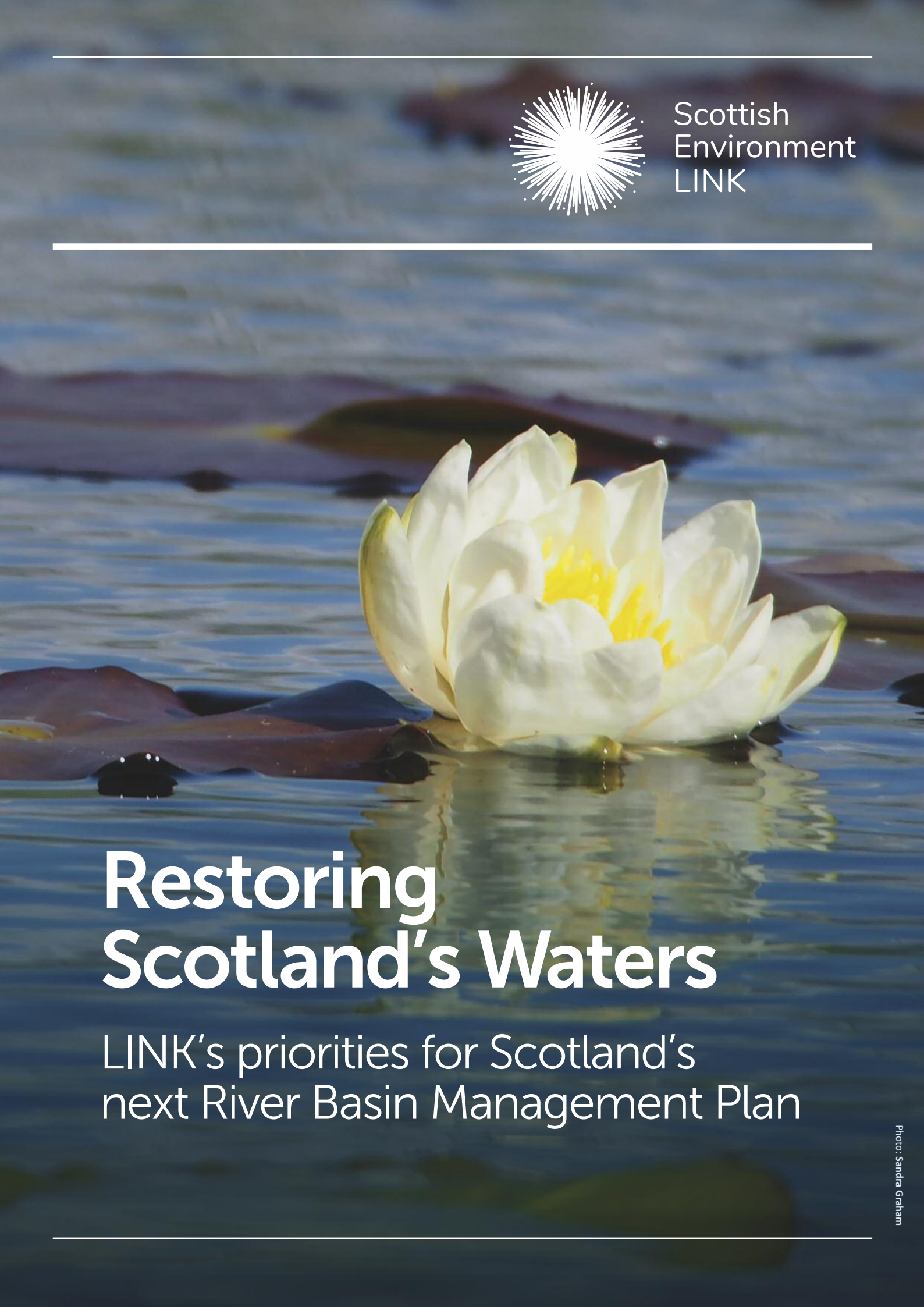
Scottish Environment LINK



Restoring Scotland's Waters

LINK's priorities for Scotland's next River Basin Management Plan

Photo: Sandra Graham

Introduction to Scottish Environment LINK

Scottish Environment LINK is the forum for Scotland's voluntary environment community, with 50 member bodies representing a broad spectrum of environmental interests with the common goal of contributing to a more environmentally sustainable society.

Its member bodies represent a wide community of environmental interest, sharing the common goal of contributing to a more sustainable society. LINK provides a forum for these organisations, enabling informed debate, assisting co-operation within the voluntary sector, and acting as a strong voice for the environment. Acting at local, national and international levels, LINK aims to ensure that the environmental community participates in the development of policy and legislation affecting Scotland.

LINK works mainly through groups of members working together on topics of mutual interest, exploring the issues and developing advocacy to promote sustainable development, respecting environmental limits. This report is supported by the following organisations:

Atlantic Salmon Trust

BSCG Badenoch & Strathspey Conservation Group

buglife Scotland

The Cairngorms Campaign

froglife leaping forward for reptiles & amphibians

Marine Conservation Society

scottish wild land group

Scottish Wildlife Trust

Photo: istockphoto.com

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Contents

Introduction

This report provides commentary on the issues affecting Scottish freshwaters, with the primary aim of influencing the development of the next River Basin Management Plan (RBMP), due for publication in December 2027. It highlights persistent challenges and identifies the actions that we believe are required to tackle them. The report seeks to shape the fourth RBMP to ensure that it is more ambitious, targeted, and deliverable.

Working with nature and investing in natural solutions is a cost-effective, less intensive approach to address issues such as pollution, drought and flooding, which modify habitats, affect species survival, and have knock-on impacts on Scotland's economy.

The actions highlighted in this report all contribute to the urgent task of securing healthier water environments across Scotland.

Photo: **Charlie Phillips**

1 Adopt a source to sea approach

Scotland is renowned for its freshwaters. From their source to the sea, they provide a home to iconic species such as the wild Atlantic salmon and freshwater pearl mussel, provide drinking water, are used to generate electricity, support game fisheries and are essential for the production of food and drinks, such as whisky. They are important for our heritage and promote health and well-being by providing opportunities for many recreational activities and aesthetic enjoyment. Their natural capital means that they have considerable economic value.

Scotland's freshwater ecosystems represent an intricate network that flows from the highest mountain springs through to our coastal waters. The conventional compartmentalised management of these systems has historically failed to recognise their interconnected nature. When we examine water quality issues in isolation, we miss the cumulative impacts that occur across the entire catchment.

Pollutants originating in freshwaters transform and compound as they travel downstream, ultimately flowing into coastal waters where they impact marine ecosystems. Contaminants and sewage debris don't simply disappear at river mouths – they continue their journey into estuaries, beaches and nearshore habitats, affecting marine life such as shellfish beds, seagrass meadows and coral communities. This connectivity between freshwater and marine environments creates complex challenges that single-point interventions cannot address, as the ecological consequences ripple across the entire source-to-sea continuum.

The concept of source to sea management acknowledges that our waterways function as continuous systems where upstream activities invariably affect downstream conditions. This holistic perspective becomes particularly pertinent when considering that much of Scotland's landmass drains into sensitive coastal environments, including internationally significant estuaries and firths. The ecological health of these transitional waters largely depends upon the quality of freshwater inputs they receive.

What action is required?

- Develop governance structures, such as catchment-based management frameworks, that manage water from source to sea as complete systems rather than isolated segments.
- Develop metrics that measure ecological connectivity between freshwater, transitional, and marine environments.
- Use flagship species like wild Atlantic salmon that depend on the entire source-to-sea continuum as indicators and conservation priorities.
- Prioritise upstream pollution prevention by focussing pollution control efforts at source areas before contaminants enter the water system.
- Restore longitudinal connectivity by removing or modifying barriers that prevent natural water, sediment, and species movement throughout the system.
- Coordinate habitat improvements from headwaters to coastal areas to maximise ecological benefits.
- Create incentive schemes for upstream stewardship by providing financial benefits to upstream land managers who protect downstream water quality.
- Fines levied for pollution incidents should be fully allocated to the restoration of freshwater biodiversity in the catchment.

Further information: **Source to Sea briefing**

https://www.scotlink.org/wp-content/uploads/2025/04/Source-to-Sea-Briefing-March-2025.pdf

Photo: **Charlie Phillips**

Photo: istockphoto.com

2 Reduce spillages from the sewer network

The ageing infrastructure of Scotland's sewer network presents a significant challenge to water quality. Many urban areas rely on Victorian-era combined sewerage systems that channel both sewage and surface water runoff through the same pipes. During periods of heavy rainfall, these systems become overwhelmed, triggering combined sewer overflows (CSOs) and other emergency overflows that discharge untreated or partially treated effluent directly into waterways.

The volume of water in combined sewerage systems is highly dependent on the amount of run-off from rainfall on roofs, roads, and other hard or waterlogged surfaces. In wet weather, the amount of surface water entering the sewers may overload the capacity of the sewer. To prevent damage to the network and untreated water backing up into streets and homes, these combined sewers have overflows built in to relieve pressure on the sewer. Combined Sewer Overflows (CSOs) are typically designed to only operate at high flows, with raw diluted sewage being diverted from the sewer into a nearby watercourse.

There are over 4,000 CSOs in Scotland however only 34% are monitored to record the duration and frequency of spills, with data made publicly available for only 7% of overflows.[1] In comparison 91% of CSOs in England[2] and 96% of CSOs in Wales[3] are currently monitored.

Scottish Water reported sewer overflows in Scotland spilled over 21,000 times in 2023, for an average of 10 hours per spill event.[4] The total number of spills is likely to be much higher as these statistics only relate to 34% of the overflows that are currently monitored.

Spills of diluted but untreated sewage increase nutrient, organic matter, microplastic and chemical contaminant concentrations in water bodies. Sewage can also act as a source of persistent chemicals, which do not break down in the environment. As they continue to accumulate, they will eventually reach a threshold of harm. These inputs disturb natural ecosystem functions and reduce water quality. The breakdown of sewage organic matter will reduce dissolved oxygen levels and this will severely impact aquatic plant and animal species biodiversity. Sanitary items flushed down toilets also litter river banks and beds, and end up in coastal waters where they litter beaches. All of these impacts affect the wildlife living in the water, and can cause illness in water users such as anglers, kayakers and wild swimmers.

It is vital that people have the right to access safely managed drinking water services – defined as services that are located on premises, available when needed and free from contamination; and adequate sanitation – having access to facilities permitting the safe disposal of human waste and maintaining hygienic conditions.

1 Scottish Water – https://www.scottishwater.co.uk/Your-Home/Your-Waste-Water/Overflows
2 UK Government – https://www.data.gov.uk/dataset/19f6064d-7356-466f-844e-d20ea10ae9fd/event-duration-monitoring-storm-overflows-annual-returns
3 Welsh Water – https://corporate.dwrcymru.com/en/community/environment/combined-storm-overflows
4 Scottish Water – https://www.scottishwater.co.uk/Your-Home/Your-Waste-Water/Overflows/Live-Overflow-Map

What action is required?

We welcome the recent publication by Scottish Water of a near real time map of spills from monitored overflows,[4] however despite Scottish Water publishing a routemap for Urban Waters in 2021, only 3% of CSOs have been identified as high priority discharges for improvement by 2027.[5] To tackle this problem we believe the following actions are required:

- Implement monitoring of all CSOs and make spillage data available in real time.
- Progressively phase out the use of CSOs through investments in the Scottish sewerage network to separate foul and surface water, increase capacity, and reduce the reliance on CSOs, prioritising all large and frequently spilling CSOs and those affecting protected areas.
- In the interim, the outfalls from CSOs should be fitted with screens to prevent sewage related debris from entering watercourses and coastal waters.
- Invest in nature-based solutions such as SUDS, rain gardens, and green roofs to reduce reliance on the sewerage network.
- Ban all avoidable single-use plastics in wet wipes and other sanitary items, such as tampons and their applicators, where suitable alternatives exist, and make reusable sanitary products more accessible.
- Apply Extended Producer Responsibility (EPR) to all sanitary products (not just those that contain plastic) to cover clean-up costs.
- Improved labelling and consumer awareness to promote correct disposal. As a minimum this should include requirements from the EU Single Use Plastics Directive (e.g. a requirement for products to display 'Plastic in Product' and 'Do not flush' labels).
- Promote the fitting of filters in washing machines to capture microfibres from clothing.

Further information: **Source to Sea briefing**

https://www.scotlink.org/wp-content/uploads/2025/04/Source-to-Sea-Briefing-March-2025.pdf

Combined Sewer Overflows Policy Paper

https://media.mcsuk.org/documents/Storm_Overflows_Position_Statement_-_Marine_Conservation_Society_-_March_2023.pdf

4 Scottish Water – https://www.scottishwater.co.uk/Your-Home/Your-Waste-Water/Overflows/Live-Overflow-Map

5 Scottish Water – https://www.scottishwater.co.uk/About-Us/What-We-Do/Urban-Waters-Routemap

Photo: istockphoto.com

Photo: Sergey Yeliseev

3 Build resilience of freshwater environments to climate change

Scotland, and the world, is facing a twinned climate and nature crisis. Building resilience to the climate crisis and nature restoration must go hand in hand through effective nature based solutions which deliver multiple benefits, such as sequestering carbon emissions, creating habitats for wildlife, and mitigating the impacts of the climate crisis. Restoring our freshwater habitats, in particular, can make an important contribution to building resilience to flooding and mitigating for increasing water temperatures. Nature-based solutions allow for a long-term strategy of climate resilience and should therefore be looked on as the first-choice option.

SEPA estimates that 284,000 properties, businesses and services are currently at risk in Scotland, and this is expected to increase to almost 400,000 by 2080 as a result of climate change. Peak rainfall intensities and river flows are expected to increase by 50% and 60% respectively, and sea levels around the coast of Scotland will continually rise at faster rates, and are predicted to be between 0.8 and 1.9m higher by 2100.

In addition to the effects of flooding, average water temperatures in our rivers have risen by 0.8°C since the 1970s,[6] with summer maxima increasing even more dramatically in some catchments.[7] These thermal shifts have profound implications for temperature-sensitive species like Atlantic salmon and stoneflies, whose life cycles are dependent on cooler environments.

Giving more space for rivers and coasts to move and adjust naturally will regenerate habitat, improve wildlife, and help us adapt to climate change. Measures such as avoiding development on floodplains (including where mitigation is proposed), arable reversion and implementing measures such as crop rotations will support our adaptation to the effects of climate change, helping to restore the functionality of some floodplains. High proportions of rivers are disconnected from their floodplain by embankments and flow control structures, limiting the scope of those floodplains to hold water during high flows and contributing to downstream flooding issues.[8]

6 Pohle, et al. (2019). Citizen science evidence from the past century shows that Scottish rivers are warming. https://www.sciencedirect.com/science/article/abs/pii/S0048969718352100?via%3Dihub

7 Loerke, et al. (2023). Long-term daily stream temperature record for Scotland reveals spatio-temporal patterns in warming of rivers in the past and further warming in the future. https://www.sciencedirect.com/science/article/pii/S0048969723028152

8 Maltby, E., Ormerod, S., Acreman, M., Blackwell, M., Durance, I., Everard, M., Morris, J., Spray, C., Biggs, J., Boon, P., Brierley, B., Brown, L., Burn, A., Clarke, S., Diack, I., Duigan, C., Dunbar, M., Gilvear, D., Gurnell, A., Jenkins, A., Large, A., Maberly, S., Moss, B., Newman, J., Robertson, A., Ross, M., Rowan, J., Shepherd, M., Skinner, A., Thompson, J., Vaughan, I. and Ward, R. (2011). Chapter 9: Freshwaters – Openwaters, Wetlands and Floodplains. UK National Ecosystem Assessment, pp. 295-360, Cambridge, UK, UNEP-WCMC.

Photo: **Matt Wilson**

The restoration and recreation of wetlands, such as reedbeds, ponds, wet meadows and wet woodlands, will make a significant contribution to securing biodiversity (such as amphibians and a wide range of aquatic invertebrates), healthy functional ecosystems and the provision of ecosystem services, as well as being crucial to the protection and enhancement of rivers, lakes and other freshwater habitats. Other measures such as natural regeneration and targeting tree planting to riparian areas will help to shade watercourses and prevent water temperatures rising. The Riverwoods initiative[9] has highlighted the transformative potential of native woodland restoration along riparian corridors. Beyond providing shade that moderates water temperatures, these woodlands create intricate root systems that stabilise banks, filter agricultural runoff, and slowly release groundwater during dry periods. The fallen woody material they contribute to waterways creates flow diversity and habitat complexity that helps aquatic communities withstand climate extremes.

In Scotland we are already ahead of the game with using sustainable solutions to flood risk. Our flood management legislation advocates a sustainable approach to reducing flood risk, including the use of natural flood management techniques such as riparian and catchment woodland creation, river restoration, instream woody debris, and floodplain washlands.[10] However, the uptake of these measures is generally low, and much more should be done to manage our freshwater environment in a natural, sustainable way.

Connectivity is a key attribute required for healthy, functioning ecosystems. The prioritisation of projects or proposals mapped through Nature Networks could be used to enhance connectivity, both directly (e.g. fish passage projects which improve physical connectivity, and enhancements to lateral connectivity by reconnecting rivers with their floodplains) as well as by considering the quality of connected habitats. For example, a river restoration project may be more valuable if it links upstream and downstream areas which have already been restored, as it increases the area of connected high quality habitat. Mapping of priority wetland habitats would also identify existing areas of good-quality habitat as well as opportunities for restoration, and allow the identification of areas where habitat restoration or re-creation will be valuable to support biodiversity delivery as well as creating functional floodplains/coastal habitats that can play a role in flood and coastal erosion risk management.

9 https://www.riverwoods.org.uk/

10 Flood Risk Management (Scotland) Act 2009: https://www.legislation.gov.uk/asp/2009/6/contents

What action is required?

- **Restoration of riparian habitats:** Restoring, enhancing and protecting riparian habitats, the land adjacent to a freshwater body, is a valuable line of defence against flooding. These habitats play a key role in mitigating the effects of flooding through dissipating the speed and volume of flood water, reducing impacts downstream. Riparian areas can absorb and store water during high flows and slowly release it, reducing the likelihood of surrounding land becoming overwhelmed with flood water.

- **A catchment-based approach:** Natural flood management (NFM) techniques play a crucial role in mitigating flood risks. This involves planting trees and restoring wetlands to slow water flow, creating flood plains to allow rivers to expand safely, and restoring meandering river courses. These measures work with nature to reduce the speed and volume of floodwater. These techniques work best when they are employed on a catchment wide basis so that the flow of water is managed from source to sea.

- **Promoting sustainable farming practices:** This can play a significant role in flood management. Encouraging soil management techniques that reduce runoff and promoting crop rotation and cover crops to improve soil structure can help mitigate flooding at its source. By combining these various approaches, Scotland can work towards reducing the impact of river flooding and creating more resilient riverside communities.

- **Enhance funding and financial incentives:** Establish dedicated, long-term funding streams for NFM projects. This could include creating a specific NFM grant programme or integrating NFM more prominently into existing flood management budgets. Additionally, develop financial incentives for landowners and farmers to implement NFM measures, such as payments for ecosystem services or for land used in NFM schemes.

- **Improve the evidence base and monitoring:** Invest in long-term monitoring programmes to build a robust evidence base for NFM effectiveness, focussed on existing and new demonstration sites. Use this data to develop more accurate models for predicting NFM outcomes, helping to reduce uncertainty and build confidence in these approaches.

- **Integrate NFM with other environmental objectives:** Align NFM initiatives with other environmental goals such as biodiversity enhancement, water quality improvement, and carbon sequestration. This could help attract additional funding and support from various sectors.

Further information: **Building nature-based resilience to flooding**
https://www.scotlink.org/wp-content/uploads/2024/10/Flooding-LINK-briefing.pdf

Photo: istockphoto.com

Photo: Craig Macadam

4 Restore natural processes to rivers and lochs

Scotland's industrial heritage has left over 2,200 barriers in rivers that block natural flows and fish migration. Few Scottish rivers remain free-flowing, where water and sediments move unimpeded, fish migrate freely, and rivers naturally adjust on their floodplains. Despite plans to address 262 barriers by 2027, complete restoration would take over 50 years at current rates.

Rivers need space to move naturally, helping regenerate habitats and adapt to climate change. While fish passes allow migratory movement, only complete barrier removal restores natural flow processes and sediment movement. Rivers have been disconnected from floodplains by embankments and flow control structures, limiting their ability to hold water during high flows and provide habitat for reptiles, amphibians, invertebrates, and wetland plants.[11]

The underground water flow amongst stones and gravels below rivers forms crucial habitat for invertebrates and influences river chemistry. These invertebrate populations support fish, and are vital to Scotland's food, drink, and tourism sectors.[12]

Climate resilience depends on this underground flow, which can be damaged by abstraction, development, and sedimentation.

Scotland's lochs have been extensively modified through water level manipulation, shoreline hardening, and nutrient enrichment. These interventions have caused biodiversity loss and habitat deterioration. Restoration requires recognising that lochs evolved within specific hydrological regimes, where natural water level fluctuations create essential habitat diversity.

Pumped storage hydropower in the Scottish Highlands presents additional concerns. While providing grid storage and balancing capabilities, these projects can damage ecologically sensitive landscapes. Beyond immediate habitat destruction, the rapid and frequent water level fluctuations required for scheme operation significantly alter watershed hydrology and loch shoreline dynamics. These changes can profoundly disrupt aquatic food webs and damage sensitive spawning grounds crucial for migratory fish species, particularly Atlantic salmon.

11 Maltby, E., et al. (2011). Chapter 9: Freshwaters – Openwaters, Wetlands and Floodplains. UK National Ecosystem Assessment, pp. 295-360, Cambridge, UK, UNEP-WCMC

12 The economic value of game fishing was estimated at £112 million per annum in Scotland in 2004 (Radford, A., Riddington, G. & Anderson, J. (2004) The Economic Impact of Game and Coarse Fishing in Scotland. Report prepared for Scottish Executive Environment and Rural Affairs Department.)

What action is required?

Government policy and strategies must support:

- Projects that will restore freshwater habitats as critical nature-based solutions to climate change.
- Existing work to identify and remove unnecessary/defunct structures in our rivers, and enforcement to deal with unconsented works.
- Knowledge-sharing about techniques that work with natural processes with key stakeholders, particularly Local Authorities, and those involved in Flood Risk Management.
- Aligning nature-based solutions to flood management with the Scottish Planning Policy, particularly National Planning Framework 4 (NPF4).
- Comprehensive assessments of the impact of new structures upon freshwater, beyond just considering the impacts on migratory fish.
- The restoration and recreation of wetlands, such as reedbeds, ponds, wet meadows and wet woodlands to make a significant contribution to securing biodiversity.
- Measures avoiding development on floodplains, arable reversion and implementing measures such as crop rotations to adapt to the effects of climate change.
- Habitat restoration and creation, planned and prioritised through a spatially mapped national Nature Network informed by local knowledge to enhance ecosystem connectivity.
- Establishing a range of funding sources for habitat restoration.
- Including a target on free-flowing rivers in the monitoring framework for the River Basin Management Plan. For example, the EU's Biodiversity Strategy for 2030 includes a target to restore at least 25,000 km of free-flowing rivers.[13]
- Bespoke schemes within tier 3 of the reformed agricultural support package to encourage cooperative "at scale" applications with a focus on riparian health. These schemes also need to be sufficiently resourced.
- Full and proper implementation of the Scottish Beaver strategy.[14]

Further information:

The Importance of free-flowing rivers
https://www.scotlink.org/wp-content/uploads/2022/05/LINK-Free-flowing-rivers-briefing-May-2022.pdf

Hydropower and freshwater habitats
https://www.scotlink.org/wp-content/uploads/2024/10/Hydropower-LINK-briefing.pdf

13 European Commission, 2021. EU Biodiversity Strategy for 2030, p.14. Available at: https://op.europa.eu/en/publication-detail/-/publication/31e4609f-b91e-11eb-8aca-01aa75ed71a1

14 https://www.nature.scot/doc/scotlands-beaver-strategy-2022-2045

Photo: Sandra Graham

Photo: **Trevor Renals**

5 Tackle Invasive non-native species

Invasive Non-Native Species (INNS) represent one of the most significant drivers of biodiversity loss across Scotland.[15] This threat continues to intensify throughout terrestrial, marine, and freshwater ecosystems, with projections indicating worsening conditions as new species arrive and climate change progresses.

These two factors, INNS and climate change, operate synergistically, creating increasingly favourable conditions for the establishment and spread of human-introduced species. Research demonstrates that the likelihood of non-native species establishing viable populations increases significantly as temperatures rise.[16]

The impact of INNS on Scotland's natural heritage remains severe and persistent. Protected areas across the country have shown no significant improvement in ecological condition over the past 15 years, with invasive species constituting the primary pressure affecting these sites. Beyond the ecological damage, INNS impose substantial economic costs, estimated at nearly £500 million annually for Scotland alone.[17] On a broader scale, invasive species have cost the UK economy more than £5 billion over the past four to five decades – one of the highest financial burdens in Europe.[18]

Prevention and rapid response strategies offer considerable economic advantages compared to delayed intervention. Timely action implemented at appropriate ecological scales can yield substantial cost savings while better preserving natural systems. However, the accelerating spread and intensifying impacts of INNS across Scotland clearly demonstrate that current management efforts remain insufficient.[19] Eradication programmes often fall short of completion, success metrics frequently fail to address appropriate ecological scales, and best practice protocols are inconsistently followed.

To achieve meaningful nature restoration in Scotland, greater priority must be given to effectively addressing the INNS challenge. Comprehensive and sustained action on invasive species represents an essential prerequisite for successful ecological recovery and the protection of Scotland's unique biodiversity.

15 State of Nature Report (2019) https://www.scotlink.org/publication/state-of-nature/

16 Invasive alien species and climate change. IUCN (2025). https://iucn.org/sites/default/files/2025-03/invasive-alien-species-and-climate-change-feb.-2025-update.pdf

17 Direct costs of invasive non-native species to the UK. Cabi 2023 https://www.cabi.org/news-article/invasive-non-native-species-cost-uk-economy-an-estimated-4bn-a-year-new-cabi-led-study-reveals/#:~:text=Researchers%20working%20from%20CABI's%20centres,Wales%20and%20Northern%20Ireland%20respectively.

18 Cuthbert, et al. (2021). Economic costs of biological invasions in the United Kingdom. https://neobiota.pensoft.net/article/59743/

19 JNCC Biodiversity Indicator B6 https://jncc.gov.uk/our-work/ukbi-invasive-species/

What action is required?

- Keeping Scotland's lochs, rivers and catchments free from spreading INNS, especially Ponto-Caspian species, will need a step-change in SEPA's monitoring programme and stringent biosecurity, and in public and target audience communications on biosecurity, as initiated by the Check Clean Dry campaign.[20]

- The establishment of a fully operational INNS Inspectorate active in Scotland to promote and maximise effectiveness of national INNS biosecurity efforts, with a focus on pathways of introduction.

- Regulation of the sale of invasive or potentially invasive species can be a key tool in tackling the INNS threat strategically. There is a ban on sale currently of 38 INNS species in Scotland.[21] Banning the sale of species already extensively established – eg North American Signal Crayfish – is not an alternative or significant contributor to successfully tackling ongoing invasion through control and eradication at whole-population scale. The Great Britain Non-Native Species Secretariat (GBNNSS) Horizon Scanning exercise identified the top 30 non-native species likely to become invasive in Britain over the next ten years – seven of these species live in freshwaters. LINK recommends that the sale of all relevant species on this list should be banned in Scotland. Species that are relatively recently established and extending range in Scotland should be the next priority.

- Monitoring and Reporting: To facilitate early warning and rapid response reporting systems should be simplified, with clear and explicit government-led guidance on reporting of INNS for both professionals and the public. When INNS control programmes are undertaken, monitoring must extend beyond the lifetime of individual projects to detect potential re-invasion.

Further information: **Invasive Non-native Species in Scotland**
https://www.scotlink.org/wp-content/uploads/2024/10/LINK-Briefing-Invasive-Non-native-Species-in-Scotland-October-2024.pdf

20 https://www.nonnativespecies.org/what-can-i-do/check-clean-dry
21 https://www.legislation.gov.uk/ssi/2019/38/schedule/made

Photo: GBNNSS

Photo: istockphoto.com

6 Protect groundwater from over abstraction

Groundwater represents one of our most precious natural resources, yet it remains largely unseen and consequently undervalued. There are over 4,000 boreholes in Scotland and 20,000 springs and wells used for private water supplies.[22] These groundwater resources not only supply drinking water, but simultaneously support agriculture, industry, and maintain the ecological health of our rivers and wetlands. However, the increasing demands placed upon these finite resources have led to over-abstraction, whereby water is withdrawn faster than it can naturally replenish. This imbalance threatens not only our future water security but also the delicate ecosystems dependent upon groundwater-fed springs and streams, particularly during periods of drought when surface water sources may diminish.

The consequences of excessive groundwater abstraction extend far beyond mere water scarcity. As water tables decline, the costs and energy requirements for pumping increase substantially, leading to greater carbon emissions and operational expenses. In coastal regions, over-abstraction can trigger saltwater intrusion, wherein seawater infiltrates freshwater aquifers, rendering them unusable for decades or even centuries.

The ecological consequences of excessive groundwater abstraction are profound and far-reaching. As water tables decline, groundwater-dependent ecosystems experience significant stress, often leading to irreversible damage. Wetlands, which serve as crucial habitats for diverse flora and fauna, may dry out completely, resulting in the loss of specialist species adapted to these unique environments. Lowered groundwater levels can reduce the base flow to rivers and streams, leading to increased water temperatures and decreased oxygen levels that stress aquatic organisms. During prolonged periods of abstraction, the disconnection between groundwater and surface water bodies can transform perennial streams into intermittent ones, disrupting the life cycles of fish, amphibians, and aquatic invertebrates that rely on continuous water flow for survival, reproduction, and migration.

These impacts demonstrate that groundwater management must be approached with consideration for both immediate needs and long-term sustainability. Effective protection of groundwater resources requires a shift in our collective mindset regarding water as a resource. Integrated catchment management approaches, that consider the interconnections between surface water, groundwater, land use, and climate change, enable more holistic and adaptive strategies. By embracing such comprehensive approaches, we can ensure that our groundwater resources remain viable for generations to come, balancing human needs with environmental sustainability in a changing climate.

22 Macdonald, A.M. et al. (2005). An overview of groundwater in Scotland. SJG 41:3-11 https://nora.nerc.ac.uk/id/eprint/12230/1/AMM_overview_NORA.pdf

What action is required?

- **Strengthen abstraction licensing:** Implement more rigorous licensing requirements with volume limits based on aquifer recharge rates and environmental flow needs.
- **Establish groundwater protection zones:** Create designated areas with restrictions on activities that could harm groundwater quality or quantity.
- **Mandate monitoring and reporting:** Require all significant abstractors to install monitoring equipment and regularly report usage data.
- **Set minimum ecological flow standards:** Develop science-based standards for minimum flows needed to sustain groundwater-dependent ecosystems.

Photo: istockphoto.com

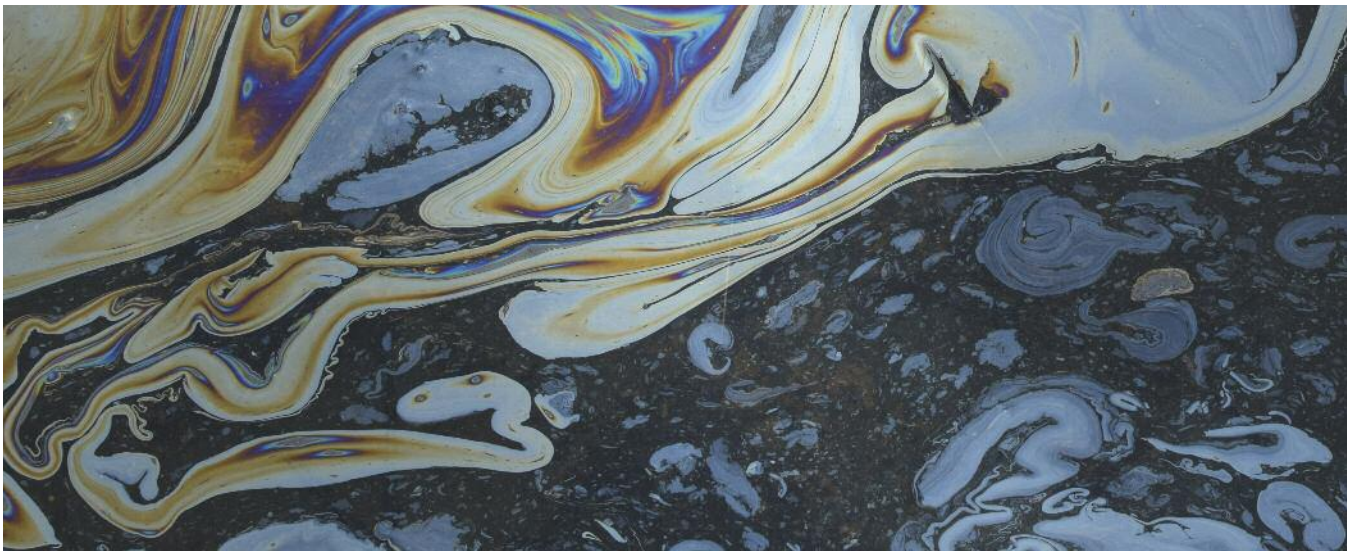

Photo: istockphoto.com

7 Chemicals – novel pollutants

Despite great strides in tackling diffuse and point source pollution from traditional sources such as agriculture, mine drainage, and the sewerage network, there is still much to do to tackle the growing number of novel pollutants. The WFD Watch List provides a useful starting point for identifying pollutants of potential concern, however the surveillance required is limited. In this regard SEPA should go beyond minimum compliance requirements and investigate further the prevalence of substances on the Watch List across Scotland, not just in a limited number of samples to fulfil the Watch List monitoring requirements.

Similarly SEPA should develop monitoring programmes for other novel pollutants including:

- Pharmaceuticals such as analgesics (eg paracetamol, ibuprofen, etc.), antidepressants (eg fluoxetine), antibacterial compounds (eg triclosan), anticonvulsants (eg carbamazepine), and oestrogens.
- Veterinary medicines such as wormers (eg avermectins), and domestic flea treatments (eg fipronil and imidacloprid).
- Agricultural chemicals such as fungicides (eg tebuconazole, prothioconazole, etc.) and molluscides (eg metaldehyde and ferric phosphate).
- Emerging persistent pollutants such as all PFAS compounds (not limited just to PFOA & PFOS).

Furthermore, ecological/biological monitoring should be carried out in line with environmental contaminant monitoring to determine if there are associated effects on populations as a result of chemical contaminants. The Environment Agency is developing an Early Warning System as an approach to combat emerging contaminants, in order to take a proactive, rather than reactive approach, and we would like to see SEPA develop something similar.

A robust and strategic approach to tackling chemicals in the freshwater and nearshore environment is urgently required. Scotland, alongside England and Wales as part of UK REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), should align with EU REACH framework which will prove to be much more cost-effective and prevent any unnecessary work, time and money being spent on system duplication. Only by linking elements of the Water Framework Regulations with a regulatory control of substances of very high concern can the intended protection of water bodies/aquatic ecosystems be achieved.

What action is required?

- Extend monitoring beyond minimum compliance requirements to assess the prevalence of Watch List substances across all Scottish water bodies.
- Develop comprehensive monitoring programmes for pharmaceuticals, veterinary medicines, agricultural chemicals, “forever” chemicals such as PFAS and other emerging contaminants of concern.
- Conduct parallel ecological/biological monitoring alongside contaminant surveillance to establish cause-effect relationships.
- Develop a proactive monitoring and response framework similar to the Environment Agency's Early Warning System.
- UK REACH framework to fully align with European REACH decisions to ensure protections in the UK aren't lower than the EU.
- Raise awareness in consumers about the environmental impacts of household products containing novel pollutants.

Further information:

The chemical pollution crisis: a growing problem with achievable solutions

https://www.scotlink.org/wp-content/uploads/2021/10/Chemical-Pollution-briefing-for-MSPs.pdf

Photo: istockphoto.com

Photo: **Neil Phillips**

8 Extend monitoring to small waterbodies

Scotland's freshwater monitoring programmes have historically focused on larger water bodies classified under the Water Framework Directive. This approach, while pragmatic from a resource perspective, overlooks the ecological significance of smaller water features that collectively form a substantial portion of the freshwater resource.

Headwater streams, despite accounting for over 70% of total stream length in many catchments, remain largely unmonitored. These capillary-like waterways serve as critical spawning habitat for salmonids and provide unique ecological niches for specialised invertebrate communities adapted to their distinctive physicochemical conditions. They also function as the primary interface between terrestrial and aquatic environments, making them particularly vulnerable to land-use practices in their immediate vicinity.

Springs and seepages represent groundwater-surface water transition zones with exceptional biodiversity value relative to their size. These features often support highly specialised species assemblages adapted to the stable temperature regimes and distinct water chemistry that characterise groundwater inputs. The cryptic nature of many of these habitats means their very existence often goes undocumented until they are lost to development or drainage.

Ponds and small standing waters have similarly escaped systematic assessment despite their disproportionate contribution to aquatic biodiversity. Studies in the Central Belt have demonstrated that a network of small ponds often supports more macroinvertebrate species than a single large water body of equivalent total area. These small waters frequently serve as stepping-stone habitats that maintain metapopulation dynamics across landscapes.

The current monitoring gap creates a fundamental information deficit about the status of these small waters. Without baseline data, detecting change becomes impossible, and degradation can proceed unnoticed until ecological thresholds are crossed and recovery becomes difficult or impossible.

What action is required?

- Small water bodies must be given the same priority as other important habitats, given their important contribution to Scotland's environment, wildlife and tourism sectors.

- Connectivity is a key attribute required for healthy, functioning ecosystems. Habitat restoration and creation, planned and prioritised through a spatially mapped national Nature Network in NPF4. Informed by local knowledge, this could be used to enhance connectivity, as well as by considering the quality of connected habitats. Mapping of priority wetland habitats would also identify existing areas of good-quality habitat as well as opportunities for restoration and allow the identification of areas where habitat restoration or re-creation will be valuable to support biodiversity delivery.

- Habitat restoration and creation should be funded by a combination of sources including Water Framework Directive, Scottish Rural Development Programme payments, the Nature Restoration Fund from government, Flood Risk Management funding, Scottish Water investment programme and other sources. Together, this spatial planning and framework integration can deliver the "urgent step change in effort" that the biodiversity crisis demands.

- Improving joint working, including via the sharing of information so that stakeholders are clearer on the contributions that they could make to improving the state of estuarine and coastal waters by undertaking work further up the catchment. Funding criteria for catchment based projects should include an assessment of whether they have incorporated actions which will contribute to improvements.

- Finally, it is important to monitor our progress towards addressing loss of our smaller freshwater bodies. A target should be developed, and progress towards meeting that target should be reported on a regular basis as part of the River Basin Management Plan.

Further information: **The Ecological Importance of Small Freshwater Bodies**
https://www.scotlink.org/wp-content/uploads/2022/05/Small-water-bodies-briefing-May-2022.pdf

Photo: Mae Mackay

Photo: **Philip Price**

9 Balance access to nature with space for nature

Scotland's access rights, enshrined in the Land Reform (Scotland) Act 2003 and expressed through the Scottish Outdoor Access Code,[23] have increased engagement with freshwater environments. This openness has fostered valuable connections between people and nature, yet the growing popularity of water-based recreation presents increasingly complex management challenges.

Visitor pressure has intensified dramatically across Scotland's most accessible and scenic freshwaters. The explosion in popularity of activities like wild swimming, paddle boarding and packrafting has transformed once-quiet lochs and rivers into busy recreational spaces, particularly during summer months and near population centres. The number of outdoor swimming groups registered in Scotland has quadrupled over the past decade, while sales of paddle sports equipment have shown consistent year-on-year growth.

This increased human presence carries various ecological implications. Waterbird breeding success can be affected as recreational disturbance increases. Studies at sensitive loch shorelines have documented vegetation trampling, soil compaction and bank erosion at popular access points. The issue extends beyond physical impact to include noise disturbance, which can disrupt breeding behaviours even when direct human presence remains distant from nesting sites.

Dog-related disturbance presents particular challenges. Despite guidance in the Scottish Outdoor Access Code regarding dog control near wildlife, observational studies at several wetland sites indicate compliance remains inconsistent. Ground-nesting birds prove especially vulnerable, with flushing distances significantly greater in response to off-lead dogs compared to human walkers alone. In addition, the disturbance caused by dogs entering waterbodies can result in damage to vegetation, clouding of the water through silt disturbance, be a source of pollution from pesticides used to treat fleas and ticks, and affect the breeding success of amphibians, fish and invertebrates.

The geographic concentration of access pressure compounds management challenges. Accessible waterways near urban centres and transport links experience disproportionate visitor numbers, creating hotspots of intense recreational use rather than distributing impact across wider landscapes. This pattern often concentrates pressure on precisely those water bodies already under greatest stress from urban pollutants and modified hydrology.

23 https://www.outdooraccess-scotland.scot/

What action is required?

- Implement an educational programme explaining local wildlife, their needs, and how visitors can minimise impact.
- **Implement temporal restrictions:** Establish seasonal limitations on certain activities during critical wildlife breeding periods.
- **Improve alternative recreation sites:** Develop additional facilities at less ecologically sensitive locations to redistribute visitor pressure, for example the introduction of dog water play facilities in 'Dog parks'.
- **Revise and promote the Scottish Outdoor Access Code:** Update guidance specifically addressing newer activities like paddleboarding and wild swimming.
- **Review access legislation implementation:** Evaluate how the Land Reform Act balances rights with responsibilities in light of increased recreational pressure.
- **Launch targeted awareness campaigns:** Focus on high-impact behaviours, particularly regarding dog control near water bodies.
- **Support community stewardship initiatives:** Empower local user groups to take responsibility for site protection through adoption schemes.
- **Consider targeted access permits:** Explore limited permitting systems for the most vulnerable sites during peak seasons.

Photo: Deborah Long

Photo: **Stuart Crofts**

10 Baseline monitoring and reporting

The effective management of Scotland's freshwater environments depends fundamentally upon robust, consistent monitoring that establishes baselines and tracks changes over time. The current monitoring landscape presents a complex patchwork of efforts by various organisations, each with different methodologies, frequencies and objectives.

SEPA maintains the most comprehensive national monitoring network, however resource constraints have necessitated a risk-based approach that concentrates effort on water bodies already identified as at risk or those subject to specific pressures. This pragmatic approach may overlook emerging issues in water bodies currently classified as 'not at risk' and potentially miss early warning signals of degradation.

Scottish Water's environmental monitoring focuses primarily on parameters directly relevant to drinking water quality and effluent compliance. While essential for public health protection, this targeted approach may not capture broader ecological indicators. Recent initiatives to expand monitoring around wastewater treatment outflows represent positive developments, though data accessibility for external researchers and conservation organisations remains limited in many cases.

Citizen science programmes have expanded considerably, with initiatives like the Anglers' Riverfly Monitoring Initiative providing valuable supplementary data. These programmes extend geographical coverage beyond what professional monitoring alone could achieve, though methodological standardisation and quality assurance present ongoing challenges for incorporating these data into official assessments.

Climate change adds urgency to baseline establishment, as shifting thermal and hydrological regimes redefine what constitutes 'normal' conditions. Without robust contemporary baselines, distinguishing between natural variation and anthropogenic impact becomes increasingly difficult, complicating evidence-based management decisions.

What action is required?

- Extend baseline monitoring beyond at-risk water bodies: Implement regular monitoring of currently "not at risk" water bodies to establish baselines and detect early warning signals.
- Extend the suite of parameters monitored by SEPA and Scottish Water to include emerging and novel pollutants such as pharmaceuticals, pesticides, plastics, etc.
- Implement a sentinel monitoring network: Establish a network of intensively monitored reference sites across different freshwater ecosystem types that can serve as early warning systems.
- Build on existing citizen science schemes to extend the reach and frequency of monitoring across Scotland.
- Include climate-sensitive indicators: Add specific monitoring parameters sensitive to climate change impacts, such as water temperature regimes, seasonal flow patterns, and thermal refugia availability.
- Establish a central data repository, based on an open data policy to ensure all monitoring data (with appropriate quality assurance) is publicly accessible in usable formats.

Photo: Mae Mackay

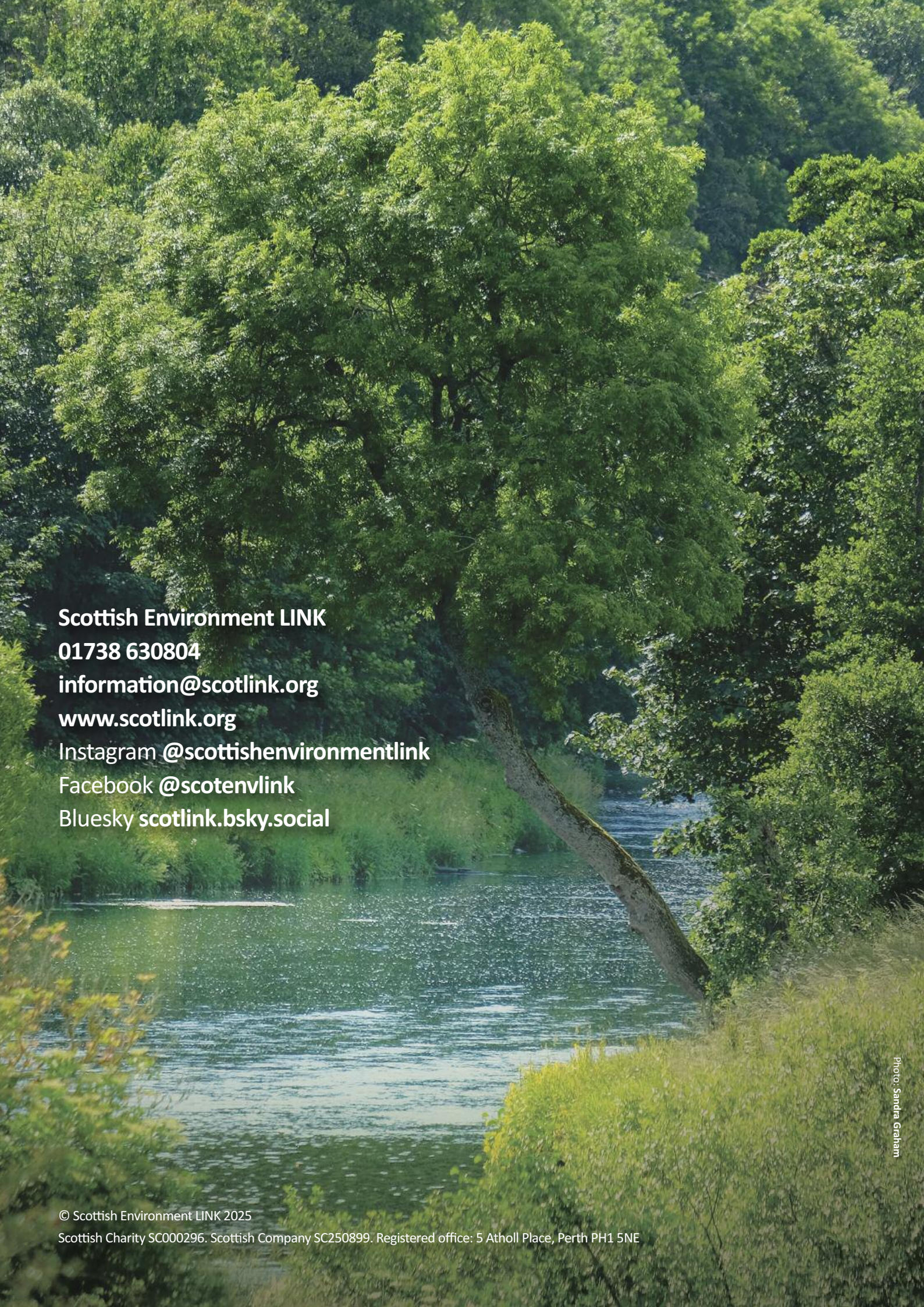

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Photo: Sandra Graham