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Addressing Europe's Freshwater Ecological Debt – A Policy Opportunity Under the Nature Restoration Regulation

Authors: Gonçalo Duarte¹, Angeliki Peponi¹, António Faro¹, Tamara Leite¹, Pedro Segurado¹, Florian Borgwardt², Annette Baatrup-Pedersen³, Sebastian Birk⁴, Teresa Ferreira¹, Paulo Branco¹

(¹ Forest Research Centre, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Lisbon, Portugal, ² BOKU University, Austria, ³ Department of Biology, Aarhus University, Aarhus C, Denmark, ⁴ Faculty of Biology, Aquatic Ecology, and Centre for Water and Environmental Research, University of Duisburg-Essen, Essen, Germany)

European freshwater ecosystems face widespread degradation, revealing a growing ecological debt across EU Member States. The EU Nature Restoration Regulation offers a critical opportunity to scale up ecological restoration and help Member States reverse these trends and restore the health and resilience of rivers and wetlands across Europe.

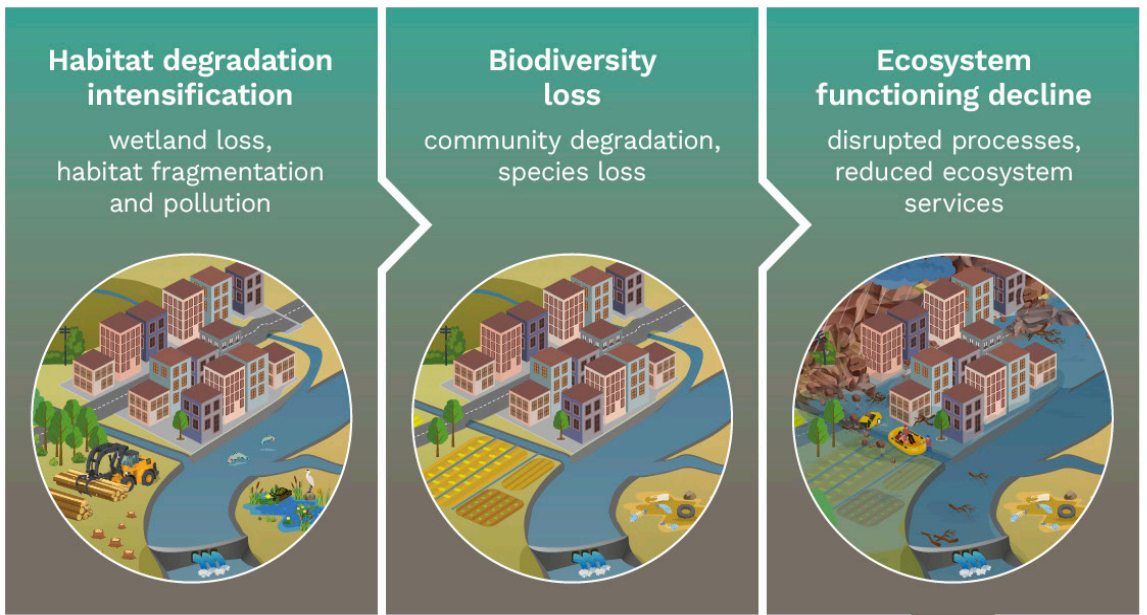
Further reading

- ➔ Duarte, G., Peponi, A., Faro, A., Leite, T., Segurado, P., Borgwardt, F., Baatrup-Pedersen, A., Birk, S., Ferreira, T., Branco, P. (2026) Europe's Ecological Debt: Mapping Freshwater Restoration Needs. *Global Change Biology* 32, e70778. <https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.70778>
- ➔ Duarte, G., Peponi, A., Segurado, P., Leite, T., Borgwardt, F., Funk, A., Birk, S., Ferreira, M.T., Branco, P. (2025) River Restoration Units: Riverscape Units for European Freshwater Ecosystem Management. *Data* 10, 46. <https://www.mdpi.com/2306-5729/10/4/46>
- ➔ Funk, A., Duarte, G., Branco, P., Hein, T., Schmidt-Kloiber, A., Leite, T., Peponi, A., Ferreira, M.T., Birk, S., Baatrup-Pedersen, A., Borgwardt, F. (2026) Moving towards Europe-wide freshwater restoration through model-based integration of policy objectives. *Water Research* 293, 125426. <https://www.sciencedirect.com/science/article/pii/S0043135426001089t>



Introduction

Freshwater ecosystems across Europe are under severe pressure from habitat degradation, pollution, and river fragmentation. A recent EU-wide spatial analysis covering European Union Member States and the United Kingdom reveals that restoration needs are widespread across European river networks. Despite decades of environmental policy under the Habitats Directive and the Water Framework Directive, large portions of freshwater habitats and river systems remain in unfavourable ecological condition. However, the implementation of the Nature Restoration Regulation (NRR) creates a timely opportunity to scale up restoration efforts and address these challenges. By supporting coordinated, landscape-scale restoration planning, this new regulation can help Member States close policy implementation gaps, restore ecosystem functioning, and improve biodiversity outcomes across European freshwater environments.



Nature Restoration Regulation



Scale of freshwater restoration needs in Europe

- ➔ Around 89% of river restoration units show restoration needs due to the poor conservation status of protected habitats from the Habitats Directive.
- ➔ Over 55% of river restoration units contain assemblages of freshwater-dependent species in poor conservation status.
- ➔ Nearly half of river restoration units are projected not to reach good ecological status under the Water Framework Directive.
- ➔ Less than 5% of river restoration units comply with both directives simultaneously.

Policy Gaps Between the Habitats Directive and Water Framework Directive

Across Europe, restoration needs tend to be greater when looking at indicators of habitats and species, than when looking at indicators of water-related ecological status. This suggests that habitat degradation often precedes biodiversity loss and eventually affects ecosystem functioning. In practice, this means that:

- ➔ Improvements in water quality alone may not be sufficient to restore biodiversity.
- ➔ Habitat condition and ecosystem connectivity require greater attention.
- ➔ Integration between the two directives remains limited in many areas.
- ➔ Strengthening coordination between biodiversity and water policies is therefore essential to achieve meaningful ecological recovery.

Europe's Freshwater Ecological Debt

Freshwater ecosystems are among the most biologically rich and socially valuable environments in Europe. They support biodiversity, provide water resources, regulate floods, and contribute to climate resilience. Yet they are also among the most degraded ecosystems on the continent.

This EU-wide spatial assessment of freshwater ecosystems shows that ecological degradation is widespread. Habitat degradation is particularly severe, affecting most river systems across Europe.

Species communities and ecosystem functioning are also impacted, reflecting the long-term effects of human pressures such as land-use change, pollution, and river modification.

These findings highlight what can be described as Europe's freshwater ecological debt—a legacy of ecological degradation that has accumulated over decades of human activity. Across Europe, we observe a cascading pattern of decline: habitat degradation occurs first, followed by biodiversity loss and, ultimately, impacts on ecosystem functioning. The scale of restoration needs identified across European river systems suggests that current conservation and water management efforts have not yet been sufficient to reverse these trends.

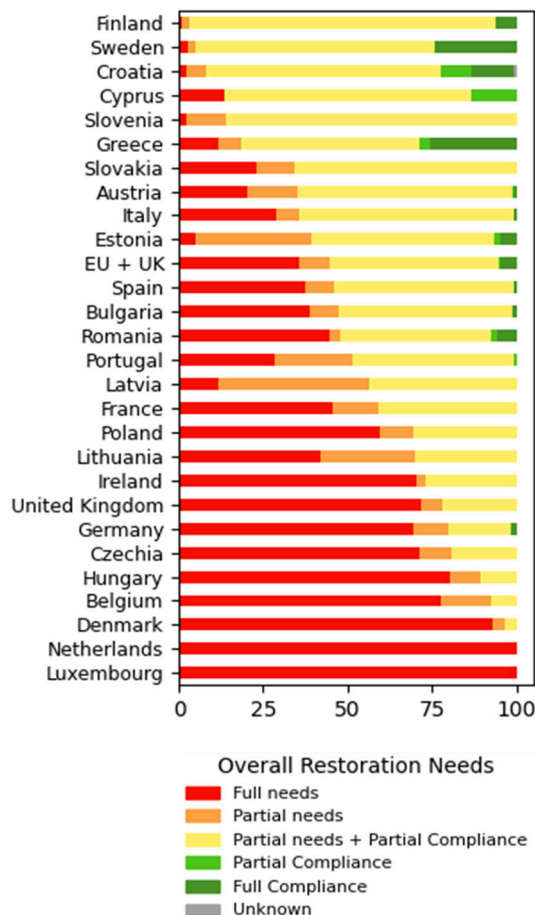


Figure 1: Distribution of River Restoration Units among restoration-need compliance classes across EU Member States and the United Kingdom (UK), based on combined restoration needs under the Habitats Directive and Water Framework Directive.

Scaling Restoration Across Europe's River Landscapes

The results reveal a clear pattern: restoration needs occur across large portions of European riverine landscapes (riverscapes) rather than being confined to isolated sites. This highlights the importance of scaling restoration beyond individual projects and adopting riverscape planning approaches that reflect the interconnected nature of rivers. Large-scale restoration planning can:

- ➔ improve river connectivity
- ➔ restore degraded habitats and strengthen biodiversity recovery
- ➔ enhance freshwater related ecosystem services
- ➔ enhance ecosystem resilience to climate change

Such approaches are essential if Europe wants to move towards transformative ecological recovery.

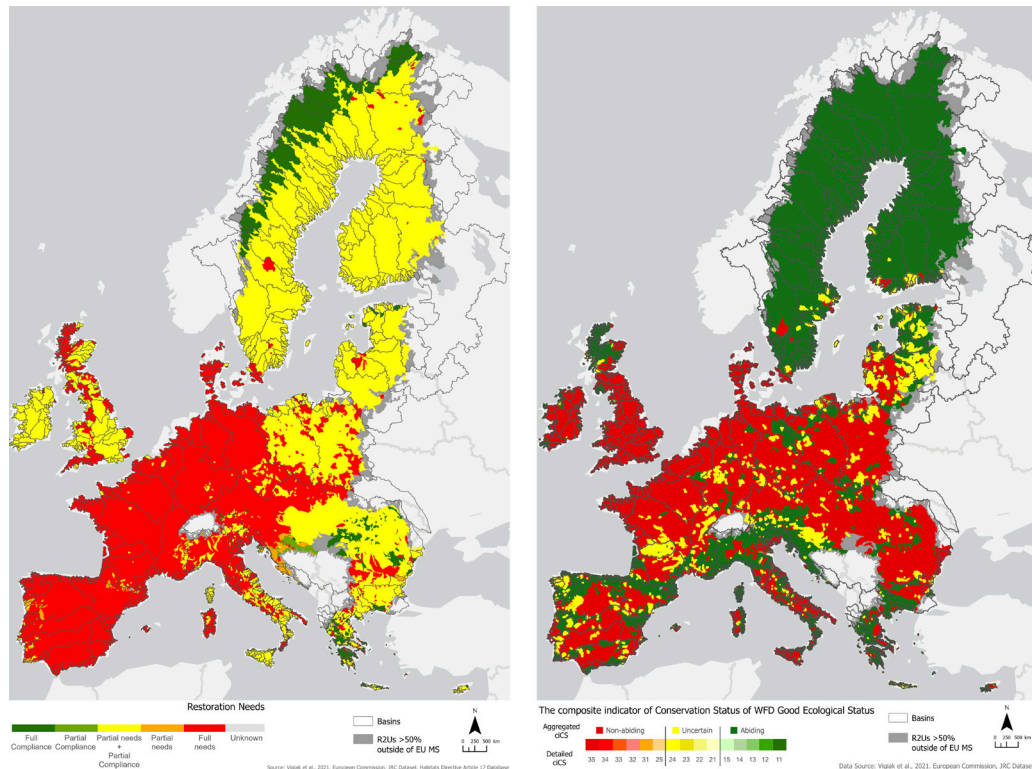


Figure 2: Restoration needs across Europe regarding the Habitats Directive (left) and the Water Framework Directive (right).

A Window of Opportunity: The Nature Restoration Regulation

The Nature Restoration Regulation provides an unprecedented opportunity to address Europe's freshwater ecological debt. By establishing legally binding restoration targets, the regulation creates a framework for Member States to expand restoration efforts and to improve ecological outcomes across river systems.

Without sustained action to restore degraded freshwater ecosystems, current trends of habitat degradation and biodiversity loss are likely to continue. As pressures accumulate, these changes may further undermine ecosystem functioning and the services that rivers and wetlands provide to society. Over time, the ecological consequences of continued degradation may become increasingly difficult to reverse and could lead to impacts that are challenging to anticipate.

If implemented effectively, the Nature Restoration Regulation can help:

- ➔ align restoration planning across biodiversity and water policies
- ➔ prioritise restoration where ecological gains are greatest
- ➔ scale restoration actions across entire river networks
- ➔ strengthen ecosystem services that support society and climate resilience

This EU-wide spatial evidence on restoration needs offers a valuable foundation for informing national restoration plans and identifying priority areas where restoration efforts can deliver the greatest ecological benefits.

Policy Recommendations

To maximise the effectiveness of the Nature Restoration Regulation, EU Member States should consider the following actions:

1. Scale restoration beyond isolated projects: Restoration efforts should move from local interventions toward coordinated actions across riverscapes.
2. Integrate biodiversity and water policies: Stronger coordination between the Habitats Directive and Water Framework Directive can improve ecological outcomes and reduce policy fragmentation.
3. Use spatial planning to prioritise restoration: EU-wide spatial analyses can help identify areas where restoration will deliver the greatest ecological benefits.
4. Support riverscape restoration planning: Planning approaches should reflect the interconnected nature of river systems and the broader landscapes that influence them.

Call to Action

The widespread restoration needs identified across European freshwater ecosystems highlight the urgency of action. The implementation of the Nature Restoration Regulation offers a timely opportunity for EU Member States to address long-standing ecological degradation. By upscaling restoration efforts and adopting landscape-scale planning approaches, Europe can begin to repay its freshwater ecological debt and restore the health and resilience of its river ecosystems.

Contact

Gonçalo Duarte

Forest Research Centre, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Portugal
goncalo.f.duarte@edu.ulisboa.pt; goncalofduarte@isa.ulisboa.pt