, water vole	Restore river and floodplain wetlands, meadows and woodland	Biodiversity, drought resilience, flood management, carbon sequestration, water quality, well-being

[z] Hydrological functions include the collection, storage and release of water, such as through processes like infiltration and storage in water bodies.

Biodiversity recovery

There is good evidence for the benefits of freshwater restoration to biodiversity, tending to be more consistent and longer-lasting following restoration of wetlands, including ponds, compared with rivers and lakes.[58,65–75] Outcomes can depend on the organisms and traits[aa] targeted as well as the scale of restoration. For example, small-scale, isolated restoration often increases the abundance of species already present but has limited effects on species diversity.[76–79]

Research indicates that biodiversity outcomes can be improved and maintained for longer by:[55,65–68,76,78,80–84]

- addressing catchment-level drivers of degradation, such as habitat fragmentation and poor soil and water management
- reconnecting and enabling recolonisation of restored sites where appropriate[bb], for example by removing barriers to species movement
- re-introducing 'ecosystem engineer'[cc] species like beavers (Box 1)
- restoring and creating good quality freshwater habitats, such as wetlands, across depleted landscapes.

Box 2: River Otter Beaver Trial, England

In 2015 a five-year trial was started to understand the impact on local people and wildlife of two groups of European beavers living on the River Otter, Devon. This was the first re-introduced beaver population in England since they were hunted to extinction 400 years ago. The trial found that the benefits for wildlife, water quality and downstream flood risk outweighed the financial costs.[85] It also demonstrated that adverse impacts to neighbouring farmland could be addressed, primarily by removing beaver dams.

Following the trial, Defra consulted on a proposed management framework for beaver reintroduction in England. Many respondents called for a national strategy, like Scotland[86], to give a clearer approach and to maximise benefits and minimise risks.[87] The EFRA Committee also made several recommendations on managing species reintroduction in England.[88]

The Government declined to adopt these measures at this stage.[89] As a result, Natural England are not currently considering any more applications for re-introduction licenses.

Natural Resources Wales is currently conducting a feasibility study on beaver reintroductions for the Welsh Government.[90]

[aa] Traits refer to measurable features of organisms, including those relating to growth, reproduction, behaviour and stress-tolerance.

[bb] For example, it may not be appropriate if it would enable the spread of invasive non-native species.

[cc] Some species are of interest because of how they influence the structure of the environment. For example, wild boar root around deeply in the soil, disturbing it and preparing it for new vegetation to establish (PN 537).

Reducing flood risk and severity

Restoration such as re-meandering rivers and re-connecting floodplains can help to reduce downstream flood risk and severity by storing and slowing water movement through the landscape. Such restoration measures are referred to as Natural Flood Management (NFM). NFM is used in UK flood risk policy in conjunction with traditional engineered defences.[dd]

There is good evidence that NFM can deliver localised reductions in flood risk and severity.[91–93] However, there are uncertainties in terms of scaling these benefits to catchment-level flood protection (PN623).[94] Evidence is also lacking on how best to implement some NFM measures.[95,96]

Newer, larger-scale projects are attempting to improve understanding and uptake of NFM across the UK (Box 3).[97–99]

Box 3: Natural Flood Management Pilot Programme

The UK Government's NFM pilot programme (2017-2021) aimed to improve understanding of the impact and implementation of NFM measures across England. It funded 60 projects, covering 4500 NFM measures, including sustainable urban drainage systems, woodland planting and leaky barriers.[ee]

Evaluation to date shows the projects collectively reduced flood risk for 115,000 homes. Measures worked well with traditional flood defences and provided some additional benefits.

The programme highlighted that multiple different NFM measures are often needed across large catchments to reduce flood risk, with more research required to improve understanding of contribution at various scales.

Successful implementation required good relationships with stakeholders, catchment-level permitting for larger-scale works, and less detailed requirements for modelled flood risk reduction, with this disproportionately costly for NFM measures in some instances.

The Environment Agency is working with partners to update guidance and tools based on these findings. This is expected to be completed by 2025.

Water pollution

Research indicates that improving water quality requires better land management practices to prevent or reduce pollution along with other restoration techniques, such as habitat enhancements.[100–103] Nature based solutions, such as treatment wetlands

[dd] Such as the Flood and Water Management Act (England and Wales) 2010 and the Flood Risk Management Act (Scotland) 2009.

[ee] Also known as leaky dams, these tend to be constructed of logs and other woody debris, mimicking natural processes that partially or fully obstruct river and stream flow.

(Box 4), may alone not be sufficient to address the volume and range of pollutants entering freshwater systems. However, they may be effective in conjunction with other measures if location and management are appropriate.[104–112]

There is some evidence to suggest that current policies to address agricultural pollution, such as Countryside Stewardship, do not go far enough to achieve significant improvements in water quality.[113–115] Several groups have also criticised planned actions on wastewater pollution, such as storm overflows[ff], saying they lack ambition, urgency and detail.[117–121]

A House of Lords Industry and Regulators Committee report noted these concerns.[122] In September 2023 the Chair, Lord Hollick, wrote to the UK Government stating that while "the Government has begun to set out its vision for the sector", the committee had "concluded unanimously that there is insufficient policy or drive to meet the Government's targets".[123]

Box 4: Treatment wetlands

Treatment wetlands are artificial wetlands designed to improve water quality. They do this by employing natural processes that help to filter pollutants from water, particularly nutrients like nitrate and phosphorus.[124] They are increasingly being implemented to help remove pollutants from agricultural and urban run-off, and as a tertiary form of effluent treatment.[125]

Evidence indicates that treatment wetlands can offer a lower cost, less carbon intense method to improve water quality prior to discharge into surface waters.[104,105,126–131]

However, the efficacy of treatment wetlands can vary depending on design, operational management, local weather conditions and incoming water composition.[105,127,130] There is also a lack of evidence of their performance long-term.[129]

While some commentators recommend additional actions for effluent treatment, there is support for the increased use of treatment wetlands to reduce water pollution from urban and agricultural sources.[131–134]

Climate change

There is extensive evidence to show that restoration can help the UK adapt to the impacts of climate change by creating freshwater habitats more resilient to extreme weather events, such as floods.[61,135,136]

Evidence on the contribution restoration could make to storing greenhouse gases (GHG) is inconclusive. Globally, rivers are a net source of carbon dioxide emissions.[137] It is currently unclear how restoration might reduce GHG emissions from these

[ff] Storm overflows are part of the sewerage system that release excess contaminated water into rivers or the sea when the system is at risk of being overwhelmed, such as during heavy rainfall. Investigations by regulators are ongoing into the excessive or unnecessary use of storm overflows by UK water companies, for example during dry conditions.[116]

systems, although reducing eutrophication is likely to help, while re-establishing riparian habitats, particularly woodland, will increase carbon storage.[138,139]

Many standing water habitats, including lakes and other wetlands, are significant carbon stores, although they can also become sources of GHG emissions.[140–143] This complex balance is affected by many factors including temperature, vegetation, water quality and quantity, making it challenging to understand the net effect of restoration on climate change mitigation.[144–150] For example, some research shows that improving water quality in shallow lakes will reduce carbon sequestration, but also reduce methane release.[151–153]

Overall, research suggests that naturally functioning wetlands (including ponds and floodplains), particularly mature sites with more vegetation, are more likely to be effective at carbon sequestration than other freshwater habitats.[140,148,154]

Health and wellbeing

There is growing evidence to suggest that restoration can improve the health and well-being benefits derived from UK freshwater habitats.[5,155] See Green Blue Infrastructure Impacts on Health and Wellbeing.

Improving the condition and accessibility of freshwater habitats (particularly in urban areas), has been shown to increase visit frequency and duration, recreational and physical activity, reported well-being benefits, and opportunities for social cohesion and education.[156–160]

Challenges

Stakeholders have identified several challenges to achieving freshwater restoration in England, although the challenges may also apply to Northern Ireland, Scotland, and Wales.

Integrated legislation and policy

Many stakeholders have raised concerns about the legislative and policy framework in England, stating that it has led to opportunistic and local-scale restoration, and failed to deliver the required change.[20,134,161–170]

A key concern is the requirement for better integration of environmental policy and legislation to facilitate catchment-wide benefits and to prevent restoration being undermined by conflicting decisions in different sectors.[56,161,162,169–173]

Examples of higher-level, integrated policies include the Future Generations Act (Wales), Environmental Policy Principals (England), and Scotland's Land Use Strategy. However, stakeholders have concerns that limited resourcing, implementation, and evaluation of these may restrict their effectiveness.[131,133,161–163,163,164,167,170,171,174]

The UK Government said it would publish, in 2023, a Land Use Framework for England to "ensure the country meets its net zero and biodiversity targets at the same time as helping farmers adapt to climate change while continuing to produce high-quality, affordable food". Publication has been delayed.[176,177] The House of

Lords Land Use in England Committee called for the creation of a Land Use Commission to prepare and update the framework, as well as wider recommendations.[175]

The UK Government also noted the need for "improvements to how we manage our water system with a streamlined policy and legal framework" in its Plan for Water.[39] The Plan outlined ambitions to develop long-term catchment plans covering all water bodies and including conservation priorities identified in Local Nature Recovery Strategies.

Stakeholders welcomed this, calling for a more joined up approach with other land use and water management planning.[gg] They suggested these integrated plans could be used to better prioritise restoration investment, such as from the Water Restoration Fund and ELMS.[134,162,164,167,171,178–180]

Many commentators also called for a more strategic direction.[63,133,161,163,166–168,170,171,181,182] In January 2023 the OEP also raised this issue, recommending clearer governance and the development and implementation of unifying delivery plans for restoration objectives.[42]

Stakeholders also called for funding increases for Catchment Partnerships, changes to their legal footing, such as enforcement powers or two-way engagement duties, and more clarity on how private investment will be integrated in this management approach. They feel addressing these challenges will enable partnerships to deliver restoration more consistently and implement larger-scale projects.[56,134,161,162,164,167,169,171,173,178,183,184]

Several additional policy integration challenges were identified by stakeholders, including the need for:

- better consideration of headwaters[hh], small water bodies, and wet floodplain habitats in restoration targets and land-use policies.[56,57,63,133,134,161–163,166,167,167,170,181,182] Research shows these habitats are important for biodiversity, flood management, and climate change mitigation, although they are mostly excluded from current legislation, such as the WFD Regulations, and policy, for example the Plan for Water[39]

- expanding freshwater quality standards to consider additional pollutants and indicators of broader habitat condition.[57,133,163,164,167,171,178,186] In late 2023, Defra reported that additional freshwater monitoring would be implemented in England, taking a more holistic approach and aiming to increase spatial coverage.[187,188]

- more regulation of private nature markets and clearer policy guidance to increase effectiveness and improve engagement from investors and implementors (e.g. farmers).[133,165,167,179,180,183,184,189] A three-year programme

[gg] Including River Basin Management Plans (RBMPs), Local Plans, Flood Risk Management Plans, and Water Company Drainage and Wastewater Management Plans.

[hh] Composed of many different interconnecting streams and tributaries, headwaters are the source of all rivers and streams and are often found at the highest elevation in a catchment area. They comprise an estimated 70% of river length across the UK.[185]

between Defra and the British Standards Institute to develop standards for nature investment was announced in the Nature Investment Framework in 2023.

Funding

Stakeholders have welcomed government investment in restoration, but many state that there is a lack of the necessary specific and long-term funding needed to deliver more permanent, larger-scale, and more successful restoration projects.[56,133,161,162,178,181,183,184,189]

For example, most payment agreements under Environmental Land Management Schemes (ELMS) in England[ii] and the Sustainable Farming Scheme (Wales)[jj] are planned to last 2-5 years, with only the higher tiers of ELMS (Countryside Stewardship[kk] and Landscape Recovery) offering longer arrangements.[190]

Other stakeholders have stated that a lack of long-term funding hinders restoration monitoring, limiting the evidence base for restoration.[57,161,163,164,171,179,181,191] Some suggested that minimum ecological monitoring requirements should be included in funding to determine restoration success. Wider, long-term appraisal could then be directed to 'flagship' projects.[56,57,161,179,181] Similar approaches are used in other countries.[57,179] Research to develop monitoring standards in the UK is ongoing.[192]

Many stakeholders had concerns around resourcing for environmental regulators, stating that they do not have the capacity or budget to enforce compliance with existing regulation or to monitor progress on policy targets.[56,132,133,161–163,172,178,179,191] In 2023 the Government said that it would increase funding for the Environment Agency's enforcement capacity by an extra £2.2 million a year.[39]

Some stakeholders stated that delivering more and better restoration is likely to require increased investment and capacity-building in supporting sectors, such as in research and development, horticulture, and nature-based construction.[131,134,162,165]

Barriers to nature-based restoration

Stakeholders identified several barriers including:

- risk-averse consenting processes, such as planning permission, that prefer more predictable engineered options
- siloed policy areas and ring-fenced funding for certain objectives, meaning that multi-functional project funding can be difficult and time-consuming to obtain

[ii] These are replacing Common Agricultural Policy (CAP) in England now the UK has left the EU. They pay for managing land in a way that delivers 'public goods', such as biodiversity or carbon sequestration. There are three schemes in England - Sustainable Farming Incentive (SFI)+ Countryside Stewardship (CS) ('combined offer'), and Landscape Recovery (LR) – reflecting increasing scale and complexity of actions. SFI and Landscape Recovery have launched, with revised CS due to be launched in 2024.

[jj] Separate to ELMS, this Welsh scheme will replace the CAP and aims to improve environmental management practices on agricultural land in Wales. It is due to be implemented from 2025.

[kk] This older scheme is being evolved as part of ELMS instead of 'Local Nature Recovery' schemes.

- short windows for grant application and project delivery that do not consider natural timescales, for example where implementation is restricted due to spawning seasons or dangerous weather conditions. This can restrict design consideration, with higher management costs and reduced effectiveness[20,56,131,133,162,164,167–170,173,184,189]

Suggested proposals to address barriers include that nature-based solutions be the default option wherever feasible and creating nature-based consenting teams within government departments.[133] Other funding mechanisms cited include the Natural Environment Investment Readiness Fund and Landscape Recovery (in ELMS), which are perceived as more accessible for larger-scale, nature-based restoration.[63,133,164,171,182,184]

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Contributors

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Members of the POST board*

Professor J Biggs (Freshwater Habitats Trust)*

Kate Chandler, Dan Roberts, Emma Pollitt (Wildfowl and Wetlands Trust)*

Alistair Chisholm (Chartered Institution of Water and Environmental Management)

Rob Collins (The Rivers Trust)

Natural England*

Matthew Doran (CLA)

Lucinda Gilfoyle (Water UK)*

Dr D Gowing & Olivia Nelson (Floodplain Meadows Partnership)

Dr R Grawbowski (Cranfield University)*

Janina Gray (Wildfish)

JNCC

Martin Janes (River Restoration Centre)*

Professor P Johnes (University of Bristol)*

Sir John Lawton

Sue Marrs (NatureScot)*

J McCarthy (Scotland Rural College)

Dr S Mckenzie (Trent Rivers Trust)

Zoe Moore (NFU)

Ofwat

Professor S Ormerod (Cardiff University)*

Dr M Peacock (University of Liverpool)

Dr A Pickard (Centre for Ecology and Hydrology)

Dr Alan Puttock (University of Exeter)

Charles Rangeley-Wilson (CaBA Chalk Streams Working Group)

Joel Rees-Jones (LIFE River Dee)

Alan Sargent (3keel)

Professor C Sayer (University College London)*

Environment Agency*

Matthew Simpson (35percent/Constructed Wetlands Association)

Professor C Spray (University of Dundee)*

Defra*

*Denotes people and organisations who acted as external reviewers of the briefing

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