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# Nature Credits for Freshwater Restoration under the EU Nature Restoration Regulation

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The Nature Conservancy

# Foreword

At The Nature Conservancy (TNC), we work across more than 80 countries to conserve the lands and waters that life depends on. Increasingly, our work shows that achieving ambitious restoration and conservation goals requires not only robust government policies and public investment, but also innovative ways to support nature with private capital. This is why TNC is actively engaging in nature finance and exploring emerging nature credits as a tool to help accelerate and scale positive outcomes for biodiversity, freshwater ecosystems, and communities.

Through projects and initiatives in Europe, North America, Latin America, Africa, Asia, and Australia, TNC is working with governments, businesses, financial institutions, local communities, and conservation partners to test approaches that reward measurable nature outcomes, attract restoration and conservation investment, and strengthen the safeguards needed for nature markets and credits to deliver durable economic and ecological benefits.

Europe is entering a critical decade for nature restoration. The EU Nature Restoration Regulation marks an important step translating ambition into legally binding commitments to restore rivers, wetlands, and forests that support biodiversity, strengthen climate resilience, and provide benefits for communities. Meeting that ambition will require more than public funding alone. As governments, communities, businesses, and civil society move from commitment to implementation, nature-positive private finance, including well-designed nature credits, could help support river restoration at the scale needed.

Lessons from today's pilot projects, policy development, and implementation will help shape approaches in Europe and beyond. At its core, this report is about how additional finance, and specifically nature credits, could contribute to river restoration under the Nature Restoration Regulation, while identifying the practical, financial, governance, ecological, and scientific conditions needed for these mechanisms to succeed.

At TNC, we believe that nature credits should become one component of a broader financing architecture that brings together public, private, and philanthropic capital to support restoration where it can deliver measurable and lasting outcomes for people and nature. Crediting is not a substitute for public funding, or for long-term stewardship. The findings presented in this report highlight both the promise and the limitations of nature markets and underscore the importance of strong safeguards, scientific integrity, transparent governance, and practical monitoring systems.

Above all, this report reinforces a simple idea: financing mechanisms should serve nature restoration, not the other way around. With thoughtful and practical design, a focus on results, and stronger alignment across sources of capital, we can restore Europe's freshwater ecosystems to benefit people and nature today while also protecting those benefits for future generations.

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# Executive Summary

This report assesses the role of **biodiversity (nature) credits** in supporting the implementation of the Nature Restoration Regulation (EU) 2024/1991, with a specific focus on financing **barrier removal and freshwater ecosystem restoration** under Article 9. It situates nature credits within the broader EU policy trajectory, evaluates their practical applicability, and outlines the financial, governance, and methodological conditions required for their effective deployment.

The NRR establishes a legally binding Union-wide objective to restore 25,000 km of free-flowing rivers by 2030, primarily through barrier removal. Estimated **costs range from €224 million to €1.6 billion** depending on prioritisation strategies, with strong evidence that cost-efficiency can be achieved through carefully planned interventions. However, significant **uncertainty surrounding future EU budget allocations**, particularly under the Multiannual Financial Framework (2028–2034), creates a structural financing gap that cannot be met through public funding alone.

In this context, biodiversity credits are emerging as a **complementary financing mechanism** capable of mobilising private capital. This report explores strengths and weaknesses of both **voluntary models** (characterised by flexibility and innovation) and **compliance-driven systems** (offering greater scale and predictability). The EU's current approach, as reflected in the Roadmap towards Nature Credits, aims to combine these strengths through a principles-based framework allowing voluntary contribution to public nature restoration targets, and strict coherence with the mitigation hierarchy and environmental acquis. Yet, the report finds that the **current voluntary biodiversity credit markets remain immature**, characterised by low transaction volumes, fragmented standards, limited buyer engagement, and unresolved methodological challenges, particularly around additionality, monitoring, and durability. As a result, they are **unlikely to contribute at scale before 2030**. Early implementation of the NRR will therefore rely predominantly on public funding, with voluntary private engagement tested by **pilot projects** with potential developments for subsequent stages.

A phased and dual-track strategy is identified as essential. In the short term (2026–2027), **public finance should, alongside restoration activities, fund capacity building,** including baseline data collection, barrier including baseline data collection, barrier inventories, methodological development, environmental impacts assessment and MRV (Monitoring, Reporting and Verification) systems development. In parallel, pilot nature credit schemes should be developed to **test methodologies and governance models**. In the medium term (post-2027), these efforts, along with **blended finance mechanisms**, can support the gradual emergence of a more mature, standardised, and scalable market.

The report highlights that effective integration of biodiversity credits into National Restoration Plans (NRPs) requires careful alignment with regulatory requirements, including **additionality, permanence, and non-duplication of funding**. It also underscores the importance of **robust MRV systems**, enabling the monitoring of various ecological indicators (species, habitats, connectivity) with modern tools (remote sensing, field data, eDNA), while recognising the technical complexity and cost of monitoring freshwater systems.

From a financing perspective, restoration activities span three main phases: planning, implementation, and post-restoration monitoring, each with distinct cost drivers. While public funding remains the backbone of financing (currently covering up to 91% of needs**), private capital can be mobilised through blended finance structures**, and other mechanisms that can **support the emergence of biodiversity credits**. However, small-scale and fragmented projects typical of European landscapes face high transaction costs and limited investor appeal, making **aggregation into regional or national portfolios** a critical enabling condition.

Governance emerges as a central determinant of success. The report finds that **regional and national-level coordination**, combined with basin-level alignment for transboundary systems, offers the most effective **balance between ecological coherence and financial viability**. It is important, however, that responsibility is not diluted among different stakeholders at higher governance levels. Public actors play a pivotal role in aggregating projects, de-risking investments, and developing market infrastructure, including registries, standards, and technical assistance platforms.

Finally, the report stresses the **structural limits of private finance in the context of legally binding restoration targets**. Biodiversity restoration generates public goods with **uncertain and long-term financial returns**, making it inherently challenging to finance through market mechanisms alone. Public funding therefore remains indispensable, not only to bridge financing gaps but also to ensure additionality, safeguard ecological integrity, and support early-stage project development.

In conclusion, biodiversity credits (voluntary and compliance) have the potential to become a **meaningful component of the EU's restoration financing architecture** in the long term, but only as part of a broader, carefully sequenced strategy. Their effectiveness will depend on **strong public leadership, robust regulatory frameworks, institutional support and sustained investment in market infrastructure and ecological data systems**.

# A. Introduction and Situation analysis

## 1. EU policy trajectory on nature credits and nature markets.

Summary of the EU policy trajectory on nature credits and nature markets.

The European Union's approach to biodiversity (nature) credits[1] has undergone a significant transformation over the past decade. Initially, EU biodiversity policies, such as the 2011 Biodiversity Strategy to 2020, focused on **regulatory protection, green infrastructure, and public funding**, with little emphasis on market-based instruments like biodiversity credits. This **contrasted with global developments**, where the U.S. pioneered habitat and wetland mitigation banking as early as 1972, and Australia's Environmental Stewardship Program, launched in 2008, began paying farmers for biodiversity conservation, exploring the concept of market-based incentives for biodiversity protection.

A turning point came in May 2020, when the EU Biodiversity Strategy for 2030, part of the European Green Deal, introduced the potential for **market-based instruments**, explicitly exploring biodiversity offsets and credits to mobilize private finance. The 2022 proposal for the EU Nature Restoration Law further signalled this shift, setting binding restoration targets while leaving the role of biodiversity credits undefined. Globally, the Kunming-Montreal Global Biodiversity Framework (KM GBF), adopted at COP15 in 2022, explicitly **encouraged biodiversity credits and offsets as market-based solutions**, giving momentum to the EU's growing openness to such tools.

By 2023–2024, the EU began engaging with international frameworks like the Taskforce on Nature-related Financial Disclosures (TNFD) and the Science Based Targets for Nature (SBTN), as well as the Corporate Sustainability Reporting Directive (CSRD), recognizing the **need to integrate nature into corporate accounting and value chains across the EU**. In September 2024 Ursula von der Leyen advocated in favour of biodiversity credits as a tool to leverage private financing for biodiversity restoration and stewardship. This groundwork culminated in July 2025 with the publication of the **Roadmap Towards Nature Credits**, marking a decisive policy shift. The Roadmap formalized the adoption of the Biodiversity Credits Alliance (BCA), International Advisory Panel on Biodiversity Credits (IAPB) and the World Economic Forum (WEF) joint principles (BCA *et al.*, 2024), additionality, measurability, transparency, permanence, no double counting, and alignment with global goals like the KM GBF, and committed to pilot projects (2025–2027) testing nature credit systems for ecosystem restoration, pollinator support, and soil health. Led by governments in France, Finland, and Peru, these pilots aim to explore methodologies, governance, MRV and assess their impact on their ability to generate funding for nature restoration.

Parallel to these developments, the EU has leveraged private finance mechanisms to complement public funding. Programs like InvestEU (2021–2027) and the Natural Capital Financing Facility (NCFF) have demonstrated how **blended finance, combining public guarantees with private capital**, can scale biodiversity-positive investments in agroecology, peatland restoration, and green infrastructure. Additionally, the EU LIFE programme funds projects exploring the potential of biodiversity credits, such as the LIFE BiodivCReW programme, which investigates biodiversity credits for wetland restoration. The EU Taxonomy and Corporate Sustainability Reporting Directive (CSRD) further signal regulatory support, with **biodiversity criteria driving demand for nature-positive activities and biodiversity credits as part of ESG strategies**.

The Roadmap's key objectives reflect this evolution: mobilizing private finance to **bridge the €65 billion annual biodiversity financing gap**, complementing public funding (including the EU's 10% budget

[1] Biodiversity credits and nature credits are both recognized in academic and institutional literature, and are used interchangeably in the current report. While **biodiversity credits** typically focus on conserving or restoring specific species or ecosystems, **nature credits** often encompass a broader range of natural assets, including ecosystem services like carbon storage or water purification. Both terms reflect evolving frameworks for valuing and incentivizing nature conservation.

allocation to biodiversity by 2026–2027), and ensuring high integrity through adherence to Nature Market High-Level Principles and alignment with global frameworks. With **pilot projects launching in 2025 and expert group meetings planned throughout 2026 and 2027,** the EU is poised to operationalize nature credits as a critical supporting layer to nature restoration financing. This structured approach aims to position the **EU as a leader in integrating market-based solutions into biodiversity conservation**, balancing innovation with environmental integrity.

For a comprehensive overview of the global evolution of nature credits, including the key milestones that have shaped the EU's current framework, see Annex I. The timeline captures the progressive integration of market-based instruments, from early U.S. and Australian initiatives to the EU's recent policy shifts, highlighting the foundational steps toward today's structured approach to biodiversity financing.

### Implications for coherence with the NRR, and linkages with NRP preparation and implementation needs.

The EU's Nature Restoration Regulation (NRR, EU 2024/1991) sets legally binding restoration targets for 2030 and 2050, while the Multiannual Financial Framework (MFF) 2028–2034 (COM/2025/570 final) proposal aims to streamline funding instruments like LIFE, CAP, and ERDF into National and Regional Partnership Plans. Despite the **urgency for Member States to submit their National Restoration Plans (NRPs)** by September 2026 to maintain EU funding eligibility, they confront **significant uncertainties**: the MFF negotiations and their impact on future biodiversity funding remain unresolved, with great risks of Member States overestimating revenue streams from public sources, potentially leading to poorly assessed budgets or misaligned NRPs.

While technically possible, the integration of nature credits as a complement to public funding into NRPs and alignment with the NRR requirements presents challenges. Key issues include ensuring additionality (i.e., credits must fund gains that would not occur otherwise), establishing robust MRV (Monitoring, Reporting, and Verification) systems, maintaining market integrity, and avoiding duplication with existing funding (Paracchini *et al.*, 2026). The Commission's Roadmap towards Nature Credits (COM/2025/374 final) outlines a **voluntary framework for high-integrity markets**, but pilot schemes (e.g., Verra SD VISta, Wallacea Trust, Plan Vivo) are still refining their methodologies and potential private contributions remain difficult to estimate.

Preparing NRPs that may incorporate biodiversity credits requires **careful financial planning, legal alignment, and stakeholder engagement**. Revenue from credits is uncertain and often delayed, as issuance depends on verified biodiversity gains. **Upfront costs**, such as baseline assessments, MRV infrastructure, certification, and verification, can be substantial, particularly for small landowners. Blended finance models, **combining public grants** (e.g., LIFE, ERDF, CAP, EIB) **with biodiversity credits and private loans** (e.g., InvestEU), are likely necessary but must be structured to ensure additionality and durability.

NRPs must define **robust baselines and counterfactual scenarios based on scientific evidence** (e.g., Article 17 Habitats Directive data), and permanence periods must align with the NRR's long-term objectives. Furthermore, high-quality MRV systems are essential for credibility. NRPs must budget for standardized baseline assessments and ongoing monitoring, leveraging remote sensing, in-situ sensors, and citizen science to reduce costs. **Third-party verification** is critical to prevent fraud and ensure measurable biodiversity gains.

The current Multiannual Financial Framework (MFF) already supports nature restoration through programs like LIFE, the Common Agricultural Policy (CAP), the European Maritime, Fisheries and Aquaculture Fund (EMFAF), Cohesion Policy funds, Horizon Europe, and InvestEU. **Activities planned for 2026 and 2027 can still be funded under these existing instruments**. This provides an opportunity to allocate **public funds for preparatory work**, such as baseline studies, barrier inventories (which should already be available), barrier identification for removal, and feasibility and impact assessment studies, while leaving the **funding of actual barrier removal activities to private stakeholders**. This division ensures that public resources are used for foundational work, while private investment can be leveraged for implementation.

Finally, the Roadmap towards Nature Credits and the EU framework for Carbon Removal and Carbon Farming (CRCF, EU 2024/3012)) offer additional pathways for financing restoration. While floodplain restoration and barrier removal can contribute to carbon storage, peatlands remain the most scientifically sound and well-documented ecosystems for this purpose (Page & Baird, 2016). However, this approach is not universally applicable, as the carbon storage potential varies significantly across different ecosystems.

## 2. Financial considerations under the Nature Restoration Regulation and the NRP format.

Financing requirements for freshwater restoration relevant to Article 9.

A recent study led by Alducci (2025) synthesized data from the Open Rivers Programme (ORP), Dam Removal Europe (DRE), and the AMBER Project (2020) to estimate the financial investment required to restore 25,000 km of free-flowing rivers. The research highlights that the cost of removing river barriers is highly variable, influenced by a combination of infrastructure characteristics, project complexity, and local context.

**The physical attributes** of a barrier play a pivotal role in determining removal costs. Taller and longer barriers demand significantly higher budgets, each additional meter in height can increase costs by 44%, while every extra meter in length adds 3.9% to the total. Dams are the most expensive to remove, with a median cost of €200,000, whereas weirs and culverts tend to be more economical, typically ranging from €50,000 to €100,000. Barriers constructed from concrete or stone are also 68% more costly to remove than those made of wood or earth. Additionally, older barriers, particularly those built over a century ago, are often obsolete and, as a result, cheaper to dismantle (Alducci, 2025).

**Project complexity** is another critical cost driver. Sediment management, such as relocating or treating contaminated sediment, can significantly escalate expenses. Dewatering (diverting water to enable safe removal) is a common and costly step, while mitigation measures, such as reinforcing embankments or reconstructing roads, may also be required. **Post-removal efforts**, including monitoring and revegetation further contribute to the total budget.

The **geographical and administrative context** also shapes costs. Barriers in low-income countries, such as those in Eastern Europe, are typically 73% less expensive to remove compared to those in middle- or high-income countries. While private or public ownership has minimal impact on costs, unlicensed or ownerless barriers are often cheaper to address. In most cases, however, barriers or the land they occupy are privately owned, necessitating **budget allocations for various types of compensation**, whether for annoyance, loss of access, or even outright purchase, to ensure project realization. Finally, **safety measures and liability** questions need to be addressed prior to removal.

*Table 1: Average costs associated with the removal of river barriers, broken down by phase: Pre-Demolition, Demolition, and Post-Demolition. Each phase includes the primary activities, their average costs, and the key cost drivers influencing expenditures. From Alducci (2025).*

| Phase | Activities | Average Cost | Key Cost Drivers |
|---|---|---|---|
| Pre-Demolition | Permits, studies, stakeholder engagement | €11,275 | Planning, legal fees, community consultation |
| Demolition | Construction, actual removal | €35,248 | Equipment, labor, insurance, safety measures |
| Post-Demolition | Restoration, mitigation, monitoring | €29,269 | Revegetation, bank stabilization, fish passage |

To estimate the cost of removing barriers to achieve the 25,000 km river connectivity target, Alducci (2025) modelled five scenarios:

*Table 01: Comparison of the estimated costs of removing river barriers to reach the goal of 25.000 km of free-flowing rivers in EU under five different scenarios, each based on distinct assumptions and methodological approaches. From Alducci (2025).*

| Scenario | Assumption | Estimated Cost | Key Findings |
|---|---|---|---|
| 1: Log-Linear Regression | Predicted costs based on barrier characteristics | €449 million | Cost-effective if barriers are prioritized efficiently. |
| 2: Robust Regression | Outlier-resistant model | €471 million | Accounts for extreme costs (e.g., complex dams). |
| 3: Stochastic Gradient Boosting | Machine learning for cost prediction | €329 million | Most accurate for high-cost scenarios. |
| 4: Ecological Prioritization | Remove barriers every 10 km (2,500 barriers) | €224 million | Cheapest option: Focuses on fragmented rivers. |
| 5: Barrier Density Assumption | Remove 18,500 barriers (0.74 barriers/km) | €1.6 billion | Most expensive: No prioritization. |

This study shows that the NRR target can be met for as little as **€224 million if barriers are strategically prioritized** (e.g., in less fragmented rivers). **Without prioritization, costs could soar to €1.6 billion**.

It should be noted however that only 7% of European barrier removals report costs, highlighting data scarcity. The table in Annex II compiles case studies from the last 10 years of river barrier removal projects, as documented by Dam Removal Europe (2026). It provides real-life examples used to generate the global estimation of dam removal costs, as well as a detailed overview of the costs, funding sources, ecological gains, and project specifics for each removal effort.

### NRP uniform format requirements.

Restoring 25,000 km of free-flowing rivers in Europe, estimated to cost between €224 million and €1.6 billion (Alducci, 2025), requires a financing strategy that **integrates public funding from EU and national sources with private financing mechanisms**. The approach must address barrier inventory, habitat restoration, stakeholder engagement, legal coordination, and adaptive monitoring, while ensuring compliance with the Nature Restoration Plan (NRP) format and alignment with broader EU policy frameworks. The goal is to create a scalable, transparent, and sustainable funding framework that leverages Europe's diverse financial instruments to achieve ambitious restoration targets.

### Necessary Actions for River Restoration

The restoration of free-flowing rivers begins with a **comprehensive barrier inventory**, building on existing datasets from Member States and publicly accessible databases such as the AMBER project database. Combined with **prioritisation guidance** (e.g., Leaniz *et al.*, 2021; European Commission, 2025) and GIS tools, this step can be completed with minimal investment, identifying low-cost, high-impact structures like small weirs and culverts for removal. The NRP fields A4.1–A4.8 require detailed documentation of each barrier, including its socio-economic function (e.g., renewable energy, navigation) and a clear plan for removal or mitigation, directly linked to Article 9 targets.

Next, **habitat and species assessments** must map Annex I habitats, protected species habitats, and favourable reference areas (FRA) for re-establishment. These assessments, mandated under NRP field 3.2, are essential for justifying restoration measures and securing funding. For example, floodplain restoration projects targeting spawning grounds or riparian habitats can leverage EU LIFE Programme grants, which

co-finance barrier removal and species reintroductions, alongside national biodiversity funds for monitoring and ecological evaluation.

**Stakeholder engagement** is critical, particularly in agricultural landscapes where land-use changes may face resistance. Early engagement with local communities, landowners, and NGOs, through **participatory planning, compensation schemes**, and assessments of potential compensations to landowners, can mitigate conflicts and build support. The NRP field 2.1.1 requires a summary of public participation processes, while CAP Strategic Plans can provide funding for agri-environment schemes that incentivise cooperation from farmers.

**Legal and policy coordination** must streamline Environmental Impact Assessments (EIAs), Habitats Directive and Water Framework Directive compliance, and derogations to accelerate project implementation. The NRP fields 4.2.7 and 4.2.9 emphasise the need to align restoration measures with EU energy and climate plans, national CAP strategic plans, and emerging frameworks like the Carbon Removal Certification Framework (CRCF). By venturing into CRCF territory, restored wetlands can unlock additional funding streams, while Horizon Europe funding can support research into innovative permitting processes, and InvestEU provides loans for projects that demonstrate clear returns on investment. Finally, national legislation must also be observed and safety and liability questions addressed.

The core of river restoration involves barrier removal and floodplain restoration. Removing obsolete barriers, such as culverts and small weirs, restores river connectivity, while floodplain restoration (e.g., embankment removal, rewetting) enhances biodiversity and climate resilience. The NRP fields 9.2.1.1 and 9.2.2.1 require estimates of the net additional free-flowing river length (km) and floodplain area ($km^2$) to be restored, both by 2030 and beyond. Notably, **small barrier removal projects often lack the scale or perceived return to attract private investors, making bundling multiple removals a more viable strategy for private financing**. Such bundled projects can be presented as high-impact packages, improving their appeal to investors seeking measurable environmental outcomes.

Finally, a **robust MRV framework** is essential to track progress, assess biodiversity gains, and ensure adaptive management. The NRP fields 5.1–5.5 mandate the inclusion of monitoring indicators for biodiversity, connectivity, water quality, and climate resilience, with a focus on leveraging remote sensing, citizen science (e.g., AMBER app), and AI-driven data analysis to reduce costs and improve accuracy. Technological developments in this area are **not only cost-effective but also replicable across other restoration projects**, providing additional value for EU environmental research programmes. Impact-linked funding, where payments are tied to measurable outcomes such as carbon credits or biodiversity gains, can further incentivise private sector participation.

### Public and Private Funding Options

The biodiversity finance landscape is an ever-changing domain with both **domestic and international financial flows providing financing solutions tailored to various applications**. UNDP BIOFIN Catalogue of Finance Solutions offers a comprehensive overview of available solutions worldwide, some of which are developed in this report.

**Public funding is and should remain the backbone of river restoration**, financing up to 91% of current needs (EIB & European Commission, 2020). EU programmes offer significant resources, with the LIFE Programme (€5.43B) particularly well-suited for barrier removal, floodplain restoration, and species reintroductions. Cohesion Policy Funds (€392B) target less developed regions and cross-border projects, making them ideal for large-scale floodplain restoration and community engagement. For research-driven restoration, Horizon Europe (€95.5B) funds scientific studies on barrier removal and ecological monitoring (MRV), while CAP Strategic Plans (€387B) provide targeted support for agricultural landscapes, including floodplain rewetting and agroforestry. InvestEU (€26.2B) offers loans and guarantees for sustainable infrastructure, such as floodplain restoration projects with clear economic returns (European Commission, EU Funding Programmes, 2021).

National funding sources complement EU programmes, with **National Water Agencies providing local expertise and flexibility** for barrier removals and monitoring, and National Biodiversity Funds supporting species reintroductions and ecological assessments. For large-scale initiatives, green bonds, both at the EU level and in national schemes, provide a scalable option, monetising environmental benefits such as carbon sequestration and flood resilience. **Philanthropic organisations and eco-tourism revenue**, although difficult to estimate, offer additional support, particularly for small-scale, community-driven projects (EIB, 2023).

Private financing remains underused yet critical for scaling ecological restoration. Two complementary pathways exist: **upfront financing mechanisms and revenue-generating markets**.

Upfront financing covers initial restoration costs, with **investors expecting returns**. Instruments like green bonds and sustainability-linked loans fund nature-positive projects, tracking performance via biodiversity or carbon metrics. Use-of-proceeds bonds target specific activities, while sustainability-linked bonds tie interest rates to environmental targets (Carter et al., 2026).

In contrast, revenue-generating markets **monetise the co-benefits of restoration**, creating financial incentives for private participation. Payment for Ecosystem Services (PES) schemes, carbon credits, and biodiversity credits enable projects to generate revenues by quantifying and selling ecological improvements (e.g., flood prevention, wetland restoration, or fish habitat gains) (Carter *et al.*, 2026).

To overcome the **high risks and long payback periods that deter private investors**, blended finance (combining public, philanthropic, and private capital) can de-risk projects. Concessional loans or guarantees (e.g., from development banks or public agencies) can absorb early-stage risks, making restoration projects like barrier removal or floodplain rewetting more attractive to institutional investors (Carter et al., 2026). Tax incentives and corporate sustainability commitments (e.g., under the EU Taxonomy or CSRD) further align restoration with ESG goals, though their effectiveness depends on robust monitoring and transparent reporting of outcomes.

Ultimately, scaling restoration finance requires both pathways: **upfront instruments to cover capital costs and revenue markets to sustain long-term investments**. Without addressing commercial risks (e.g., uncertain returns), ecological risks (e.g., failed outcomes), and social risks (e.g., equity for local communities), private finance will remain limited in its contribution to biodiversity goals (Carter et al., 2026).

### Most Relevant Funding per Activity

For barrier inventory and prioritisation, LIFE Programme and National Water Agencies are the most relevant public funding sources. Notably, many Member States already have **national inventories, which, combined with existing EU-wide datasets, can be used for national prioritisation** work with minimal investment.

Similarly, habitat and species assessments benefit from national programs, LIFE programme and Horizon Europe funding, with biodiversity credits and green bonds providing private financing for projects targeting Annex I habitats and protected species.

Legal and policy coordination requires Horizon Europe research funding and InvestEU loans to streamline permitting and derogations, supplemented by tax incentives for landowners and blended finance for innovative solutions.

Barrier removal and floodplain restoration are best funded through a blend of LIFE Programme, InvestEU loans, CAP Strategic Plans, and green bonds, with corporate participation providing additional support through nature credits. However, **small projects often lack the scale or potential gain to attract private investors**, making bundled barrier removal packages a more viable approach for private financing. Carbon credits and PES mechanisms can monetise the climate and biodiversity co-benefits of floodplain

restoration, while impact-linked funding ensures accountability and performance-based payouts (EIB, 2023).

MRV frameworks rely on LIFE Programme and Horizon Europe funding for infrastructure and research, with impact-linked funding and corporate sustainability reporting offering private sector engagement. This ensures that restoration projects are not only implemented but also monitored, verified, and adapted to maximise ecological and socio-economic benefits.

### General Recommendations

To ensure the success of the river restoration financing strategy, **build on existing inventories to prioritise small obsolete barriers** whose removal delivers high connectivity gains at low cost. Leverage **public finance (EU funds, national budgets) to perform preparatory studies, impact assessments, and enhance MRV capacities**, reducing risk and attracting private investors. Streamline legal processes by aligning restoration measures with CAP Strategic Plans and EU energy/climate policies, while using Horizon Europe funding to innovate in permitting and compliance.

**Promote nature-based solutions** like floodplain restoration and peatland rewetting, which deliver multiplier effects such as flood resilience, carbon sequestration (with potential to leverage CRCF finance streams), and eco-tourism revenue. Engage stakeholders early through **participatory planning**, **compensation schemes**, and assessments of potential compensations to landowners, particularly in agricultural landscapes, and align restoration with CAP interventions to incentivise farmer cooperation. Finally, **implement robust MRV frameworks** using remote sensing, citizen science, and AI-driven analytics to track progress, ensure adaptive management, and attract impact-focused private financing.

By integrating these strategies, Europe can achieve its 25,000 km free-flowing rivers target while ensuring NRP compliance, financial sustainability, and broad stakeholder support.

### Blending EU, national and private sources while safeguarding public funding for public goods.

Blending public and private finance is increasingly recognized as a practical and necessary approach for the EU to mobilize the massive, yet underutilized, resources of private capital and bond markets for public goods such as nature-based solutions and biodiversity restoration. By its very design, **blended finance** enhances the risk-return profile of projects, making them more attractive to private investors (EIB, 2023). The key insight is that **public funds should complement private investment**, acting as a catalyst to attract repayable capital, de-risk early-stage ventures, and ensure projects deliver measurable public benefits beyond legal requirements.

At the heart of this strategy is the **development of robust nomenclature instruments**, such as biodiversity taxonomies, which provide common references for financial institutions to analyse and select opportunities. These taxonomies, increasingly adopted at both the EU and national levels, help qualify and align financial flows with global biodiversity goals, such as the Kunming-Montreal Global Biodiversity Framework (KM GBF). They ensure that blended finance mechanisms, whether payment for ecosystem services, green bonds, or sustainability-linked loans, are not only market-friendly but also aligned with public policy objectives such as the EU Taxonomy Regulation (EU/2020/852) and the Do No Significant Harm (DNSH) principle (EIB, 2023).

Blending finance and risk mitigation are central to unlocking private investment in large-scale green infrastructure projects that might otherwise struggle to secure financing. Public funding sources, such as grants from the EU LIFE Programme or concessional loans from the EIB, often provide the first-loss capital or guarantees that absorb the initial risk for private lenders (EIB, 2023). This approach has been successfully piloted in projects like the EBRD's Chisinau River Bic Rehabilitation and the Caisse des Dépôts' Branche de Croix canal restoration, which demonstrate how **EU guarantees and blended facilities can mobilize private capital while ensuring additionality and transparency** (EU Business and Biodiversity Platform, 2024). For instance, the Sienna Biodiversity Private Credit Fund, supported by a €60 million

guarantee under the InvestEU Sustainability Guarantee, provides up to 70% credit risk coverage for small and medium firms, enabling earlier-stage biodiversity projects to access financing with weaker collateral. These mechanisms not only reduce the cost of capital but also create a financing continuum from seed-stage innovation to scalable, repeatable models (EIF, 2026).

**Early-stage capacity building and investment support** are critical to bridge the knowledge gap and make restoration projects bankable. This includes providing concessional loans and pay-for-results grants (e.g., following the REDD+ model for landscapes) and offering risk-sharing guarantees for projects most likely to attract private co-funding (EIB, 2023). For example, the EIB Natural Capital Financing Facility (NCFF) within an EIB-funded Urban Framework Loan combined EU grants with concessional loans to support urban nature restoration, demonstrating a proof of concept that can be scaled up under InvestEU to promote biodiversity credits to corporate investors, by providing the necessary de-risking and structuring to make such investments bankable and impactful (EIB & European Commission, 2020).

The Green Assist and RESTORE initiative, explored in a recent article by the European Climate, Infrastructure and Environment Executive Agency (2025), further illustrates how **advisory services and targeted investment support can accelerate biodiversity restoration and conservation**. Green Assist, a platform designed to provide technical assistance and advisory services, collaborates with projects like RESTORE to develop investment-ready pipelines of nature-based solutions (Climate, Infrastructure and Environment Executive Agency, 2025). This approach aligns with the need for innovative financing mechanisms that can combine public grants, technical assistance, and private capital to scale up restoration efforts. The partnership emphasizes the importance of **capacity building, project structuration, and the development of blended facilities** that can attract institutional investors, including pension funds and insurance companies, which are increasingly seeking long-term, impact-aligned assets (EIB, 2023). By integrating these advisory services with EU guarantees and thematic bonds, the initiative aims to create a pipeline of credible biodiversity projects, from wetland restoration to pollinator habitat recovery.

Additional **debt instruments**, such as use-of-proceeds bonds or thematic bonds (green, blue, social, resilience, SDGs) are increasingly being used to finance nature-based projects, particularly those issued at the sovereign or corporate level. These instruments apply a transparent project selection process (pre- and post-issuance) to ensure impact alignment, such as the International Capital Market Association (ICMA) Green Bond Principles (International Capital Market Association, 2022). The combining of EU/national grants with private credits (e.g., biodiversity + carbon) or output-based aid (payments per ha restored) is gaining traction, but requires careful governance to avoid double-counting, ensure additionality, and include Indigenous Peoples and Local Communities (IP/LC) consent.

Safeguarding public funding requires a multi-layered approach: from DNSH and PPP compliance to the development of high-integrity biodiversity credit markets (e.g., Biodiversity Credits Alliance, 2024). **Public funds should be used to** de-risk initial investment**, provide technical assistance for project structuration, and ensure that blended finance mechanisms are** transparent, equitable, and aligned with global standards (EIB, 2023). The EIB's experience with the Natural Capital Financing Facility (NCFF) and the InvestEU Advisory Hub highlights the **importance of advisory services, capacity building, and the development of blended facilities that can be tailored to the needs of small, innovative, and early-stage projects** (EIB, 2023). These instruments not only mobilize private capital but also create a pipeline of bankable restoration projects, from wetland restoration to pollinator habitat recovery.

## 3. Existing examples of market-based restoration finance.

Existing nature credit / nature market models.

Governments worldwide are adopting diverse policy-led approaches to develop nature credit markets, structured around three core archetypes. These archetypes (**principle-driven, shared governance, and centralised governance**) reflect varying degrees of government involvement in market design, regulation, and administration. While not rigid categories, they highlight how governments balance flexibility, oversight, and market functionality to support biodiversity conservation and restoration.

The International Advisory Panel on Biodiversity Credits (IAPB), in collaboration with partners, identified and analysed 19 of the most established government-led nature market frameworks globally (International Advisory Panel on Biodiversity Credits *et al.*, 2025). These frameworks span six continents and cover a range of biomes and sectors, offering a comprehensive snapshot of how governments are enabling, regulating, and administering nature credit markets. Detailed tables summarising this study can be found in Annex IV.

*Figure 1: Map of 19 national frameworks for nature markets. Different colors indicate the operational state of the framework and the nature of the market (voluntary VS compliance). (International Advisory Panel on Biodiversity Credits* et al., *2025)*

### 1. Principle-Driven Approaches

- **Government Role:** Regulator and enabler
- **Key Features:** Governments set high-level principles, provide infrastructure, and facilitate market growth, but delegate most administrative and transactional functions to the private sector. The focus is on creating enabling conditions for voluntary participation, often tied to corporate ESG goals or pilot initiatives.
- **Use Case:** Primarily voluntary markets, where demand is driven by corporate disclosure, ESG commitments, or pilot projects rather than legal mandates.
- **Advantages:** Flexibility, innovation, and lower administrative burden on governments.
- **Challenges:** Limited control over project quality and outcomes; requires strong integrity safeguards.

### 2. Shared Governance Approaches

- **Government Role:** Regulator and administrator
- **Key Features:** Governments provide robust regulatory oversight, approve projects, publish credit and transaction data, and maintain registries, while the private sector handles credit transactions, legal agreements, and project implementation. This archetype is the most common, appearing in 13 of the 19 identified frameworks.
- **Use Case:** Mostly compliance markets, where offset obligations are legally mandated for developers.
- **Advantages:** Balances government oversight with private sector efficiency; ensures transparency through registries.
- **Challenges:** Fragmentation in implementation, particularly in federated systems; requires coordination between multiple stakeholders.

### 3. Centralised Governance Approaches

- **Government Role:** Regulator, administrator, buyer, and seller
- **Key Features:** Governments take full responsibility for operating or managing the majority of market functions, including credit issuance, administration, and sometimes acting as buyers or sellers. These models are often programmatic, operating at a landscape scale by aggregating multiple projects.
- **Use Case:** Both compliance and voluntary markets, with a focus on large-scale, coordinated restoration.
  **Advantages:** High degree of standardization, consistency, and control; ensures alignment with national biodiversity goals.
- **Challenges:** Requires significant institutional capacity, long-term funding, and political stability; risk of bureaucratic inertia.

The three archetypes offer governments a spectrum of tools to design nature credit markets that balance market functionality, regulatory oversight, and ecological integrity. While each archetype prioritises different trade-offs between flexibility and control, **all must integrate operational details, such as compliance requirements, additionality, durability, and transparency, to ensure high-integrity outcomes** (International Advisory Panel on Biodiversity Credits *et al.*, 2025).

Core principles like the **mitigation hierarchy** (present in 11 frameworks) and **no net loss/net gain targets** (also in 11 frameworks, with some, like England's Biodiversity Net Gain, mandating a 10% net gain) are widely adopted to ensure ecological integrity. Most frameworks (14/19) focus on restoration as the primary credit-generating activity, followed by protection, enhancement, and land protection (International Advisory Panel on Biodiversity Credits *et al.*, 2025).

While **additionality** is universally required across all frameworks, often tied to regulatory or financial conditions, **durability** standards vary widely, with most requiring 20–30 years of protection (12/19) and a few mandating perpetual safeguards (4/19). **Monitoring and reporting** are mandatory in all frameworks, though frequencies differ, and third-party audits are required in 8 cases, ensuring credibility. However, critical social and governance elements are less consistently addressed: only 4 frameworks explicitly mandate public consultation, and no harm/benefit-sharing principles are rarely mentioned (3/19), with data sovereignty for Indigenous Peoples and local communities addressed in just 2 frameworks. This highlights a gap in equitable and inclusive practices, despite robust ecological and administrative standards (International Advisory Panel on Biodiversity Credits *et al.*, 2025).

By examining these government-led frameworks and their integration, gaps, and opportunities, EU-policymakers have access to valuable insights to design and implement European nature credit markets frameworks that are not only functional and scalable but also equitable, transparent, and ecologically robust.

EU-level and international examples of market-based or quasi-market mechanisms used to finance ecosystem or freshwater restoration.

BiodivCReW's analysis reveals a complex landscape of over 90 biodiversity credit schemes worldwide, each with distinct designs, objectives, and scopes (Gradeckas & Vaquié, 2026). However, **not all are equally suited to freshwater restoration or the EU context**, which requires credit schemes to support fragmented, small-scale, mosaic multi-ecosystem wetlands that can be grouped into a single project and reflect EU land ownership patterns. Furthermore, many European conservation and restoration projects span multiple ecosystem types, making cross-ecosystem applicability critical for ecological integrity and practical project design (Gradeckas & Vaquié, 2026).

Recognizing this, BiodivCReW rigorously evaluated these schemes and identified eight of the most applicable for the EU, particularly for financing ecosystem or freshwater restoration activities (Annex V).

To compare and assess these schemes, BiodivCReW used the BCA's High-Level Principles (HLPs) Assessment Matrix v1.0 (Biodiversity Credit Alliance, 2025). This matrix applies a scoring system from 0 to 3 across multiple criteria, enabling a standardized evaluation of each scheme's strengths and weaknesses. The criteria include outcomes, equity, governance, and implementation, among others, allowing for a nuanced comparison of how each scheme addresses biodiversity objectives, demand integrity, credit issuance and tracking, durability, and third-party audits. These principles were co-developed by the key best practice forums in the voluntary biodiversity market. They represent the baseline criteria for high-quality and high-integrity biodiversity credit schemes and projects. Since they play an important role in assessing credit scheme quality, it is important to integrate as many parameters that could directly inform each criterion (Gradeckas & Vaquié, 2026).

Following this analysis, **Verra and Wallacea Trust emerged as the two final schemes for further consideration**. Both offer a credible, flexible, and widely applicable biodiversity crediting approach, actively piloted globally, including in Europe.

Verra's SD VISta Nature Framework stands out for its institutional credibility as the largest ICROA-certified voluntary carbon standard, providing immediate legitimacy and trust in the biodiversity market. Its quantitative ecosystem condition accounting aligns closely with nature reporting frameworks like TNFD, CSRD, and GRI, reducing the gap between corporate nature accounting and biodiversity crediting. The framework also supports credit stacking with carbon credits and uses a standardized, interoperable Nature Credit unit. However, it faces challenges such as high methodological complexity, slow timelines for approvals and issuance, and limited suitability for small, fragmented lands (Gradeckas & Vaquié, 2026).

Wallacea Trust offers an open-source methodology with a multimetric, interoperable credit unit, making it accessible and adaptable to diverse ecosystems, including European wetlands. It is easy to use, has an active project pipeline of 11+ projects spanning nearly 250,000 hectares, and allows flexible credit stacking with third-party standards. However, it lacks a formal standard or central registry, raising concerns about governance and operational clarity. Close interlinkages between its methodology developer, project developers, and service providers may also create perceived conflicts of interest. Additionally, its benefit-sharing requirement and reliance on academic peer review for verification may complicate implementation in the European context (Gradeckas & Vaquié, 2026).

While it is theoretically possible to design a "perfect" scheme that meets all criteria and maximizes impact, real-world success depends on factors beyond theoretical design. Market readiness, stakeholder engagement, regulatory alignment, and scalability play critical roles in determining whether a scheme achieves its intended outcomes. Integrity challenges in the voluntary biodiversity market further complicate this, arising from the voluntary nature of the market, the absence of stable and predictable financing pathways, limited integration with existing regulatory frameworks, uncertainty around long-term stewardship obligations, and the diversity of land tenure and management contexts, particularly in European landscapes. Compliance markets face a set of different problems that can be broadly summarized by the fact that policies that force polluters to internalize their environmental costs always face political resistance, leading to compromises in their design (Zu Ermgassem *et al.*, 2025) Together, these factors can constrain the consistent delivery, durability, and accountability of biodiversity outcomes, underscoring that **achieving high-integrity results depends not only on credit scheme design**

**but also on complementary policy frameworks, long-term financing mechanisms, and supporting institutional arrangements**, as well as on implementation approaches that foster cooperation among schemes and attract private investment (Gradeckas & Vaquié, 2026).

IAPB's analysis of the 19 government-led frameworks (Annex IV), spanning compliance compensation, voluntary contributions, and market-based mechanisms, highlights both the diversity of approaches and the common challenges they face (International Advisory Panel on Biodiversity Credits *et al.*, 2025). By learning from these international examples, the EU can refine its own mechanisms to ensure they are not only theoretically sound but also practically effective in driving real-world restoration outcomes.

The 19 government-led nature credit approaches reviewed by IAPB provide a wealth of practical experience, tested models, and hard-won lessons that are directly relevant to designing a high-integrity European framework for nature markets. From compliance-driven systems to voluntary mechanisms, these diverse approaches offer valuable insights into market design, governance, and implementation, equipping policymakers with the knowledge to build robust, equitable, and scalable nature credit markets in the EU context:

- Linking to National Biodiversity Targets: some governments are aligning nature credit frameworks with biodiversity targets like 30×30. This approach ensures that **credits directly contribute to measurable national and global conservation objectives**, enhancing policy coherence and accountability.
- Harmonizing Legislation Across Jurisdictions: important state-level autonomy leads to fragmented regulations, making it difficult for companies to navigate compliance requirements across different regions in federated states. Governments are working to **centralize and harmonize processes, to reduce complexity and ensure consistency**.
- Balancing Voluntary and Compliance Markets: the goal is to **maximize market efficiency while ensuring market integrity and accessibility for all buyers**. Some allow habitat banks to serve both markets, leveraging compliance demand to scale voluntary activity. Others are concerned about fragmented demand or the lack of rules for ecological equivalence in voluntary schemes. Furthermore, the **majority of compliance markets are based on "no net loss" principle, therefore not contributing to nature restoration targets (which require "net gain"**).
- Job Creation and Local Benefits: **nature credit markets are stimulating job creation, particularly for local communities**, strengthening livelihoods and local stewardship of natural resources. The cost of community involvement and higher skill requirements potentially reflects in increased price of credits.
- Complementary Financing Tool: governments emphasize **nature credits should not replace traditional aid, public finance, or established instruments** like in-lieu fee funds. Instead, credits can complement these sources by unlocking private investment.
- Sector-Specific Applications: nature credits are being applied across diverse sectors, from agriculture to extractive industries. Countries must balance environmental goals with economic priorities in function of local contexts and long-term priorities.
- Leveraging Carbon Market Expertise: governments are **applying lessons from carbon credit markets to nature credits**. This cross-pollination reduces learning curves and accelerates market development, though officials caution that the **two markets are not identical and should not be conflated**.
- Flexibility in Ecological Equivalence: some countries require compensation within the same ecosystem, while others allow more flexible approaches, such as restoring higher-value ecosystems to offset damages to lower-value areas. This **flexibility reduces compliance burdens for companies but can undermine ecological integrity**.
- Advance Mitigation via Habitat Banking: instruments, such as **habitat banking, create a ready supply of credits** before environmental impacts occur. This approach streamlines authorization for developers and reduces the time needed to secure offsets. Governments are increasingly supporting proactive offsetting, particularly in areas with high development pressure, such as renewable energy zones.
- Some governments express a preference for mitigation banking over permittee-responsible compensation or in-lieu fees. **Banks are seen as more transparent, regularly monitored, and**

**capable of generating credits at scale**. This preference is often informal but shapes market dynamics and developer behavior toward more standardized solutions.

- Weak enforcement of environmental impact assessments (EIAs) can create perverse incentives. Companies may opt to pay cheap fines rather than conduct EIAs or pay for compensation. **Strong enforcement is critical to ensure that compensatory measures are rigorously applied**. This highlights the need for robust monitoring and accountability systems.
- Transfer of Liability to Habitat Banks from permittees is a key enabler for scaling markets. Without this transfer, permittees retain responsibility for long-term management, which many lack the capacity or expertise to fulfill. Governments are exploring regulatory changes to **delegate this responsibility to banks, reducing the burden on companies and increasing market attractiveness**.
- Demand Drivers: strong legal obligations stimulate demand, particularly for compensatory mitigation. On a smaller scale, voluntary markets demand is driven by risk mitigation, ESG concerns, and disclosure requirements are key drivers of demand.
- **Sustained political leadership and long-term funding are critical for market resilience**. Changes in administration can lead to funding cuts, loss of technical expertise, and policy uncertainty, undermining market credibility. It is important to embed resilience into frameworks to ensure continuity regardless of political shifts, attract private investment and maintain investor confidence.
- **Lack of land titling and ownership data is a major barrier**. Many communities lack formal titles, preventing them from accessing benefits from credit projects. Governments are exploring national maps to identify rights-holders and ensure equitable benefit-sharing, but progress is slow and requires targeted interventions.
- Without **standardized baseline ecological data**, governments struggle to identify priority areas for protection and funding. National biodiversity inventories and targets help identify underfunded ecosystems and guide credit market development. This data is also essential for measuring additionality and ensuring that credits represent genuine ecological gains.
- Better coordination between ministries and capacity building are urgently needed. **Silos between agencies hinder interoperability**, particularly with carbon markets. Limited capacity leads to low compliance checks and accountability issues. Governments are working to centralize data and improve collaboration to streamline processes and reduce fragmentation. Some countries have aligned nature and carbon market regulators to leverage shared expertise and infrastructure, enhancing efficiency and transparency.

Applicability to EU NRR Article 9 context.

There's a whole ecosystem of frameworks and schemes, spanning compliance markets, voluntary initiatives, and government-led programs, that can provide valuable examples of good practices in financing NRR freshwater restoration activities. From China's Jiangxi Province Wetland Mitigation Banking to Colombia's Habitat Banks, **these frameworks demonstrate transferable design features** that can inform the NRR's implementation, particularly around freshwater ecosystems restoration activities financing, while embedding "do no harm" principles into proposed strategies (International Advisory Panel on Biodiversity Credits *et al.*, 2025).

What makes these examples especially instructive is their diversity in governance models, some are compliance-driven (England's Biodiversity Net Gain, Colombia's Habitat Banks), others are voluntary with high integrity (Finland's Ecological Compensation), and a few are hybrid frameworks combining public oversight with market mechanisms (France's SNCRR, China's Wetland Banking).They echo different NRR requirement: how to restore ecosystems without causing ecological deterioration elsewhere, how to finance ambitious restoration targets, and how to ensure high integrity in market transactions. By examining these frameworks, the EU can avoid reinventing the wheel and instead adapt proven models to its unique ecological, legal, and economic context.

Freshwater and Wetland Frameworks: Lessons in Market Design and Ecological Integrity

- Jiangxi Province (China): A Compliance-Driven Model with Provincial Coordination

China's Jiangxi Province Wetland Mitigation Banking is a relatively new but **rapidly scaling compliance-driven framework** that has already facilitated USD 16.7 million in wetland restoration by 2024. Its strength lies in **provincial-level coordination**, where a wetland resource database tracks ecological balance indicators and transactions, ensuring transparency and accountability. Unlike the EU's fragmented approaches, Jiangxi's system is **highly centralized** at the provincial level, with regional management institutions overseeing restoration projects and ensuring ecological equivalence (like-for-like) but with flexibility to prioritize high-value habitats such as floodplains.

The framework's legal backbone, China's Wetland Protection Law (2022), creates predictable demand for restoration credits, similar to how the EU's Water Framework Directive could be strengthened to mandate biodiversity investments. Private financing (green bonds, corporate sponsorship) complements public funding, providing a scalable model for the NRR's Field 4.3.1.4 (Private Financing), which emphasizes integrating diverse funding sources. Furthermore, both the EU and China face shared challenges such as **agricultural runoff degrading wetlands and competing land uses, including urbanization, which threaten wetland conservation and restoration efforts** (Mao et al., 2018; Bian et al., 2020),

- US Stream/Wetland Mitigation Banking: The Gold Standard for Compliance Markets

The US Stream/Wetland Mitigation Banking market is **the world's largest and most mature compliance-driven framework**, transacting USD 3.6 billion annually (BenDor *et al.*, 2023) under the Clean Water Act (1972) and Endangered Species Act (1973). Its success is built on three pillars:

1. **Centralized registries** (RIBITS) that track credits, transactions, and ecological outcomes in real time, preventing double-counting and ensuring market integrity.
2. **Predictable demand** from regulated buyers (developers legally required to offset impacts), which drives market scale and long-term revenue stability.
3. **Third-party certification and monitoring** by agencies like the US Army Corps of Engineers and EPA, ensuring ecological gains are durable and measurable.

Unlike the EU's voluntary biodiversity credit markets (VBM), which still suffer from fragmentation and price opacity, the US system provides a blueprint for NRR compliance markets. **By mandating biodiversity disclosures (e.g., EU CSRD) or national biodiversity laws, the EU could create predictable demand for restoration credits**, aligning with the NRR's Article 9 obligations to restore ecosystems without ecological deterioration. However, the US still struggles with ecological challenges: only ~2% of barriers have fish passage, and ~50% of rivers remain impaired by agricultural runoff. Furthermore, a major evaluation of the effectiveness of decades of the program demonstrated that **developer-led offsets were consistently delivering low-quality outcomes because of low standards and weak enforcement** (Zu Ermgassen *et al.*, 2025). These limitations highlight that market mechanisms alone cannot solve systemic issues, they must be paired with strong legal frameworks, public funding, and innovative restoration approaches.

European Frameworks: Tailoring Global Lessons to Local Contexts

- France's SNCRR: A Hybrid Model for Compliance and Voluntary Markets

France's Natural Compensation, Restoration, and Renaturation Sites (SNCRR) framework is a decentralized but nationally coherent model that has been operational since 2023 under the Green Industry Law. It allows for **both compliance and voluntary biodiversity credits**, with regional prefects approving projects and local monitoring committees ensuring ecological integrity. The framework's "**supply-side approach" pools restoration measures across larger landscapes, enhancing ecological connectivity and efficiency**, a model the EU could adapt for its 25,000 km river restoration target.
SNCRR's strengths include:

- State-backed certification of credits, ensuring credibility for buyers.
- Flexibility within a national framework.
- Focus on landscape-scale restoration to maximize ecological co-benefits.

However, France's system is still early in its implementation, and challenges such as data gaps in ecological equivalence and uneven stakeholder engagement persist. These issues mirror those in the EU's Roadmap towards Nature Credits, which is still in the public consultation phase. By learning from France's decentralized governance and state-backed certification, the EU could design a NRP-compliant framework that balances local flexibility with national coherence.

- Finland's Voluntary Ecological Compensation: A Science-Based Model for High-Integrity Restoration

Finland's Voluntary Ecological Compensation framework is a relatively new but **scientifically robust model** that targets habitat types and species' habitats under the Nature Conservation Act (2023) and 2023 Ministry of Environment Decree. The framework uses a "natural value hectare" metric (quantity × quality) to quantify ecological gains, ensuring that restoration measures are measurable and verifiable.
Finland's model offers several advantages for the EU NRR:

- Science-based metrics ensure ecological gains are not arbitrary.
- Regional implementation allows tailored approaches for Finland's temperate landscapes.
- Authority-hosted registry tracks projects and outcomes, ensuring transparency.

However, Finland's system is still limited in scale. The framework's **voluntary nature means that predictable demand is still a challenge**, and private financing (e.g., impact-linked funding) has yet to fully materialize. These limitations highlight the need for the EU NRR to pair market mechanisms with strong legal mandates (e.g., mandatory biodiversity disclosures or national biodiversity laws) to drive market scale and ensure high integrity in market transactions.

- Germany's Habitat Banking (IMR Framework): A Model for Ex-Ante Credit Production and Durability

Germany's Habitat Banking framework operates under the Impact Mitigation Regulation (IMR), which requires **no net loss and like-for-like compensation within the same bio-geographic region**. The framework's **ex-ante credit production allows developers to purchase credits before ecological gains are realized**, providing revenue stability for restoration projects and de-risking investment for private financiers.
Germany's model offers several key lessons for the EU NRR:

- Ex-ante credit production de-risks projects and ensures revenue stability for private investors.
- 40+ state-specific approaches allow flexibility within a national framework, offering a parallel to the EU's NRR.
- Long-term durability requirements (25–30 years) ensure ecological gains are sustained.

However, Germany's system still faces challenges in ecological equivalence assessments and uneven implementation across states. By learning from Germany's ex-ante credit production and durability requirements, the EU could design a NRP-compliant framework that balances flexibility with scientific rigor.

Frameworks Embedding "Do No Harm" Principles: Lessons in Ecological Safeguards and Market Integrity

- England's Biodiversity Net Gain (BNG): A Model for Mandatory Net Gain and Durability

England's Biodiversity Net Gain (BNG) framework is a **compliance-driven model** that requires all new developments to achieve a 10% net gain in biodiversity units compared to the pre-development state. The framework's Biodiversity Gain Hierarchy (avoid > minimize > compensate) ensures that **ecological harm is systematically addressed**, and statutory biodiversity credits provide a market-based financing mechanism for restoration projects.
BNG's strengths include:

- Mandatory net gain requirements ensure no net loss of biodiversity, directly supporting the NRR's Article 9 obligations.
- Standardized biodiversity units (BUs) allow consistent comparisons across ecosystems.

- Public registries track transactions and ecological outcomes, preventing greenwashing and ensuring market integrity.

However, BNG's system still faces challenges in implementation delays and uneven stakeholder engagement, particularly in agricultural landscapes. It also suffers from governance and monitoring gaps, as Defra **lacks central oversight of enforcement by local authorities**. Furthermore, the ecological metric limitations mean the statutory biodiversity metric often fails to deliver real gains for birds and butterflies, instead prioritizing medium-distinctiveness habitats over strategic conservation areas (Duffus *et al.*, 2025; Zu Ermgassen *et al.*, 2025). By learning from BNG's mandatory net gain requirements and durability mechanisms, but also its pitfalls, the EU could design a NRP-compliant framework that ensures ecological integrity while leveraging private financing.

- Colombia's Habitat Banks: A Model for 1:1 Offsets with Multipliers and Government Validation

Colombia's Habitat Banks framework is a compliance-driven model that requires developers to offset impacts through 1:1 ha-for-ha offsets with multipliers for ecologically valuable habitats. The **framework's government validation ensures high integrity, and public registries track transactions and ecological outcomes**.
Colombia's model offers several key lessons for the EU NRR:

- 1:1 offset requirements with multipliers ensure ecological value is maintained, but also emphasise the importance of ecologically valuable ecosystems.
- Government validation of habitat banks provides third-party assurance, encouraging private investment.
- Flexibility to serve both compliance and voluntary markets, maximising demand and revenue for project holders.

However, Colombia's system still faces **challenges in ecological equivalence assessments** and uneven implementation across regions. By learning from Colombia's offset requirements and multiplier mechanisms, the EU could design a NRP-compliant framework that ensures ecological integrity of valuable ecosystems while leveraging diverse funding sources.

The EU Nature Restoration Regulation is a once-in-a-generation opportunity to scale up biodiversity restoration financing across Europe. To make this opportunity a reality, the EU should build on the lessons learned from other government-led frameworks. They demonstrate that successful restoration financing requires:

1. **Strong legal mandates to create predictable demand** (e.g., mandatory biodiversity disclosures or national biodiversity laws).
2. Market-based mechanisms that ensure **high integrity, transparency, and durability** (e.g., centralized registries, third-party verification, long-term contracts).
3. Blended finance models that **combine public funding** (EU LIFE, InvestEU) **with private financing** (green bonds, biodiversity credits, PES).

# B. Research and Analytical Questions.

## 1. Modalities for using nature credits.

### Nature credits adaptation to support river connectivity and floodplain function restoration.

To adapt existing biodiversity credit schemes to support river connectivity and floodplain function restoration, the two most relevant frameworks identified in the BiodivCReW LIFE project analysis were examined in depth. The requirements and guidance outlined in the Wallacea Trust Biodiversity Futures Initiative and the Verra SD VISta Nature Framework were compiled and critically assessed in light of **the unique ecological, hydrological, and social complexities inherent to freshwater restoration projects** (Gradeckas & Vaquié, 2026).

#### Key Adaptations for Freshwater Projects

Credit Unit redefined to reflect rivers' linear and lateral nature:

- River kilometres reconnected (e.g., 1 credit per km with improved connectivity)
- Floodplain hectares restored (e.g., 1 credit per ha)

**Ecological significance should be prioritised over distance**. A small but critical barrier (e.g., blocking a salmon run) should carry more weight than a larger, low-impact barrier.

#### River-Specific Metrics

**The metrics for river restoration must align with the project's primary goal**, whether that's fish passage, flood protection, or water quality improvement. If the goal is fish passage, metrics should focus on biodiversity impact (fish species richness and abundance, macroinvertebrate diversity, and the presence of migratory species), hydrological integrity (natural flow regimes, fish ladder functionality, connectivity and barrier removal progression) and physico-chemical parameters (dissolved oxygen levels, water temperature, and sediment quality). If the goal is flood protection, metrics should prioritize hydrological integrity (floodplain inundation patterns, meandering restoration, and natural water retention capacity), structural health (riverbank stability, sediment balance, and the absence of erosion). If the goal is water quality improvement, metrics should include physico-chemical parameters (levels of nitrogen, phosphorus, heavy metals, and other pollutants) and/or biodiversity impact (macroinvertebrate diversity, riparian vegetation health, and the presence of pollution-tolerant species). To **facilitate integration with other frameworks** (e.g. TNFD, SBTN), it is imperative to maximise alignment between used metrics and indicators (e.g. water quantity related targets directly addressed with the outcomes of a barrier removal , with monitoring and communication using similar metrics and indicators).

#### Tiered Pricing with Centralized Inventory

The financial feasibility of river restoration projects is often undermined by wildly disparate costs: a modest culvert removal might cost a few thousand euros, while dismantling a large dam could require millions (Alducci, 2025). Such **disparities can render expensive projects commercially unviable**, even if their ecological outcomes are as important as those from cheaper alternatives. It may make sense to **pool all connectivity outcomes in a centralized inventory with standardized prices**, offering the possibility to purchase credits tied to kilometres of river reconnected, rather than credits per barrier removed. This approach simplifies purchasing for buyers while ensuring fairness, but it introduces a new layer of complexity: the need for **a centralizing authority, operating at either the national or basin level**, to

oversee barrier removal projects, standardize methodologies, and ensure transparency and accountability across the entire restoration portfolio.

### Certification Issuance for Upfront Costs

Barrier removal costs can be prohibitive, often requiring **significant upfront investment**, while the ecological benefits, such as restored fish populations or improved floodplain function, may take years to fully materialize. To address this challenge, the EU's roadmap for nature credits introduces a two-step model: **certification** followed by **crediting**. Certification provides formal, independently verified recognition that a nature-positive action, such as barrier removal, meets high-quality standards for biodiversity relevance and good practices. This process assesses the design, implementation, and expected effects of the intervention, offering a trusted signal of environmental integrity. **By securing a certificate, project developers can attract early financial support**, build stakeholder trust, and access payments for their certified actions. Over time, as results are demonstrated, **nature credits may be issued to monetize the verified impact**, ensuring that upfront costs are offset while maintaining transparency and credibility. This approach aligns with the EU's broader goal of rewarding nature-positive actions through high-integrity, market-based tools (European Commission, 2025).

### MRV: Measuring Recovery in Complex Systems

Monitoring river and floodplain restoration is inherently challenging due to the **highly dynamic nature** of these ecosystems. Unlike terrestrial habitats, rivers are underwater, constantly shifting environments where traditional remote sensing tools often fall short. Many critical outcomes, such as sediment balance, riverbed health, or fish populations, can only be accurately assessed through on-site audits and field surveys, which **significantly drive up monitoring costs** (Basset, 2025). Flowing waters also pose unique difficulties for eDNA sampling, where rapid water movement can dilute or disperse genetic material, complicating efforts to track species presence and biodiversity (Wood *et al.*, 2021). To keep costs manageable and ensure reliable verification, it is essential to **develop and deploy MRV technologies tailored to riverine environments**, such as improved eDNA protocols, advanced hydrological sensors, and AI-driven remote sensing tools. Public-funded programs like LIFE or Horizon Europe can play a pivotal role by supporting innovation in this space, increasing visibility of these challenges, and encouraging greater public and private investment in sustainable monitoring solutions.

### Timeliness for 2030 implementation.

The Nature Restoration Regulation (NRR) sets ambitious milestones, but the voluntary biodiversity credit market remains nascent, with extremely low transaction volumes and limited buyer engagement (Pollination, 2024; Bloomlabs, 2026). Given current market dynamics, it is unrealistic to expect significant scaling before 2030. Projections suggest that **meaningful private investment and credit issuance will likely ramp up only after 2030**, with greater momentum by 2050 as regulatory clarity improves and market confidence grows (World Economic Forum, 2023).

Similarly, the regulatory framework itself will take time to mature. While the NRR provides a strong policy direction, **enforcement mechanisms, standardized methodologies, and certification processes require years of development**, testing, and refinement. Early compliance with NRR may rely on pilot projects and voluntary commitments rather than large-scale credit trading.

To bridge the gap between today's market immaturity and future regulatory readiness, a dual strategy is essential:

1. Public Funding for Capacity Building (2021–2027 MFF Cycle)

- Impact Assessments and MRV Development: Use EU grants (e.g., LIFE, Horizon Europe) to fund the **development of river-specific MRV tools, build capacity and know-how and set up transnational basin-scale projects**.
- Pilot Projects: Launch demonstration projects in key river basins to test methodologies, build data repositories, and refine credit calculation models. Ideally, a **public-private partnership** would send an **encouraging signal** to the rest of the market and attract more private investors.
- Stakeholder Engagement: Establish expert working groups and regional roadmaps to **align methodologies across member states**.

2. Roadmap and Expert Group Planning (Until 2027)

- Exploratory Phase (2025–2027): Focus on consensus-building among different stakeholders, **standardization of metrics, pricing, and verification protocols**, pilot projects implementation and showcasing.
- Regulatory Alignment: Work closely with EU agencies and member states to ensure that **voluntary market frameworks (e.g., biodiversity credit registries) are compatible with future NRR compliance pathways**.

To accelerate progress, the Commission's Roadmap towards Nature Credits (2025) proposes a two-step model: certification followed by crediting. Certification provides upfront recognition that a project meets high-quality standards for nature-positive action, assessing its design, implementation plan, and expected effects, enabling operators to access early payments or guarantees without waiting for outcomes to materialize. This addresses a critical barrier: the high upfront costs of restoration projects, which often deter action due to delayed returns. By contrast, nature credits are issued progressively as verified results are demonstrated, translating outcomes into tradable units. This dual approach allows immediate financing for certified actions while ensuring long-term integrity through outcome-based crediting, aligning with the **Roadmap's goal to kick-start markets via public seed finance and de-risking mechanisms** (e.g., InvestEU, LIFE programme).

Relevance of different governance levels for NRP drafting and reporting.

European wetlands restoration faces **varying limitations depending on the scale of the project**. Too-small projects, typical of fragmented European landscapes, are often commercially unviable due to **high MRV and certification costs per credit**. Investors and buyers are typically uninterested in projects where transaction costs represent a disproportionate share of the credit value, **leaving small landholders and local communities without pathways to access restoration funding** (EIB, 2023). Additionally, small-scale projects may lack ecological coherence, making it difficult to demonstrate meaningful biodiversity or hydrological gains that justify public or private investment.

On the other hand, too-large projects, covering entire river basins or large administrative regions, can suffer from **diluted responsibility and lack of stakeholder engagement**. No single agency or entity feels directly incentivized or capable of implementing the project alone, especially when it spans multiple land uses and ownerships, ecosystems, or jurisdictions. This "split incentives" problem increases administrative costs, complicates governance, and can lead to delayed or diluted implementation, as no one entity feels directly accountable for the project's success (EIB, 2023). These issues can be partly addressed in basin-wide projects that explicitly include a **supranational entity tasked with basin-wide management**, wielding sufficient authority and ensuring that all interests are represented and that restoration efforts are ecologically and politically coherent.

The governance level at which credit schemes are most appropriate for European wetlands restoration is **predominantly regional and national**, with selective basin-level coordination for projects that span entire river systems or cross national borders. This approach balances the need to support fragmented, small-scale wetlands, common across Europe, with the practicalities of land ownership, MRV costs, and stakeholder coordination. Aggregating these small, mosaic ecosystems into regional or national portfolios **reduces transaction costs, enables participation by small landholders, and maintains methodological consistency**, while still allowing buyers to purchase credits tied to measurable ecological outcomes (Gradeckas & Vaquié, 2026). This approach requires regional- or national-level governance, where ministries, agencies, and regional authorities can align policies, funding, and priorities to support multi-ecosystem restoration. A national entity could establish a centralized registry of eligible wetlands, standardize MRV methodologies, and define credit pricing tiers based on ecological value rather than project size. This ensures that fragmented projects are treated as a cohesive portfolio, increasing their attractiveness to investors while maintaining auditability and ecological coherence. This higher level governance further supports the centralized inventory concept, where credits are issued based on kilometres of river reconnected rather than individual barriers.

The Uniform Format of the National Restoration Plan (NRP) provides structured fields to reflect this governance approach and integrate the centralized inventory concept outlined earlier (European Commission, 2025). **Small-scale wetlands can be grouped into regional or national portfolios** reflected in Field 14.1.5 (Scale of Planning), while **basin-level coordination** is addressed through Field 7.1.4.1 (CFP Measures) and Additional Information IV (Inventory of Artificial Barriers) for transboundary rivers. Field 4.2.11 (Synergies with Other Member States) and Field 14.1.5 (Transnational option) further ensure international coordination, allowing restoration efforts to align with EU-wide ecological connectivity goals, such as the Water Framework Directive and the NRR's target of restoring 25,000 km of free-flowing rivers by 2030.

## 2. Mechanisms to mobilise private sector resources.

Mechanisms to mobilise private finance.

**Private investment in biodiversity in Europe is growing but remains insufficient** due to structural barriers, political risks, and ecological complexities (Zu Ermgassen et al., 2025). Private finance cannot lead restoration efforts without strong public-sector involvement. To unlock the scale of private investment needed to meet the EU's biodiversity and restoration targets, public actors must lead the transformation by **building a resilient, investable, and ecologically coherent biodiversity credit market** (EIB, 2023). While voluntary markets for biodiversity credits are still developing, their potential to mobilise private finance can be maximised through **regulatory frameworks, financial instruments, and blended solutions that address the "public good" nature of nature-based investments** (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). These mechanisms must be designed to **reduce risk, increase profitability, and align with corporate sustainability strategies**, ensuring that private capital is directed toward projects that deliver measurable ecological gains. At the same time, governments can play a proactive role by introducing mandatory requirements, reward structures, and innovative financial instruments that catalyse investment in nature-based solutions (EIB, 2023).

Regulatory interventions are essential to create a **predictable and scalable demand for nature credits**. Frameworks must be designed to embed nature credits as go-to tools for private investments in nature, explicitly defining their use cases and intended outcomes. Governments can introduce mandatory action, such as requiring industries to offset biodiversity impacts through credit purchases, with financing drawn from lenders, capital markets, or repayable from taxes and user fees. Alternatively, stronger profit incentives can be created by integrating credits into corporate ESG strategies, supply chain requirements, or regulatory compliance frameworks. Three broad regulatory approaches stand out:

- **Reward structures**, such as Payments for Ecosystem Services (PES), provide financial payments for delivering nature-based projects. These can encourage private sector participation but may

rely heavily on public funding, limiting the scale of private investment unless paired with other mechanisms (EIB, 2023).

- **Punishment structures** involve regulatory penalties or requirements that mandate nature-based solutions, such as building codes mandating green roofs in urban areas or wetland mitigation credits for real estate development near protected areas. These create a clear cost for inaction, pushing companies to invest in credits or restoration projects to avoid penalties (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024).

- **Cap-and-trade markets** set regulatory limits on biodiversity loss or emissions, allowing trade between market participants to meet policy goals cost-effectively. A biodiversity cap-and-trade system would mirror the EU Emissions Trading System (EU ETS), shifting from limiting damage to actively driving ecological gains. For example, a cap on allowable biodiversity loss could evolve into a floor of minimum ecological gains, rewarding projects that exceed restoration targets. However, designing such a system requires careful selection of metrics (species diversity, landscape reconnection, water quality, …) and geographical scales to ensure ecological integrity and avoid leakage to regions with weaker regulations (BioInt, 2025).

Corporate engagement is another critical mechanism, but its potential hinges on addressing **the lack of clear pathways for using nature credits within existing sustainability frameworks**. While companies could integrate nature credits into their ESG commitments, and climate pledges, most current frameworks do not yet explicitly outline how credits can or cannot be used to meet voluntary targets. Without clear direct guidance from frameworks like the EU's Corporate Sustainability Reporting Directive (CSRD), the Taskforce on Nature-related Financial Disclosures (TNFD), or Science-Based Targets Network (SBTN), **companies face uncertainty about whether and how nature credits can contribute to their biodiversity disclosures**. To unlock corporate participation, voluntary standards must first define the role of nature credits, specifying their acceptable applications, limitations, and alignment with broader sustainability objectives. Only then can companies confidently leverage credits to demonstrate measurable progress, enhance ESG reporting, and meet stakeholder or regulatory expectations.

Beyond regulation, financial instruments tailored to address the unique risks and characteristics of nature-based projects must bridge the gap between project potential and investor confidence. This includes :

- Concessional loans and pay-for-results grants, such as those used in the REDD+ model, which provide **upfront funding tied to verified outcomes**.

- Debt issuance through securitisation of natural capital, using existing **assets** (e.g., land, carbon credits, or agricultural production) as **collateral** to secure loans.

- Risk-sharing mechanisms, such as **guarantees or insurance features, to de-risk projects** and attract private capital. For instance, the European Investment Bank (EIB) has successfully used guarantees and contingent debt to support nature-based projects under the Natural Capital Financing Facility (NCFF), demonstrating how public funds can catalyse private investment by absorbing early-stage risks (EIB, 2023).

- Thematic bonds, including green, blue, social, resilience, and SDG-aligned bonds, can also **finance nature-based projects by linking proceeds to verified ecological outcomes**. Sovereign or corporate issuers of use-of-proceeds bonds can earmark funds for restoration projects, while sustainability-linked bonds tie interest payments to the achievement of biodiversity targets, aligning financial returns with environmental performance (International Capital Market Association, 2022).

Blended finance is particularly effective for scaling nature credits, combining public, philanthropic, and private capital to **address the illiquidity, long time horizons, and high transaction costs of restoration projects** (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024).

Blended structures, such as debt, equity, performance-based grants, and guarantees, can pool resources from development finance institutions, private investors, and NGOs to support projects during their early stages. For example, the EIB's InvestEU programme has already demonstrated how concessional financing and advisory services can unlock investment in nature-based solutions, particularly in sectors like agriculture and urban infrastructure where corporate demand for sustainability is growing (EIB, 2023). Similarly, **wetland mitigation credits, which price the ecological value of wetland restoration, offer a model for monetising nature's benefits in real estate and infrastructure development**. While rare in Europe today, such credits, especially for coastal wetlands, could become a significant revenue stream for conservation, as they align financial incentives with ecological restoration.

Performance-linked loans and guarantees can further reduce the perceived financial risk of such investments, making it easier for corporations to allocate capital to nature-based solutions. Financial intermediaries, including **green banks and impact investing platforms**, play a key role here by **aggregating projects, standardising contracts, and providing secondary market liquidity**, thereby reducing transaction costs for both buyers and sellers.

Capacity building and technical assistance are also vital. Early-stage support, such as **financial technical assistance**, **project preparation facilities**, and **credit enhancement**, can help developers meet the rigorous standards required for credit issuance (Zu Ermgassen *et al.*, 2025). The EIB's InvestEU Advisory Hub, for example, provides guidance to promoters on enhancing nature-based solutions within larger financing transactions (EIB, 2023), while accelerator programmes can support small, innovative projects that might otherwise struggle to access capital. These initiatives not only **reduce the administrative burden on project developers** but also build a **pipeline of investable projects**, increasing the credibility of nature credits as an asset class.

Finally, **data and valuation tools can enhance the attractiveness of nature credits to private investors**. The Ecosystem Services Valuation Database (ESVD) provides monetary values for ecosystem services, helping financial institutions assess the return on investment for nature-based projects. For example, ASN Bank's 'Make Nature Count' initiative uses ESVD data to inform decision-making, highlighting how monetising ecosystem services can align environmental objectives with broader economic goals. Similarly, Payment for Ecosystem Services (PES) schemes, such as wetland mitigation credits, **compensate landowners for maintaining or enhancing ecosystem services**, creating a direct financial incentive for conservation (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). These mechanisms can be scaled up by involving businesses and financial institutions in their design, ensuring that they generate revenue streams while delivering ecological benefits.

Roles of public actors in aggregation, de-risking and market-enabling infrastructure.

One of the most pressing challenges in scaling nature-based solutions is the **fragmentation of small projects, typical of European landscapes**, where **transaction costs per credit exceed the economic value of the intervention**. This fragmentation is further exacerbated by poor coordination between different sources of finance, which leads to competition between existing funding streams and results in projects that are strong candidates for return-seeking finance ending up funded by direct grants (Zu Ermgassen *et al.*, 2025). Public actors can address this by **aggregating projects into larger, more attractive portfolios**, reducing the administrative burden on developers and simplifying access to capital for investors (EIB, 2023). For example, **public funds can be used to bundle small dam removals, wetland restorations, or floodplain reconnections into a single credit portfolio**, making it easier for institutional investors to purchase credits in bulk. This approach aligns with the need for specialised vehicles and funds, which can focus on specific sectors (e.g., river connectivity, agricultural landscapes) and achieve economies of scale that generalist portfolios cannot (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). The European Investment Bank's (EIB) Natural Capital Financing Facility (NCFF) and similar programmes demonstrate how public capital can be used to de-risk bundles of projects, improving their risk-return profiles and making them more appealing to private investors (EIB,

2023). By **reducing the cost of due diligence, standardising contracts, and providing technical support, public actors enable portfolio-level aggregation** that would otherwise be infeasible for individual project developers.

De-risking is another critical role for public actors, as biodiversity projects are often **perceived as high-risk, illiquid, and long-term, with uncertain cash flows and ambiguous environmental outcomes**. Public actors can shift this risk profile through **guarantees, concessional loans, and first-loss capital**, making projects investable for private financiers (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). For instance, guarantees, where a public institution absorbs the first loss in a transaction, can incentivise private co-investment by reducing the downside risk for lenders and investors. While guarantees are not yet widely used in European biodiversity finance due to the sector's immaturity, interviews with financial experts suggest they could play an enabling role alongside grants and concessional loans, particularly for projects that are technically sound but financially fragile (Basset, 2025). Similarly, concessional loans, provided at below-market rates, can improve the financial viability of restoration projects by lowering the cost of capital. These loans are particularly effective when combined with blended finance structures, where public capital is used to absorb early-stage risks, while private investors purchase credits tied to verified outcomes (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). National and EU-level programmes, such as InvestEU, LIFE, and the Green Assist initiative, are already deploying these tools to support SMEs and project promoters, offering **free advisory services to help them navigate complex financing landscapes and meet the stringent requirements for credit issuance** (Climate, Infrastructure and Environment Executive Agency, 2025). By providing patient capital and loss absorption capacity, public actors can unlock investment in projects that would otherwise struggle to attract private financing.

At the market-enabling level, public actors can foster the development of **standardised infrastructure that reduces transaction costs and increases transparency**. This includes technical assistance programmes, such as Green Assist, that provide free advisory services to project promoters, financial institutions, and intermediaries, helping them prepare projects for investment and secure blended finance (Climate, Infrastructure and Environment Executive Agency, 2025). Technical assistance can also support the development of special purpose vehicles (SPVs), which are increasingly used to **pool capital and distribute it to smaller initiatives in a traceable way**. SPVs enable the implementation of silvo-pastoral systems, wetland restorations, and river connectivity projects, where lack of access to capital, debt aversion, and limited technical expertise are common barriers (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). By acting as market makers, public institutions can also **standardise contracts, reporting frameworks, and credit issuance processes**, ensuring that projects meet the four core components of the Green Bond Principles (GBP) or other recognised standards (International Capital Market Association, 2022). This not only improves the auditability and credibility of nature credits but also aligns them with the reporting requirements of CSRD, TNFD, and SBTN, which are increasingly shaping corporate expectations around biodiversity disclosure and accountability. Public actors can further leverage philanthropic capital through Project Finance for Permanence (PFP) models, which secure long-term funding for large-scale conservation by combining government commitments, private investment, and philanthropic donations. Examples like Eternal Mongolia's PFP, where public funding leveraged private and philanthropic capital to safeguard 14.4 million hectares, illustrate how public-sector leadership can catalyse multi-stakeholder collaboration at scale (The Nature Conservancy, 2025).

However, public disengagement can undermine these efforts. Recent high-profile withdrawals of asset manager partners from UK public-private nature restoration funds, citing insufficient returns, highlight the **risks of relying too heavily on de-risked public capital without sufficient regulatory incentives or market demand for biodiversity credits** (Basset, 2025). This underscores the need for **stronger policy alignment**, including mandatory biodiversity reporting (CSRD), stricter regulations to prevent natural harm, and the **redirection of harmful subsidies** (e.g., in agriculture) to align with restoration goals (OECD, 2021). Additionally, Nature Transition Plans for companies and financial institutions, as outlined in the Global Biodiversity Framework (GBF), can provide a framework for time-bound, measurable commitments that

private actors are more likely to fund. These plans can help align corporate strategies with biodiversity goals, creating predictable demand for nature credits and fostering greater private-sector engagement. Also, expanding the EU Taxonomy to include biodiversity projects could align public and private incentives.

Ultimately, the role of public actors in this context is to enable private finance by creating the conditions for investment to flow at scale. This requires a revolution in public policy, including revolutionary changes in regulations and incentives, **substantial public investment in market infrastructure, and a commitment to transparency and accountability** (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). The illusion that private finance can lead restoration efforts without strong public-sector involvement is misplaced; instead, **public actors must lead the transformation, using aggregation, de-risking, and market-enabling tools to build a resilient, investable, and ecologically coherent biodiversity credit market** (EIB, 2023). Only then can Europe's fragmented wetlands, rivers, and floodplains be restored at the pace and scale needed to meet its restoration targets.

### Limits of private finance mobilisation for legally mandated restoration targets, and the 'additionality' principle.

Private finance faces significant limits in mobilising the capital needed to meet legally mandated restoration targets, particularly for biodiversity credit schemes. The challenges are both structural and operational: **strict timelines and regulatory deadlines often clash with the long-term, high-risk nature of restoration projects**, while low liquidity and high transaction costs deter private investors who prioritise short-term returns (EIB, 2023). Additionally, **fragmented or small-scale projects, common across European landscapes, struggle to attract commercial capital due to high upfront costs and uncertainty around ecological outcomes**. Without robust public support to de-risk investments and align financing with regulatory requirements, private finance remains hesitant to commit at the scale needed (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024).

Private sector participation is further constrained by the **risk-return profiles** of nature-based solutions, which are often **illiquid, long-term, and high-risk**. Grants remain the most common tool for financing early-stage projects, as they cover revenue shortfalls and enable innovation, but they are not scalable for large-scale restoration (EIB, 2023). Loans, whether market-rate or concessional, carry **repayment risks, particularly for beneficiaries who may struggle to generate cash flows from ecological restoration**. Equity instruments, while flexible, are rarely used due to the lack of scalable liquidity and the risk-adjusted returns demanded by investors (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). Even when blended finance (combining public, private, and philanthropic capital) is deployed, **the transaction costs and complexity of structuring deals often outweigh the benefits**, especially for small or fragmented projects typical of European landscapes. The **perceived failure of carbon markets**, particularly the Voluntary Carbon Market (VCM), further dampens enthusiasm for biodiversity credits, as stakeholders extrapolate the VCM's shortcomings, such as **overcrediting, lack of transparency, and weak additionality**, to biodiversity credits schemes (Zu Ermgassen *et al.*, 2025). The argument that "if carbon credits couldn't get it right, how can biodiversity?" creates a psychological barrier that hampers market development, despite the fundamental differences between the two (Basset, 2025).

Demonstrating additionality in this context requires **robust proof of ecological impact and alignment with regulatory frameworks**. Biodiversity credits schemes offer two primary approaches to additionality: the **financial/regulatory surplus approach**, which shows that activities are not legally required and depend on credit revenue, and the **embedded approach**, where credits are tied to measured uplift versus a baseline (e.g., NARIA Framework) (Gradeckas & Vaquié, 2026). In the case of nature credits contributing to NRR goals, however, additionality is best understood as relative to individual actors' legal obligations. Nature credits can support the delivery of national NRR objectives, provided they respect the mitigation hierarchy, generate measurable nature-positive outcomes and avoid double funding and counting.

However, operationalising additionality is fraught with challenges. Projects often prioritise reporting over proving causality, making it difficult to establish that biodiversity gains were directly caused by the

intervention rather than natural recovery or pre-existing commitments (Basset, 2025). Self-selection bias, where project implementers are intrinsically motivated, further complicates additionality, as it becomes unclear whether the credit mechanism was the catalyst for action or merely a passive reward. Zu Ermgassen *et al*. (2025) argue that nature markets should start with the **conservative assumption that land management outcomes are non-additional**, and that high-quality, credible evidence is required to demonstrate otherwise. Furthermore, while biodiversity credits schemes focus on restoration projects, additionality and baseline scenarios are even more difficult to establish in stewardship projects, where the goal is to maintain or enhance existing biodiversity rather than create new gains. To address these challenges, schemes must **invest in counter-factual scenarios, robust monitoring, and third-party verification** to ensure that credits represent genuine, non-duplicative benefits. However, too stringent MRV requirements may adversely affect the financial viability of the project and hinder private investments. Governments need to carefully analyse the trade-offs and strategically support private stakeholders in their reporting activities.

Voluntary schemes face even greater scrutiny, as they must compete with compliance markets and demonstrate that their mechanisms are not simply **relabelling existing legal obligations or public funding as "market-based" solutions**. The lack of awareness about the economic value of ecosystem services and the difficulty in monetising restoration benefits further limit voluntary engagement (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). While tools like ESVD and SEEA provide critical insights, they do not alone create the economic incentives needed to steer private capital toward restoration beyond existing mandates or public funding. Furthermore, voluntary biodiversity credit mechanisms often struggle to attract private finance due to **lack of clarity on the possible use of obtained credits**: guidance on claims is still under development and the potential of a secondary market for biodiversity credits is not yet fully explored. Private stakeholders are yet to witness the **full range of benefits provided by nature credits**. Moreover, technical capacity gaps persist, with many restoration projects **lacking bankable business models**, while governance challenges, such as insecure land tenure and unequal benefit distribution, hinder locally-led initiatives. Additionally, policy fragmentation and the absence of clear sectoral pathways for transformation, reinforced by a lack of comprehensive financial scenarios, limit the ability of markets to channel private investment effectively (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024).

To unlock private finance at scale, policy and sectoral transformation are essential. Governments must catalyse economic shifts by **embedding biodiversity considerations into sovereign financing, taxonomies, and transition planning** (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). Sectoral regulations, such as those in agriculture, energy, or infrastructure, should explicitly incorporate biodiversity targets, creating a predictable demand for credits. Nature transition plans for companies and financial institutions, as outlined in the GBF, can provide a **framework for** time-bound, measurable commitments **that private actors are more likely to fund**. Technical assistance, such as the EU B&B Platform, IDH's convening methods, or the IUCN Nature+ Accelerator Fund, can help project developers structure bankable business models, reducing the perceived risk for investors (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). Meanwhile, landscape approaches that address land tenure insecurity, unequal benefit distribution, and indigenous stewardship can ensure that finance flows to locally-led initiatives rather than being concentrated in large, externally managed projects.

Blended finance and risk mitigation are critical tools for bridging the gap between public mandates and private investment. By **combining concessional finance, guarantees, and first-loss capital with private capital, blended structures can lower risk perceptions and improve the risk-return profile of projects** (Finance for Biodiversity Foundation and United Nations Environment Programme, 2024). Examples like the EBRD's Chisinau River Basin Rehabilitation or the Caisse des Dépôts Branche de Croix canal restoration show how public funds can crowd in private investors for infrastructure projects that would otherwise struggle to secure financing (EU Business & Biodiversity Platform, 2024). However, these mechanisms must be carefully designed to **avoid dependency on public capital or the perception that projects are artificially de-risked**. The ultimate goal is to create a self-sustaining market where restoration is

financially viable without perpetual subsidies, but this requires regulatory certainty, standardised methodologies, and a clear demonstration of additionality (Zu Ermgassen *et al.*, 2025).

## 3. Demand-side considerations.

Drivers of nature credits purchase by private actors.

Private actors may purchase nature credits for a variety of **strategic, financial, and reputational reasons**, driven by both voluntary motivations and regulatory pressures. According to the EIB's market study (2026), 80% of corporates and 63% of financial institutions cite **strengthening resilience against biodiversity risks**, **dependencies, and impacts** as a primary driver, while 67% of corporates and 63% of financials aim **to enhance extra-financial reporting**. For many corporations, the primary incentive lies in mitigating risks, whether related to climate hazards, supply chain disruptions, or regulatory compliance, while simultaneously strengthening resilience and ESG commitments. Investing in nature-based solutions offers tangible benefits: it can **reduce exposure to water-related risks, enhance supply-chain robustness, and improve operational continuity in high-risk environments**. For utilities and infrastructure providers, nature credits tied to projects like wetland restoration or floodplain reconnection serve as a **hedge against increasing climate volatility, lowering vulnerability to extreme weather events**. The insurance sector, in particular, stands to gain from **risk-adjusted premium reductions when restoration efforts demonstrably decrease disaster exposure**, historical data shows that every $1 invested in disaster risk management can yield up to $60 in avoided losses, making nature-based interventions a cost-effective form of resilience-building (EIB, 2023). Beyond risk mitigation, corporations are increasingly motivated by reputational considerations, as stakeholders, including consumers, investors, and regulators, demand **greater accountability for environmental impacts**. Nature credits can be integrated in regulatory or voluntary reporting frameworks (CSRD, TNFD, SBTN) for companies to signal tangible progress toward biodiversity goals and bolster brand value (Pollination, 2024).

However, for voluntary demand to reach the scale required, economic incentives must be strengthened. While high-integrity contributions to nature remain a motivation for some, in the absence of a regulatory framework, most private actors will only commit capital if they **perceive reputational advantages or direct financial returns**, such as revenue from carbon credits, biodiversity credits, or insurance-linked savings, or cost efficiency gains. The EIB study (2026) identifies that 26% of respondents cite the absence of profitability or return on investment for biodiversity as the major reason why they do not invest large amounts into biodiversity. Without clear economic value, reliance on philanthropy and marketing-driven demand will remain insufficient. Governments and regulators can accelerate this transition by implementing both carrots and sticks: **tax benefits, lending incentives, and procurement rules can reduce the cost of participation**, while **mandatory reporting and regulatory requirements (e.g., biodiversity net gain laws) create a predictable demand for credits**. The success of compliance markets, such as Germany's eco-point system, England's Biodiversity Net Gain, or the U.S. wetland mitigation banking under the Clean Water Act, demonstrates that legal obligations are often the most effective drivers of credit market scaling. These systems, built around compensation mandates, have created the largest functioning biodiversity credit markets globally, proving that **policy certainty is critical for market development** (Bloomlabs, 2026).

Ultimately, the private sector's engagement with nature credits hinges on two pillars: **economic viability and policy alignment**. By linking credits to verifiable cost reductions, risk mitigation, and regulatory compliance, governments can create a framework where private investment in nature-based solutions is not just a philanthropic act but a strategic, financially sound decision. Without these incentives, the market will remain fragmented and underdeveloped, failing to meet the ambitious restoration targets set by policymakers.

Potential buyers' profiles.

A key challenge is the "public good" nature of river and lake ecosystems. Biodiversity improvements, such as enhanced fish populations, improved water quality, or increased recreational opportunities, **accrue broadly to society rather than to individual investors**. This makes it difficult to finance river restoration privately, as benefits are not easily captured or monetised.

The categories of actors most likely to participate in nature credit markets are those with **direct material risks, regulatory obligations, or financial incentives tied to ecological restoration**. Utilities and infrastructure operators, particularly those dependent on natural resources, are prime candidates, as their operations face physical risks from climate hazards and regulatory pressure to mitigate environmental impacts. For example, **data centers and power plants** rely heavily on water for cooling, making them acutely sensitive to water temperature, scarcity and quality degradation. Their participation is driven by **materiality of risk**, as nature-based solutions (e.g., wetland restoration, floodplain reconnection) can reduce vulnerability to droughts, floods, or regulatory penalties. Similarly, **hydropower companies and water-dependent corporates** (e.g., food and beverage firms) have a vested interest in maintaining ecosystem services that underpin their operations, from water supply to flood regulation.

Financial institutions, especially **banks and insurers**, are also increasingly active, though their engagement varies by strategy. The EIB study (2026) found that financial respondents favour nature-based solutions through targeted investments, philanthropic donations and the purchase of carbon credits, with **80% integrating biodiversity as a factor into their investment and financial policies**. Insurance companies, in particular, are uniquely positioned to benefit from nature-based solutions, as they can **hedge physical risks by investing in projects that reduce claims payouts over time**. For instance, financing a drought-prevention mechanism could lower the likelihood of drought-related losses, directly impacting premium pricing and profitability. However, their participation is constrained by short-term contract cycles and principal-agent issues, where benefits from reduced future risks are not immediately reflected in pricing. Furthermore, the **mismatch between investment timing and risk reduction benefits** represents an additional barrier to scaling insurer participation. Despite these challenges, insurers with large asset portfolios (e.g., €1 trillion in combined EU-based assets) are exploring ways to integrate nature-based solutions into both underwriting and investment strategies, recognizing their potential to enhance resilience and generate financial returns.

Large corporations, especially those with **global supply chains**, are emerging as key players in financing nature-based solutions. Unlike institutional investors, who prioritize profitability, **corporates align their investments with operational risks and supply chain dependencies**. For example, a food company may fund wetland restoration to secure water quality, while an energy firm might invest in carbon sequestration to hedge future regulatory costs. These companies are structured, bankable entities with existing financial track records, making them more eligible for funding than many smaller nature-based projects. Their motivation stems from urgency (their economic livelihoods depend on stable natural resources) and strategic foresight, as they anticipate tightening EU regulations (e.g., CSRD, TNFD) and evolving carbon markets. By **leveraging their cash flows and debt capacity, corporates can deploy nature-based solutions without requiring standalone financial sustainability**.

However, cross-border participation remains minimal. **Voluntary biodiversity credit demand is overwhelmingly hyper-local**, with 96% of B2B purchases occurring domestically, and less than 4% of transactions involving cross-border credits (Bloomlabs, 2026). This reflects **regulatory fragmentation, market immaturity, and a preference for proximity in risk mitigation**. Even so, as policy signals strengthen (mandatory BNG laws in the UK or the EU's NRR), corporate and institutional demand is expected to grow, particularly among regulatory-compliant sectors like utilities, infrastructure, and extractives. The EIB study (2026) suggests that respondents identified five priority areas for scaling voluntary biodiversity finance: **Regulatory framework, Instrument credibility, Capacity building, Financial incentives, and Market design**. Financial institutions, including development banks and green investors, can further accelerate this trend by offering innovative financing structures (e.g., longer maturities, grace periods) tailored to the long-term horizons of nature-based projects.

**Water-dependent sectors**, such as drinking water supply, sanitation, and hydropower, are uniquely incentivized by the Water Framework Directive (WFD), which mandates **cost recovery for water services**. While the WFD Fitness Check highlights a lack of funding due to incomplete cost recovery in sectors like agriculture and energy, the drinking water sector stands out as a model for aligning financial flows with restoration goals (WWF, 2021). This underscores a broader opportunity: **aligning economic incentives (e.g., tax benefits, lending incentives) with ecological outcomes to mobilise private capital at scale**. As these sectors face increasing regulatory and climate pressures, their participation in nature credit markets is poised to expand, provided that policy certainty, standardized methodologies, and co-financing mechanisms are in place to mitigate risks and transaction costs.

How to scale-up demand and avoid greenwashing?

The EIB's market study (2026) confirms that **respondents know little and remain cautious about purchasing biodiversity certificates**, with awareness significantly lower than that of carbon credits. The voluntary biodiversity credit market remains in its early, experimental phase, with demand that is neither robust nor scalable in its current form. The market is **still defining core concepts, such as credit units, biodiversity indicators, and claims**, while fundamental features like additionality, baselines, permanence, and leakage lack standardization. Practically, many biodiversity credits schemes are not yet fully aligned with their theoretical requirements, and their implementation often reflects a process of trial and error rather than a mature, reliable system. This immaturity is reflected in low agreement among stakeholders about the role of voluntary contributions and reporting as key drivers, and high agreement on the complexity of biodiversity and the risk of greenwashing as major obstacles. The inconsistency of methodologies and the absence of robust governance frameworks mean that voluntary demand is fragmented, uncertain, and vulnerable to criticism, particularly given the troubled reputation of the voluntary carbon market, where projects have historically been designed to maximize credit issuance with little regard for environmental or social outcomes (Basset, 2025).

To avoid the pitfalls of the VCM, such as low-quality credits, non-additionality, and reputational damage, voluntary biodiversity credits schemes must **strictly limit the claims they permit**. The **fear of greenwashing is already a high-agreement barrier in the biodiversity credits market**, with respondents citing the lack of credibility or reliability of existing tools as a key barrier (EIB, 2026), and without clear rules, **voluntary demand risks being seen as opportunistic or symbolic rather than transformative**. Efforts of standardisation and regulation exist to curb greenwashing in voluntary biodiversity credit schemes, with both voluntary frameworks (e.g. SBTN) and regulatory efforts (e.g. the ongoing effort to introduce the EU Green Claims Directive) proposing **strict requirements for corporate claims about nature-related activities**. These rules demand **verifiable evidence, third-party validation, and explicit disclosure of ecological trade-offs**, ensuring claims represent tangible contributions, such as restored hectares or reduced pollution, rather than vague offsets. By mandating science-based methodologies, transparent baselines, and public accountability, these frameworks prevent symbolic or opportunistic narratives, aligning corporate actions with measurable ecological integrity (Netherlands Entreprises Agency, 2024).

Scalability in a voluntary context will only be achieved if robust oversight is introduced, whether through legally binding regulations, market-enabling policies, or third-party verification. The lessons from the VCM are clear: **voluntary markets must prioritize integrity, focusing on high-integrity credits that deliver verifiable biodiversity benefits** (Basset, 2025). Then only can the markets focus on volume. Without this, voluntary demand will remain niche and opportunistic, failing to generate the scale of investment needed to meet global restoration targets. The path forward requires government leadership to **align incentives, standardize methodologies, and enforce strict rules against greenwashing**, ensuring that biodiversity credits schemes contribute to real ecological restoration rather than mere corporate PR.

## 4. Supply-side considerations.

Restoration project developers, certification schemes developers and third-party MRV operators.

The implementation of restoration activities that can generate biodiversity credits in the EU is driven by a **diverse ecosystem of stakeholders, ranging from conservation NGOs and river trusts to hydropower companies, public agencies, and local communities**. The Dam Removal Europe (DRE) coalition, a network of seven leading environmental organizations, WWF, The Rivers Trust, The Nature Conservancy, the European Rivers Network, Rewilding Europe, Wetlands International, and the World Fish Migration Foundation, serves as a **central hub for coordinating dam removal and river restoration projects across Europe** (Mouchlianitis, 2025). Their case studies highlight the key stakeholders involved in implementing restoration activities (Annex II):

- **NGOs and Conservation Organizations**: WWF, The Nature Conservancy, and Wetlands International lead restoration projects, often in partnership with local NGOs, providing scientific expertise, funding, and community engagement.
- **River Trusts and Local Initiatives**: The Rivers Trust and its national affiliates mobilize local stakeholders, conduct feasibility studies, and implement on-the-ground restoration, such as weir or dam removal.
- **Public Agencies and Water Authorities**: Government agencies (e.g., ministries of environment, water boards) issue permits, provide funding, and collaborate on large-scale projects like the Selune Dam removal in France or the Hiitolanjoki project in Finland.
- **Hydropower Companies and Former Operators**: In some cases, former dam operators (e.g., Hiitolanjoen Voima in Finland) are consulted or involved in removal processes.
- **Research Institutions and Universities**: Partners like World Fish Migration Foundation and academic institutions provide ecological assessments, monitoring, and scientific validation of restoration outcomes.
- **Local Communities and Volunteers**: Indigenous groups, landowners, and citizen scientists participate in monitoring, fundraising, and advocacy, ensuring social acceptance and long-term sustainability.
- **Funders and Philanthropies**: Organizations like the European Open Rivers Programme and private foundations (e.g., Patagonia) provide critical financing for projects, often bridging gaps in public or private sector funding.

Readiness in the EU context: While these stakeholders are well-positioned to implement restoration activities, their **scalability is constrained by regulatory fragmentation, funding gaps, and stakeholder opposition**. For example, small dams (≤2m high) are easier to remove, but larger, economically valuable structures face stronger opposition from local communities and industries. The EU's Water Framework Directive (WFD) and National Restoration Plans provide a regulatory backbone, but inconsistent enforcement and funding limit rapid scaling. The DRE coalition's progress reports (2024–2025) show that **increasing number of activities across Europe indicate growing momentum**, but **knowledge dissemination, policy alignment, and cross-border collaboration remain key bottlenecks**. Furthermore, existing stakeholders remain to determine their role in the implementation of biodiversity credits frameworks. Who is the ultimate beneficiary of the generated credits? How to coordinate different projects on a larger geographical scale (e.g. river basin)?

The BiodivCReW project (Benchmarking Report on Biodiversity Certification and Credit Systems for European Wetlands) systematically evaluated voluntary biodiversity credit schemes for their suitability in the EU context, focusing on measurable ecological performance, scientific rigor, and alignment with EU policy priorities, particularly the High-level Principles (HLPs) and the European Green Deal's biodiversity and water goals. The project's rigorous assessment framework led to the **selection of two schemes as most suitable for piloting in European wetlands: Verra's SD VISta Nature Framework and Wallacea Trust** (Gradeckas & Vaquié, 2026).

Verra's SD VISta Nature Framework, selected for its institutional credibility, Verra ensures immediate legitimacy among corporates, financial institutions, and market intermediaries. Its use of standardized indicators aggregated into a condition score aligns closely with frameworks like TNFD, CSRD, and SBTN, makes it easier for corporates to justify credit purchases.

As of late 2025, Verra has a project pipeline of 10–15 projects, including European wetlands, with a cumulative area of ~200,000 hectares. The scheme is fully applicable to European wetlands, including peatlands, floodplains, and salt marshes.

However, its **high methodological complexity requiring significant technical expertise and its slow validation timelines make it less accessible for small landowners or NGOs** without strong capacity and may delay project implementation in time-bound EU-funded pilots.

Wallacea Trust is an open-source, offering a flexible, scientist-led approach that is free to use and easy to apply, making it highly accessible for conservation practitioners and small-scale projects. It allows projects **defining a custom basket of metrics tailored to local conservation goals**. This allows for highly **context-specific tailoring, which is critical for Europe's fragmented landscapes**.

The methodology is less prescriptive than full certification standards, enabling faster project development and learning-oriented pilots. However, it comes at a cost of gaps in formal governance: **Wallacea Trust lacks a centralized registry, governance framework, or standardized issuance infrastructure**. Projects must independently source third-party registries and coordinate verification, which may introduce complexity and potential conflicts of interest.

Both schemes are well-prepared for EU wetland restoration certification and are aligned with EU priorities, including the EU Biodiversity Strategy 2030, Nature Restoration Law, and CSRD, but **their widespread adoption will depend on simplifying governance, reducing costs, and ensuring regulatory recognition** (Gradeckas & Vaquié, 2026).

### MRV Technologies: Readiness and Capabilities for Biodiversity Credits

Measurement, Reporting, and Verification (MRV) is the cornerstone of trust and scalability in biodiversity credit schemes. The EU's biodiversity monitoring roadmap (2026) emphasizes the **need for integrated, multi-scale, and technology-driven MRV systems to support policy and market integrity**. The following technologies are critical for MRV in the EU context, along with their readiness levels:

- **Remote Sensing**: helps monitoring habitat extent, land-use change, and ecosystem health at continental to local scales. High-resolution satellites (e.g., Sentinel-2, PlanetScope) and drones provide frequent, cost-effective data for large areas. The EU's Copernicus program provides free, open-access satellite data, and AI-driven classification tools (e.g., Google Earth Engine) are widely available.
- **Environmental DNA (eDNA) and Genomic Tools**: detects species presence, biodiversity, and ecosystem health via DNA left in soil, water, or air samples. eDNA is increasingly used in EU monitoring programs, but standardization and cost remain challenges.
- **In Situ Studies and Field Surveys**: provides detailed ecological data (e.g., species counts, habitat condition) useful for biodiversity baselines, calibrates remote sensing and eDNA data. Easily applicable in local contexts, but scalability is limited by cost and labor.
- **AI, Machine Learning, and Digital Platforms**: automates data processing, integrates multi-source data (satellite, eDNA, field surveys), and enables real-time monitoring. Can be mobilised in other hi-tech environmental applications such as AI-driven species recognition (e.g., camera traps, acoustic sensors), predictive modeling or blockchain-enabled for transparent reporting. EU-wide adoption is hampered by data fragmentation and proprietary systems. Open-access platforms (e.g., UN Biodiversity Lab) are democratizing access, but skills gaps persist.
- **IoT Sensors and Automated Monitoring**: continuous monitoring of soil moisture, water quality, and microclimate with a network of sensors. Can measure parameters describing river health (e.g., temperature, dissolved oxygen) or peatland restoration success (e.g., water table levels). While sensor networks are expanding, calibration, maintenance, and data integration remain barriers for widespread adoption.

While individual MRV technologies are mature, their integration into a unified, scalable system faces hurdles:

- **Data Fragmentation**: EU biodiversity data is siloed across national agencies, NGOs, and private sector actors.
- **Standardization Gaps**: No single EU-wide MRV protocol or biodiversity unit exist for biodiversity credits, leading to inconsistent methodologies.
- **Cost and Accessibility**: Advanced tools (e.g., LiDAR, eDNA) are expensive, favoring large NGOs or corporations over SMEs or local communities.
- **Offer Alignment**: while there is a wide range of MRV possibilities, they don't always align with operational needs such as baseline assessment, counterfactual scenario building.
- **Regulatory Alignment**: EU policies (e.g., Nature Restoration Regulation, CSRD) are driving demand for MRV, but implementation timelines lag behind market needs.

The EU's 2026–2027 Horizon Europe Work Programme prioritizes integrating remote sensing and in-situ data, signaling growing investment in scalable MRV. Projects like Europa Biodiversity Observation Network aim to close monitoring gaps, while open-access initiatives (e.g., UN Biodiversity Lab) are democratizing ecological data.

## 5. Permanence and durability of restoration outcomes.

Permanence/durability in freshwater restoration activities.

Defining permanence and durability for freshwater outcomes, particularly in relation to connectivity and floodplain functions, requires a nuanced understanding of both ecological and legal frameworks (Living Rivers Europe, 2025). **Durability refers to the ability of a project to ensure that biodiversity outcomes endure for an extended, defined period, without implying definitive permanence**. This distinction is critical: permanence suggests an irreversible achievement of outcomes, even beyond the project's lifespan, while durability accommodates the possibility of adaptation and renewal while maintaining core benefits (Biodiversity Credits Alliance, 2024).

Achieving durability in freshwater systems often hinges on two primary approaches: **indefinite crediting periods and robust funding models that extend beyond the project's active phase**, or legal requirements that enforce management obligations for a defined duration (Wunder *et al.*, 2025). In the EU, the **Water Framework Directive (WFD) provides a regulatory foundation for durability**, requiring Member States to achieve *good ecological status* for surface waters based on assessments of physico-chemical, hydromorphological, and biological quality elements (Living Rivers Europe, 2025). Programmes like PV Nature and NaturePlus exemplify these mechanisms. For instance, PV Nature **mandates that risks to biodiversity benefits be identified and mitigated for at least 50 years**, with regular reviews every five years. Restoration projects must **transfer 20% of credits to a risk buffer**, which are cancelled if negative outcomes persist across three consecutive reporting periods, while conservation projects **retain 20% of income in a financial reserve for up to five periods to offset unavoidable losses**. NaturePlus, in contrast, calculates a non-permanence deduction factor for each project, placing credits in a buffer account managed independently and cancelling them upon non-permanence events, while incentivizing continuous crediting as long as outcomes can be demonstrated (European Commission & ICF, 2025). Other tools, such as **commercial insurance**, represent effective solutions to address reversal of positive outcomes (Holmlund *et al.*, 2026)

Permanence, while conceptually appealing, is often **impractical due to the dynamic nature of ecosystems** and the influence of external factors such as **land tenure changes or natural hazards** (EFTEC *et al.*, 2010). Freshwater ecosystems in the EU face persistent pressures including hydromorphological degradation,

with **80% of rivers being moderately to heavily modified, which challenges the achievement of permanence** (Paracchini *et al.*, 2026). The Biodiversity Net Gain (BNG) standard's shift from perpetuity to a 30-year timeline reflects this reality, acknowledging that **shorter timeframes may better align with investment attractiveness and ecological variability** (European Commission & ICF, 2025). The EU's Nature Restoration Regulation (2024) adopts a similar pragmatic approach, setting **legally binding targets for restoration by 2030 and 2050** rather than requiring perpetual outcomes, while the **SEEA EA framework provides the monitoring infrastructure to track progress toward these targets** (Living Rivers Europe, 2025). However, even within this framework, durability remains elusive. Natural hazards, such as floods or droughts, can disrupt or destroy restored habitats, while changes in land tenure or regulatory shifts may undermine long-term commitments (Wunder *et al.*, 2025).

Although barrier removal projects, particularly those decommissioning large dams, demonstrate relatively **high permanence due to the economic improbability of reversing such actions**, the true challenge lies in **ensuring that restored flow regimes, such as remeandering and riverbed maintenance, are sustained alongside the physical infrastructure**. The SEEA EA Ecosystem Condition Typology includes landscape-level characteristics such as connectivity, which is crucial for assessing the durability of restored flow regimes and floodplain functions (Paracchini *et al.*, 2026).

Beyond project-specific measures, the **stability of regulatory frameworks is fundamental to permanence** (Wunder *et al.*, 2025). The EU-wide methodology to map and assess ecosystem condition, designed to align with SEEA EA, provides such regulatory stability (Paracchini *et al.*, 2026). Environmental legislation must remain robust and enforceable to prevent reversals in conservation gains (European Environmental Bureau, 2025). For freshwater systems, this includes **not only legal protections like conservation easements but also active management programs** that address threats such as invasive species, illegal waste disposal, or unsustainable land uses. The systemic threat of impermanence in biodiversity credits mirrors challenges faced in carbon markets, where buffer pools and insurance mechanisms are used to mitigate reversal risks. However, these solutions are not without limitations: buffer pools may become exhausted, and their effectiveness depends on the quality and commensurability of the credits they contain (Wunder *et al.*, 2025). Similarly, in the biodiversity context, **the effectiveness of buffer mechanisms for freshwater credits would depend on the robustness of the underlying condition indicators** and the SEEA EA Ecosystem Condition Typology classes used to assess them (Paracchini *et al.*, 2026).

Ultimately, the goal for freshwater outcomes should be to achieve biodiversity benefits that are as long-lasting as possible, balancing ecological aspirations with financial and regulatory realities. This requires **careful selection of projects with high re-connectivity potential**, such as those identified by WWF for barrier removal or Wetlands International Europe's Swimways inventory, while **prioritizing ecosystem services like flood buffering, freshwater reservoir replenishment, and the return of key species** (Living Rivers Europe, 2025). The SEEA EA framework supports this selection process by providing standardized metrics for ecosystem condition, including connectivity indices and floodplain functionality assessments, which can help identify high-potential restoration sites (Paracchini *et al.*, 2026). Mechanisms such as long-term management plans, perpetual financing, and formal land-use restrictions can enhance longevity, but they must be complemented by rigorous monitoring and adaptive management to address evolving threats. The EU-wide methodology emphasizes the **importance of monitoring and reporting**, with ecosystem condition accounts documenting the state of ecosystems at particular moments by employing a structured three-phase methodology: **identifying variables, establishing baseline condition and rescaling into indicators**, and summarizing into an ecosystem condition index. By integrating durability and permanence considerations into project design and regulatory frameworks, freshwater outcomes can achieve both ecological resilience and long-term viability (Wunder *et al.*, 2025). The SEEA EA framework,

with its focus on ecosystem integrity and its alignment with the EU's Nature Restoration Regulation, provides the necessary structure to ensure that durability considerations are systematically integrated into freshwater restoration planning and monitoring (Paracchini *et al.*, 2026).

Most relevant indicators and their monitoring.

Defining and monitoring the most relevant indicators for nature credits is a complex but essential step toward creating a functional, tradable market. The European Union's Second Ecosystem Assessment (MAES2) provides a **structured approach to indicator selection through its Ecosystem Condition Typology (ECT)**, which organizes indicators into six classes that together contribute to the overall description of ecosystem integrity (Paracchini *et al.*, 2026). The foundation of any credible biodiversity credit scheme lies in its **ability to express outcomes in standardized physical terms**, such as a measurable **increase in ecosystem condition over a defined area and duration**. Without such standardization, credits risk becoming illiquid or confined to bespoke project-finance instruments rather than operating as fungible commodities (Basset, 2025). The SEEA EA framework's adoption as a global statistical standard helps address this challenge by providing internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets (OECD, 2021).

Yet, measuring biodiversity presents unique challenges. Unlike carbon, which has a clear, quantifiable unit, biodiversity lacks a natural metric, making it inherently chaotic and variable. Species richness, abundance, and habitat integrity are difficult to track consistently, especially given the mobility of species and the high costs of field surveys. **Transaction costs rise as monitoring becomes more complex, creating a tension between scientific rigor and practical feasibility** (Basset, 2025). To navigate this, programmes often rely on **proxy indicators**, such as Mean Species Abundance (MSA), which assesses local biodiversity intactness on a scale from 0 to 1, rather than attempting to capture the full spectrum of biodiversity. While MSA is widely used**, it primarily reflects species composition, omitting structural, functional, and landscape components** (Netherlands Entreprise Agency, 2024; BioInt, 2025). The SEEA EA Ecosystem Condition Typology explicitly addresses this limitation by **including structural state characteristics** such as vegetation density, habitat structure, and canopy coverage, as well as **functional state characteristics** like primary productivity and disturbance frequency (Paracchini *et al.*, 2026). Similarly, the **Connectivity Status Index** (CSI), developed within the Free-Flowing Rivers Assessment (FRA), provides a standardized metric to evaluate river connectivity status, capturing the degree to which rivers remain free-flowing and ecologically connected.

Beyond species-focused metrics, the concept of "**nature positive**" has gained traction as a framework for evaluating ecological performance. The MAES2 report aligns with this concept by focusing on nature-positive outcomes and using the SEEA EA framework to track progress toward the EU's Nature Restoration Regulation targets (Paracchini *et al.*, 2026). Definitions vary, but one pragmatic approach proposes that a project is "nature positive" if it positively affects at least **three regulating ecosystem services**, such as water purification, species habitat, or flood regulation (Netherlands Entreprise Agency, 2024). The Connectivity Status Index (CSI), as a measure of connectivity underpins many of these functions, ensuring that aquatic species can migrate and ecosystems can function as integrated systems. This ensures that interventions do not inadvertently trade off critical functions, while also accounting for the site-specific nature of ecosystem services. **Regulating services are often prioritized because they underpin provisioning and cultural services**, and their degradation can have cascading effects (Netherlands Entreprise Agency, 2024). However, this approach still requires further refinement to establish **robust, location-specific baselines and measurement protocols** (BioInt, 2025). The EU-wide methodology to map and assess ecosystem condition provides guidance on establishing reference levels and thresholds, which can support the development of location-specific baselines (Paracchini *et al.*, 2026).

The European Commission's presented **Ecosystem Condition Index (ECI)** offers a promising step toward standardization (European Commission, *comm. pers.*). Aligned with the UN's SEEA EA framework, **the ECI integrates abiotic, biotic, and landscape indicators into a 0–1 scale, providing a holistic yet practical tool for assessing ecological performance**. In the EU's implementation, the ECI is used to assess condition across all ecosystem types, with specific indicator sets developed for each MAES Ecosystem Category, including freshwater ecosystems (Paracchini *et al.*, 2026). However, **concerns remain about its operationality for crediting**, particularly among Member States wary of over-reliance on a single metric. Complementing the ECI, the CSI provides a river-specific connectivity metric, while quantitative assessments of floodplain functionality using an index of integrity offer a standardized approach to evaluating floodplain health and ecological processes. The challenge, therefore, is not to identify a single "perfect" metric but to adopt an "appropriate unit" that balances scientific defensibility with practicality (Basset, 2025).

In practice, this means **combining multiple indicator categories, species metrics, habitat condition, ecosystem services, and landscape connectivity**, while acknowledging that no single methodology will suit all contexts. Freshwater ecosystems exhibit significant variability, and the biodiversity impacts of interventions, such as removing a small culvert versus a large-scale project on a major river like the Danube, differ vastly, which must be reflected in the indicators chosen to track outcomes. The path forward requires **collaboration among scientists, policymakers, and market participants to refine these indicators**, improve monitoring protocols, and ensure that credit units are both meaningful and tradable (Basset, 2025). By focusing on measurable, standardized outcomes and avoiding the pitfalls of overly complex or context-specific approaches, nature credits can evolve into a robust tool for financing biodiversity conservation. The SEEA EA framework, as the global standard for ecosystem accounting, provides the foundation for developing these measurable, standardized outcomes, ensuring that nature credits are both ecologically meaningful and market-viable (Paracchini et al., 2026).

Reversal or degradation risk management.

Addressing the risks of reversal or degradation in river restoration demands a multi-layered approach that balances **institutional credibility, legal safeguards, and ecological coherence** (Living Rivers Europe, 2025). A robust biodiversity credit scheme must originate from a credible, certified organization with a high likelihood of long-term existence, as institutional continuity is the bedrock of trust in credit integrity over decades. Recognized governance standards and transparent operations are essential to maintain confidence in the durability of credited outcomes, especially when dealing with dynamic freshwater ecosystems where natural variability and external pressures can undermine restoration gains (Wunder *et al.*, 2025).

**Permanent legal protections** are a critical first line of defense. For rivers restored to free-flowing status, establishing perpetual legal safeguards ensures that **such status cannot be reversed by future licensing, repurposing, or policy shifts** (Living Rivers Europe, 2025). This requires rigorous implementation of the Nature Restoration Law (NRL), Water Framework Directive (WFD), and Trans-European Transport Network (TEN-T) policies, including the exclusion of river stretches with valid derogations from eligibility for restoration or reclassification. Equally important is the **prevention of artificial longevity for obsolete barriers through retroactive relicensing or speculative repurposing**, which could undermine ecological connectivity and hydromorphological integrity (Living Rivers Europe, 2025).

Policy coherence is equally vital. The designation of **Renewables Acceleration Areas (RAAs)** under the Renewable Energy Directive must carefully consider **hydropower plants**, whose **detrimental effects on river connectivity and ecological status often outweigh their benefits**. Excluding such projects from RAAs, or at least subjecting them to **stringent Strategic Environmental Assessments (SEAs) and Environmental Impact Assessments (EIAs)**, increases the probability to keep the reclaimed stretches

free-flowing. Coordination between RAAs and Nature Restoration Plans (NRPs) is also essential to prevent the deterioration of prime restoration areas, ensuring that **renewable energy expansion does not come at the expense of freshwater ecosystems** (Living Rivers Europe, 2025).

**Buffer mechanisms can further mitigate reversal risks** by holding back a portion of credits or financial reserves to absorb potential losses. For instance, restoration projects can set aside 20% of issued credits in a risk buffer, which are cancelled if negative biodiversity outcomes persist across multiple reporting periods. Conservation projects, in turn, may retain 20% of credit income in a financial reserve to compensate for unavoidable setbacks, ensuring revenue continuity while safeguarding ecological integrity. Such **buffers act as financial and ecological cushions**, absorbing shortfalls without compromising long-term restoration goals (Wunder *et al.*, 2025).

Ultimately, treating reversal risks effectively requires a combination of **permanent legal protections, coherent policy frameworks, continuous ecological monitoring, and financial buffers**. By embedding these safeguards into project design and regulatory oversight, restoration efforts can achieve long-term resilience, even in the face of natural variability and external pressures (Living Rivers Europe, 2025).

## 6. Safeguards and environmental integrity.

Additionality, integrity and greenwashing avoidance safeguards.

There are various strategies to achieve additionality, integrity, and the avoidance of greenwashing in biodiversity credit schemes, and the choice of approach depends heavily on the regulatory framework in which the scheme operates as well as the specific scheme being used to generate credits. To illustrate these differences, the BiodivCReW paper identifies two of the most relevant schemes for EU wetlands: Verra's SD VISta Nature Framework and Wallacea Trust. These schemes exemplify distinct approaches to balancing rigor, flexibility, and market credibility, offering contrasting solutions to the challenges of additionality, integrity, and greenwashing prevention in European contexts (Gradeckas & Vaquié, 2026). However, it is critical to note that **most nature markets have demonstrated widespread additionality failures, with empirical evaluations showing that the majority of gains have been non-additional** (Zu Ermgassen et al., 2025).

Additionality in biodiversity credit schemes is demonstrated through two primary approaches. The **financial/regulatory surplus method**, used by Verra's SD VISta Nature Framework, explicitly requires projects to prove that their activities are not legally mandated and are financially dependent on credit revenue. This is achieved through step-by-step validation, including **regulatory additionality checks** (demonstrating that the project is not a legal requirement), **financial additionality** (showing that the project is not financially viable without credits), and **barrier analysis** (proving that the project overcomes real obstacles to implementation). The **embedded approach**, exemplified by Wallacea Trust, ties credits directly to **measured ecological uplift compared to a baseline**, implicitly ensuring additionality by linking payments to tangible biodiversity gains. Here, projects define a basket of locally relevant metrics, such as taxa-based or structural indicators, which are peer-reviewed to validate their conservation relevance. While Wallacea Trust offers more flexibility in how additionality is demonstrated, Verra's structured process provides greater transparency and consistency, particularly in regions like Europe where regulatory frameworks are already stringent (Gradeckas & Vaquié, 2026). Furthermore, Zu Ermgassen et al. (2025) warn that without rigorous counterfactual analysis, even outcome-based systems can suffer from additionality failures, as project proponents are incentivized to supply non-additional 'services' (as non-additional projects have low opportunity costs, allowing them to provide cheaper units).

Integrity is upheld through institutional credibility, transparent governance, and robust measurement, reporting, and verification (MRV) systems. Verra's SD VISta Nature Framework leverages its status as an ICROA-certified standard, ensuring high institutional legitimacy and trust in the market. The framework requires **independent, third-party audits** by accredited bodies, ensuring that biodiversity outcomes are accurately measured, reported, and verified. It also aligns closely with international frameworks like the

Taskforce on Nature-related Financial Disclosures (TNFD) and the Corporate Sustainability Reporting Directive (CSRD), providing a **clear link between biodiversity crediting and corporate nature reporting**. Wallacea Trust, in contrast, prioritises open-source transparency and **academic peer review** (via the Biodiversity Futures Initiative) **to validate its methodologies and metrics**. This approach enhances accessibility and adaptability, particularly for small-scale or context-specific projects, but its lack of a formal standard and reliance on affiliated organisations (e.g., rePLANET) introduces governance concerns that must be managed transparently to maintain integrity.

Avoiding greenwashing requires **clear rules on claims, transparent project documentation, and alignment with recognised standards** (Zu Ermgassen *et al.*, 2025). Verra addresses this through explicit guidance on permissible claims, ensuring that credit purchases align with the mitigation hierarchy and nature-positive outcomes. Its **publicly accessible registry** enables scrutiny of project details, credit issuance, and retirements, preventing misleading claims and double counting. By aligning with EU regulations (e.g., the Water Framework Directive and Nature Restoration Law) and corporate reporting frameworks, Verra reduces the risk of greenwashing by ensuring that **credits reflect real, measurable, and policy-aligned outcomes**. Wallacea Trust, meanwhile, relies on its outcome-based design, where credits are tied to measurable biodiversity improvements, to substantiate claims. The framework's academic peer review process further enhances credibility, though its lack of a formal registry and close ties to affiliated organisations (such as project developer rePLANET) may pose risks of conflicts of interest if not transparently managed. Together, these mechanisms help ensure that biodiversity credits deliver on their promises, maintaining trust in the market and deterring superficial or misleading claims (Gradeckas & Vaquié, 2026).

### Integration of nature markets with other principles and EU environmental acquis.

Nature markets sit within a dense legal landscape shaped by various EU environmental acquis, among which the Nature Restoration Regulation (NRR). High-Level Principles (HLPs) offer a useful lens for scheme design (Gradeckas & Vaquié, 2026), but much of what they encode is already **anchored in existing EU water and nature legislation, and scheme credibility ultimately rests on that underlying legal coherence**.

For freshwater restoration, the Water Framework Directive (WFD), River Basin Management Plans (RBMPs), and their Programmes of Measures form a natural reference point for credit design, alongside the NRR. This suggests credit methodologies should stay **coherent with good ecological status or potential, the no-deterioration objective, environmental flows, and cost recovery principles**. Restoration efforts that draw on the EU Water Resilience Strategy, such as **water retention, floodplain reconnection, nature-based solutions, drought and flood resilience**, extend dam removal relevance beyond restoration targets alone and into the broader water security and resilience agenda.

Barrier removal, a prominent NRR measure, illustrates the point well. It sits within RBMPs and coordinating with these plans helps ensure a removal doesn't cause deterioration under the WFD. It is also only part of the picture: the WFD assesses ecological status through the **combined effect of all pressures acting on a water body**, not any single one in isolation, meaning hydromorphological **connectivity rarely operates independently of other pressures** (e.g. pollution). A scheme that addresses barriers while leaving other pressures unexamined risks producing a less durable ecological outcome. It is therefore worth encouraging assessment of the wider pressure picture on a water body, in line with this integrated logic.

The polluter-pays principle also has a bearing here: nature credits **shouldn't substitute for remediation that already falls to an identifiable responsible party under existing liability rules**. Credits are better suited to funding restoration beyond what such obligations already require.

Where restoration measures carry some risk of deterioration, the WFD Article 4(7) applicability assessment and, where Natura 2000 sites are involved, Habitats Directive Article 6(3), remain relevant reference points for demonstrating that a **project doesn't compromise conservation objectives**.

More broadly, **alignment with the wider acquis and attention to leakage and durability** help ensure credits reflect real, lasting outcomes (Biodiversity Credit Alliance, 2024; Living Rivers Europe, 2025). The Green Claims Directive proposal would add a further layer of assurance, **pushing corporate biodiversity claims toward being substantiated and verifiable**, which in turn discourages greenwashing in how credits are marketed and reported.

Taken together, this suggests nature credit mechanisms are likely to be more durable, and more readily accepted, if they grow out of this existing legal and policy fabric, with HLPs functioning as a helpful design overlay rather than the primary reference point.

### Credibility and public trust drivers.

Maintaining credibility and public trust in nature markets requires robust governance, monitoring, reporting, and verification (MRV) arrangements. A recurring challenge is the **lack of consistent data and MRV processes**, which creates a regressive cycle: the absence of structural funding leads to insufficient data, which in turn prevents additional sources of finance from flowing into projects due to the inability to conduct due diligence, capital planning, and risk analysis (Basset, 2025). This issue is particularly acute for long-term monitoring, which is often underfunded because it does not generate immediate financial returns. Even when funding is available, it is typically allocated on a project-by-project basis, rather than as part of an integrated, centralised strategy. To break this cycle, nature markets must adopt standardised MRV frameworks that ensure data is reliable, comparable, and accessible, enabling investors and regulators to assess project performance and risks effectively (European Environmental Bureau, 2025).

Governance is the foundation of credibility. Transparent, accountable structures are essential to prevent conflicts of interest and ensure that projects adhere to high-integrity standards. This includes **clear roles for standard-setting bodies, project developers, and third-party auditors**, with independent oversight to validate claims and prevent greenwashing (Wunder *et al.*, 2025).

The broader design of biodiversity credit schemes must embed BCA, IAPB and WEF's High-Level Principles (HLPs) and actively adhere to them to avoid the pitfalls that have plagued carbon markets (Wunder *et al.*, 2025). By integrating HLPs into their core requirements, schemes can address critical issues such as low-quality credits (through rigorous additionality and permanence checks), double counting (via transparent registries and unique credit serialization), and lack of transparency (through public disclosure of project data and third-party verification). Additionally, **schemes must incorporate safeguards against land grabbing and the exclusion of Indigenous Peoples and Local Communities (IPLC)**, ensuring that projects respect land tenure rights, obtain Free, Prior, and Informed Consent (FPIC), and share benefits equitably (Biodiversity Credits Alliance, 2024). This proactive approach not only enhances credibility but also aligns with the EU's emphasis on social and environmental justice, ensuring that biodiversity markets deliver genuine ecological and societal benefits.

MRV systems must be designed to generate high-quality, verifiable data on ecological outcomes. This requires standardized methodologies for measuring biodiversity gains or losses, including the use of **locally relevant indicators that reflect project-specific goals and threats**. Monitoring should be long-term and adaptive, allowing for adjustments as new data or scientific advances emerge (Basset, 2025; Wunder *et al.*, 2025). Centralised data platforms can help **aggregate and standardise information** across projects, making it easier to track progress, compare outcomes, and attract investment. Open data policies also enhance transparency, allowing stakeholders to scrutinise results and hold projects accountable (European Environmental Bureau, 2025).

Verification arrangements must rely on **independent, third-party audits conducted by accredited bodies**. These bodies could include certification organisations **accredited by governmental structures**, such as BELAC, which accredits auditors for PEFC chains of custody in Belgium. These audits should verify that projects meet additionality, durability, and no-harm criteria, and that biodiversity outcomes are accurately measured and reported. The use of buffer mechanisms, such as setting aside a reserve of credits to

compensate for potential reversals, can further enhance credibility by mitigating risks of unintended harm or project failure (Wunder *et al.*, 2025). To avoid the pitfalls seen in carbon markets, such as overestimation of benefits, leakage, or lack of permanence, verification processes must be rigorous, conservative, and science-based, with clear guidelines for addressing uncertainties or reversals.

Ultimately, a credible nature market depends on integrating governance, MRV, and verification into a cohesive system that prioritises transparency, scientific rigor, and long-term accountability. By addressing funding gaps, standardising data collection, and ensuring independent oversight, these arrangements can build public trust and enable nature markets to scale effectively while delivering genuine ecological benefits (Wunder *et al.*, 2025).

## 7. Land and water use implications.

Impacts on land and water use.

Freshwater ecosystem restoration, through measures like barrier removal, bank revegetation, river remeandering, depollution, and floodplain restoration, can profoundly reshape land and water use in Europe (Wilkinson *et al.*, 2017), but it also introduces **complex trade-offs, particularly between agriculture, floodplain restoration, and water-use**. Currently, up to 90% of Europe's floodplains are cultivated with **75% of floodplain areas showing severe reduction in extent**, 14% substantially degraded, and only 12% with moderate or no loss (Globevnik *et al.*, 2020). Degradation is driven largely by **urban and agricultural land use**, which modifies river channels, drainage, and dikes, eliminating the natural water storage and filtration functions of these ecosystems (Globevnik *et al.*, 2020). **Water storage is also heavily impacted**. In regions like France, drought episodes have increased demand for stored water, leading to solutions such as *réserves de substitution*, where groundwater is pumped into large pools for irrigation. While this addresses short-term agricultural needs, it exacerbates long-term water shortages by depleting aquifers and disrupting natural hydrological cycles.

Floodplain restoration and its associated ecosystem services could directly address many of these challenges. By reconnecting rivers to their floodplains, these measures would **enhance natural water storage, recharge groundwater aquifers, and improve flood protection by slowing water flow and increasing infiltration** (Karpack *et al.*, 2020). They would also **boost carbon sequestration** in restored wetlands and riparian zones. Yet, this ecological transition comes at a cost: it requires **reconverting productive arable land back to its original function**, necessitating a transformation of agricultural practices and a rethinking of land use priorities.

Furthermore, the economic viability of such transitions remains a hurdle. **Revenues from nature markets and restoration incentives must compete with farming revenues to encourage land-use change**. Current biodiversity credit schemes often struggle to address agricultural land and farmed landscapes effectively. **Most globally applicable schemes do not yet fully account for the specific conditions of European agricultural systems**, where long-term durability (20+ years) is challenging due to short planning horizons and the need for predictable revenue streams. Only a few schemes, such as Fundación Global Nature and the Global Biocredit Standard, explicitly engage with agricultural land, highlighting a gap in market design (Gradeckas & Vaquié, 2026).

The market for biodiversity credits from freshwater ecosystem restoration remains too immature to reliably predict the revenue farmers could generate, or how it would compete with established farming incomes. While emerging frameworks like the EU's Carbon Removal Certification Framework (CRCF) illustrate the potential for monetizing ecosystem services, the lack of standardized methodologies, transparent pricing, and long-term revenue certainty for biodiversity credits, particularly when stacked with carbon credits, creates significant uncertainty. Only when concrete revenue figures for these combined credit streams become available will it be possible to assess whether such restoration activities can offer a viable alternative to agricultural production.

Implications for land managers/farmers and interaction with CAP Strategic Plans and rural development policies.

For land managers and farmers, the rise of biodiversity credit schemes presents a **mixed picture of opportunity and uncertainty**. While these schemes are, in principle, designed to be globally applicable, their practical applicability across agricultural land and farmed landscapes remains uneven. Most globally applicable frameworks do not yet fully reflect the specific conditions of European agricultural systems, where long-term durability, often extending beyond 20 years, is challenging due to **short planning horizons and the need for predictable revenue streams** (Gradeckas & Vaquié, 2026).

The Common Agricultural Policy (CAP) Strategic Plans offer a critical bridge between biodiversity credit schemes and on-the-ground restoration. **Three of the CAP's ten key objectives, climate action, environmental care, and the preservation of landscapes and biodiversity, are aligned with the Nature Restoration Regulation** (Rewilding Europe, 2025). However, the proposal for the next CAP (2028–2034) introduces a significant risk of diluting environmental and climate ambition. The removal of mandatory ringfencing, weakening of environmental conditionality, and major shortcomings in the proposed tracking and performance systems could reduce Member States' incentives to prioritise public goods provision in agriculture. These changes also risk exacerbating disparities between Member States, undermining the EU-wide level playing field. This creates a tension between growing environmental ambitions and diminishing incentives for farmers to adopt sustainable practices. While biodiversity credits can **provide additional revenue streams, they are unlikely to bridge the widening financing gap alone**. Public investment remains direly needed to help farmers achieve EU environmental goals and ensure that restoration efforts are economically viable alongside agricultural productivity (Rewilding Europe, 2025).

Under the proposed CAP 2028–2034 (COM/2025/560 final), the current GAECs would be replaced by a new 'farm stewardship' system. Under the current system, the GAEC 8 standard requires devoting a minimum share of arable land to non-productive areas or features, such as hedges, trees, or fallow land. This provision creates a direct opportunity for farmers to leave land for rewilding, thereby promoting connectivity and permeability across landscapes to support full ecosystem functioning, a core goal of the NRR (Rewilding Europe, 2025). The new system, however, would leave place for environmental 'protective practices' defined by Member States, potentially leading to a lack of uniform approach EU-wide and associated uncertainty for farmers.

Compounding this uncertainty, nature markets for biodiversity credits remain too immature and poorly adapted to agricultural contexts to reliably predict the income they could generate for farmers (Gradeckas & Vaquié, 2026). Emerging frameworks like the EU's Carbon Removal Certification Framework (CRCF) illustrate potential, but the lack of standardized methodologies and transparent pricing creates significant barriers. Meanwhile, the **latest CAP developments risk further decreasing support for environmentally friendly practices**, reducing incentives for farmers to engage in restoration. However, public funding to support environmental restoration remains necessary to create the conditions for nature markets to mature and eventually provide a viable economic alternative for land managers.

Ultimately, the **interaction between biodiversity markets, CAP Strategic Plans, and rural development policies could unlock significant restoration potential on farmed landscapes**. The Common Agricultural Policy has significant potential to finance such nature restoration, particularly on agricultural lands that can connect larger areas and enable natural ecosystem functioning at scale, such as floodplains, buffer zones between and surrounding protected areas, or lands near high-biodiversity landscape features (Rewilding Europe, 2025). But this **requires better alignment between credit schemes and CAP instruments, clearer long-term revenue guarantees, and support for the administrative burden of participation**. As methodologies and markets mature, the ability to stack credits, secure long-term contracts, and simplify access will determine whether farmers and land managers can realistically shift toward nature-positive practices without compromising their livelihoods (Gradeckas & Vaquié, 2026).

## 8. Applicability to dam and barrier removal.

### Nature credits potential to support barrier removal under Article 9.

The European Commission has made it explicitly clear that nature credits are intended to help finance NRR activities, including the ambitious Article 9 mandate to restore at least 25,000 km of rivers to a free-flowing state by 2030 through the removal of obsolete barriers. The Commission's Roadmap towards Nature Credits specifically recognizes nature credits as a tool to finance the NRR, allowing Member States to use them to acknowledge individual contributions to national targets under both the NRR and the Global Biodiversity Framework (GBF). Furthermore, the upcoming *Report on Nature Restoration Financing* will formally acknowledge their potential to complement public funding and other private financing mechanisms.

However, nature markets are still too immature to estimate the extent to which they can contribute to the substantial costs of reaching the 25,000 km target. While the policy framework is taking shape, **critical gaps remain in standardized methodologies, transparent pricing, and robust verification systems**. This immaturity makes it impossible to reliably quantify how much nature credits can realistically mobilize for barrier removal and river restoration across the EU's diverse contexts.

To unlock this potential, **blended finance and strong regulatory signals will be vital** (EIB, 2023). **Private finance, including nature credits, should fund capital-intensive actions like dam removal, while public funds de-risk investments by covering EIA, preparatory work, and MRV**. Clear, EU-wide standards and long-term policy certainty are essential to reduce investor risk, encourage market participation, and ensure that nature credits can mature into a reliable financing mechanism.

A key practical challenge is defining appropriate indicators for nature credits in the context of barrier removal. Traditional biodiversity credits often use hectares as a metric, but this may not be suitable for linear waterway restoration. Potential indicators could include the number of kilometers of river restored, the number of barriers removed, the number of species benefiting from reconnection, or a combination of hydromorphological and ecological metrics. This will need to be clarified and standardized as the market develops.

### Legal, financial and ecological constraints. Baseline setting and MRV design for barrier interventions.

Barrier removal projects, such as those under Article 9 of the EU Nature Restoration Regulation (NRR), face a complex interplay of legal, financial, and ecological constraints that must be addressed in both project design and the development of baseline setting and Monitoring, Reporting, and Verification (MRV) frameworks. Legal opposition often arises from stakeholder resistance, particularly from **mill preservationists or hydroelectric industry advocates**, who may spread misinformation to block dam removal. In Poland, for instance, the recognition of watermill ruins as cultural heritage monuments has precluded full restoration, demonstrating how **heritage value can limit intervention options** (Dam Removal Europe, 2026). **Land ownership** is another major hurdle: in many cases, land must be purchased from private owners or compensation paid for lost revenue (e.g., agricultural or hydropower income), costs that cannot be covered by biodiversity credits alone and significantly drive up project expenses. Additionally, **permitting processes** for barrier removal can be lengthy and complex, especially for structures with historical significance or those located in artificial channels. Further legal considerations include excluding river stretches with valid derogations from restoration eligibility, avoiding retroactive relicensing of obsolete barriers, and coordinating Renewables Acceleration Areas (RAAs) under the Renewable Energy Directive with Nature Restoration Plans (NRPs) to prevent deterioration of prime restoration areas. Strategic Environmental Assessments (SEAs) and Environmental Impact Assessments (EIAs) must also evaluate impacts on NRL Articles 4 and 9(2) targets (Living Rivers Europe, 2025).

### Financial Constraints

Financial barriers are among the most significant obstacles to barrier removal. Transaction costs, including research, administration, and financing development, can be prohibitively high for small-scale projects. The European Investment Bank notes that aggregating multiple projects into portfolios can help reach sufficient scale and reduce per-project costs, but this requires coordination and additional resources (EIB, 2023). **Europe's relatively high input costs** (e.g., labor, land prices) further complicate financial viability. The **opportunity cost of land** is another critical factor: the potential revenue lost from alternative uses (e.g., agriculture, hydropower) can deter investment. Many investors willing to fund nature-based solutions globally are choosing to deploy capital in regions outside Europe, where input costs are lower and the potential for ecological impact is greater. However, some corporate investors may still be attracted to Europe's relative political and regulatory stability for certain projects (EIB, 2023).

The case of the Turnu Magurele-Nikopol Hydraulic Structures Assembly (TMNHSA), a harmful hydropower project opposed for inclusion in the EU's Connecting Europe Facility for Energy, illustrates the tension between renewable energy goals and ecological restoration, highlighting the need for careful project selection and alignment with NRR objectives (Living Rivers Europe, 2025).

### Ecological and Safety Constraints

Ecological considerations are central to barrier removal. **Sediment management** is a critical issue, as the sudden release of accumulated sediments can impact downstream water quality, habitat stability, and infrastructure. **Safety considerations** must also be addressed, particularly for large dam removals that could affect communities, crops, and existing infrastructure. Technical challenges arise with artificial channels and other heavily modified waterways, which may require specialized restoration approaches (Dam Removal Europe, 2026).

The **distribution and prioritization of barrier types** is another key factor. Not all barriers are equally significant: strategic removal of barriers on ecologically important waterways can maximize benefits, such as restoring connectivity for migratory fish species, improving river continuity, and enhancing overall ecosystem resilience (Leaniz *et al.*, 2021). Prioritization should focus on barriers that:

- Block critical migration routes for keystone species,
- Fragment ecologically valuable habitats,
- Are located in high-biodiversity or high-connectivity river sections.

### Baseline Setting and MRV Design

**Defining and monitoring indicators** for dam removal nature credits under the NRR is complex but essential. Unlike carbon, river restoration outcomes lack a natural metric, making them variable and challenging to measure. For MRV and baseline definition, a consistent set of metrics is required. A combination of **hydromorphological, ecological, and ecosystem service metrics**, such as river continuity, sediment transport, fish passage, biodiversity recovery, flood regulation, and water quality, is needed, tailored to project scale and goals, with the same metrics used for both MRV and baseline setting to ensure comparability and credibility (Netherlands Entreprise Agency, 2024).

Technological solutions can bridge the gap:

- Remote sensing: monitors river connectivity and sediment dynamics
- eDNA: assesses aquatic biodiversity recovery
- Field monitoring: captures water flow, sediment loads, and structural stability
- AI: processes datasets to identify patterns and predict outcomes

Investing in these technologies would allow keeping MRV costs accessible over time and enable credible, tradable biodiversity credits for dam removal.

## 9. Capitalisation potential and limitations.

Potential of nature markets to mobilise private capital for Article 9-relevant restoration.

The European Union's Nature Restoration Regulation (NRR), particularly Article 9, mandates the restoration of at least 25,000 km of rivers to a free-flowing state by 2030 through the removal of obsolete barriers. Financing this ambition requires mobilising both public and private capital, with biodiversity credits emerging as a potential mechanism to complement traditional funding sources. However, the current immaturity of these markets means **their contribution must be viewed as complementary rather than transformative** in the near term.

Global demand for biodiversity credits is projected to follow distinct trajectories depending on the pace of market development, policy support, and corporate adoption. The World Economic Forum (2023) outlines three scenarios that illustrate the potential scale of the market under different conditions, each with significant implications for the EU's Article 9 restoration targets.

The limited development scenario represents a conservative lower bound, grounded in historical precedent from slow-growing, niche sustainability markets. Under this pathway, **global demand could reach $760 million per year in 2030 and grow to $6 billion annually by 2050**. This scenario assumes **low adoption of nature targets** among corporations, with biodiversity credits playing a limited role in reaching those targets. Only companies already engaged in nature initiatives in 2023 would participate, and use would be largely opportunistic (WEF, 2023).

The effective development scenario offers a more ambitious but plausible pathway, grounded in **historical parallels with the voluntary carbon market**. Here, global demand could reach **$2 billion per year in 2030 and $69 billion annually by 2050**. This scenario assumes steady adoption of nature targets among large companies, supported by clear and credible guidance on how biodiversity credits can be used and how companies can make claims based on such credits. Biodiversity credits would be widely used in green product sales and increasingly to satisfy national or global goals (WEF, 2023).

The transformational development scenario imagines a **radical shift in how businesses and consumers value nature, alongside strong policy support and rapid adoption of nature targets**. Under this pathway, global demand could reach **$7 billion per year in 2030 and $180 billion annually by 2050**. This scenario assumes near-universal adoption of nature targets among large companies, clear claims guidance, and frequent use of biodiversity credits in green product claims. The EIB study (2026) suggests that achieving this would require the implementation of mandatory requirements and financial incentives, such as tax credits and grants, to improve the return on biodiversity investments. Companies would implement their commitments to global goals such as those set out in the Global Biodiversity Framework (WEF, 2023).

However, all three scenarios hinge on overcoming significant current barriers. The market remains at a very **early stage, with standardization lacking, market infrastructure largely missing, and corporate adoption limited** (only 5% of large companies have nature strategies, and even fewer use biodiversity credits) (WEF, 2023). The voluntary market's immaturity, evidenced by disjointed standards, a lack of widely accepted methodologies, and the absence of robust market governance, creates uncertainty for investors and limits liquidity, scalability, and bankability. Even under the most ambitious scenario, biodiversity credits would deliver only a portion of the financing needed to reach global nature targets, complementing rather than replacing other funding mechanisms. The key to unlocking this potential lies in addressing current fragmentation, building robust infrastructure, and establishing the clear regulatory and business frameworks that would give investors the confidence to scale their commitments (Basset, 2025). The EIB (2026) recommends a six-pronged approach: **clarifying policy contributions, standardising metrics, creating governance rules, developing market infrastructure, strengthening regulatory requirements, and designing incentives to address barriers to scaling nature markets**.

Investor interest in nature-based solutions is growing, with major financial institutions committing capital and integrating biodiversity as a factor into their investment and financial policies (EIB, 2026). However, a mismatch persists: **investors seek late-stage, bankable projects with clear revenue streams, while most nature-based projects are early-stage and lack bankability assessments** (EIB, 2023). This gap is

acute for Article 9 dam removal, which involves high upfront costs, long timelines, and uncertain ecological outcomes, with public good benefits that are difficult to monetise.

To estimate the future evolution of the nature market contribution towards the NRR Article 9 restoration activities, the **US wetland and stream mitigation market** provides a critical comparative lens. Unlike the EU's current voluntary approach, the US market is compliance-driven, anchored by the Clean Water Act Section 404. This regulatory backbone has fueled a mature, multi-billion-dollar industry with ~2,200 mitigation banks, **$3.5–5.7 billion in annual transaction volume**, and >53,000 jobs. The 2008 Corps/EPA Rule further standardized the market, establishing mitigation banking as the federally preferred approach. This regulatory certainty has attracted steady private investment, with the stream mitigation market growing at a ~6.3% CAGR for economic output (2014–2019) (BenDor *et al.*, 2023).

Comparing the mature US market to the nascent EU one must be done with caution. Estimating the current share of voluntary versus compliance markets is inherently difficult due to their vastly different stages of maturity: while compliance markets, such as the US wetland and stream mitigation industry, are estimated at approximately $10 billion per year, voluntary biodiversity credit markets have generated only around $10 million in total by the end of 2025 (Bloomlabs, 2026). Furthermore, the **share of freshwater projects within the broader voluntary biodiversity credit market remains unknown**. Corporate currently prioritize terrestrial (80%) and forest (47%) ecosystems, and financial institutions favor forests (71%) and terrestrial/agricultural systems (53% of all respondents for each ecosystem), indicating that freshwater ecosystems are not the highest priority (EIB, 2026). Even if the WEF's prediction of a $7 billion market by 2030 materializes, it is uncertain what portion will be dedicated to freshwater ecosystems, and what fraction of this global total the EU will capture. **Given these uncertainties, predicting the precise contribution of biodiversity credits to Article 9 activities in the EU is challenging**. Nevertheless, the fundamental observations remain valid: the market requires strong regulatory signals to create demand, blended finance mechanisms to de-risk investments, and capacity building to ensure robust implementation.

### Main uncertainties, risks and structural limitations.

The potential of biodiversity credits to finance Article 9 river restoration faces significant uncertainties, risks, and structural limitations that constrain their ability to mobilise private capital at scale. While global demand for biodiversity credits could reach $760 million to $7 billion in 2030 (and up to $180 billion by 2050 under the WEF's transformational scenario) (WEF, 2023), the **EU's ability to capture a meaningful share of this growth remains highly uncertain**. Regulatory uncertainty complicates projections: the European Commission has yet to clarify its proposed 'nature credits' scheme, leaving market actors in a "waiting position" without the frameworks needed to scale (Basset, 2025). **The market's contribution to closing the €37 billion annual biodiversity funding gap will likely be limited without addressing fundamental barriers tied to market integrity, additionality, and distributional dynamics**.

Risks to market integrity and scalability are substantial. Greenwashing risks are elevated by the current lack of standardized credit units, indicators, and claims frameworks, which could undermine market credibility if not addressed. The EIB (2026) found that 88% of respondents consider improving the transparency and standardisation of credit markets as a highly relevant suggestion, with lack of credibility of biodiversity gain quantification methods cited by 83% of corporates and 92% of financial institutions as a key barrier. Moreover, the gap between investor expectations (late-stage, bankable projects with clear revenue streams) and project realities (early-stage, complex initiatives with uncertain ecological outcomes) is particularly acute for Article 9 dam removal, which involves high upfront capital costs, complex stakeholder landscape, and public good benefits that are difficult to monetize (EIB, 2023).

Furthermore, structural financial barriers further limit investor participation. **The average investment size for nature-based projects is less than €2 million, yet most asset managers require a minimum of €15–20 million to justify the fixed costs of due diligence, making small-scale projects economically unviable** (EIB, 2023). This mismatch is exacerbated by the relatively higher costs of projects in the EU, where land, labor, materials, and taxes are more expensive than in the Global South, where investors currently concentrate their capital (EIB, 2023). Furthermore, long investment horizons of 5–10+ years discourage many financial entities, particularly smaller ones, from entering the field. The current allocation

of early-stage grants also tends to favor research initiatives rather than revenue-generating projects, limiting the pipeline of bankable opportunities.

Additionality constraints pose another hurdle: proving that a project would not have happened without biodiversity credit financing is complex, particularly for dam removal, where public benefits are diffuse and regulatory drivers vary across Member States. The lack of clear EU-level frameworks, standardized methodologies, and robust baseline-setting and MRV systems makes additionality verification difficult and inconsistent.

Distributional impacts raise equity and effectiveness concerns. The **current technical and political environment tends to favor grey infrastructure over nature-based solutions**, even when the latter may be more cost-effective (EIB, 2023). **Land availability and cost present major barriers**: accessing contiguous land for large-scale projects faces political and community resistance, and these costs are often ineligible for public financing. Regulatory silos impede the pooling of funding and financing across sectors, while long development lead times, exacerbated by complex stakeholder negotiations and the need to provide multiple co-benefits, deter private sector promoters who lack the resources or investment horizon to drive such processes. Capacity constraints at the project level, including insufficient human resources and technical expertise (particularly financial knowledge), further restrict development.

Perhaps most fundamentally, there is a **risk that biodiversity credits create the illusion of effective action while underlying drivers of biodiversity loss** (extractive activities, pollution, pressure on habitat) **remain unaddressed**. Without clear direction, frameworks, and transparency from the European Commission, the market risks remaining unregulated and without guardrails, prolonging its current state of fragmentation and immaturity (Basset, 2025). Until these structural limitations are addressed, the contribution of biodiversity credits to Article 9 restoration will remain modest and uncertain.

# Conclusion: Building the Foundation for Nature Credits in Article 9 Implementation

This document explores how nature credits and markets can finance the EU's Nature Restoration Regulation (NRR), focusing on Article 9's mandate to restore 25,000 km of free-flowing rivers by 2030. It highlights the €224M–€1.6B financing gap, the immature voluntary biodiversity credit market, and the opportunities and challenges of integrating these mechanisms into National Restoration Plans (NRPs). While voluntary nature credits can complement public financing, their scalability and integrity depend on robust governance, MRV systems, and alignment with EU environmental frameworks.

### Suggestions for Further Steps and Supplementary Research

2026–2027 is decisive for laying the groundwork to allow nature credits to contribute meaningfully to Article 9 implementation. Given the immature state of voluntary biodiversity credit markets, the immediate priority should not be to rely on these mechanisms as a primary financing source. Instead, the **focus must be on building the enabling conditions that will allow high-integrity nature markets to scale up and play a complementary role in the future**.

This requires a sequential strategy: **public finance must first establish the ecological data, governance systems, project pipelines, and MRV frameworks that de-risk and validate restoration efforts**. Private finance should then be mobilized selectively and transparently where it demonstrates clear additionality, durability, and credible claims.

Member States and the European Commission should prioritize:

- **Consolidate and prioritize barrier inventories** (e.g., from AMBER, Dam Removal Europe) to identify obsolete, low-function barriers (e.g., weirs, culverts) offering high connectivity gains at proportionate cost. By end-2027, Member States should have a **ranked list of priority interventions, including costs, ownership, permitting, ecological benefits, and readiness**.
- **Establish robust ecological baselines for priority river stretches and floodplains**, covering hydromorphological condition, connectivity, species presence, habitat quality, floodplain function, water quality, and pressures (e.g., sediment contamination). Baselines must include **counterfactual scenarios to demonstrate additionality** of the nature-positive outcomes of the project. This work should be **publicly funded as a core enabling activity**.
- Build MRV systems as critical infrastructure: Define standard monitoring indicators and protocols for Article 9 measures, combining delivery indicators (e.g., km of river reconnected, barriers removed) and ecological outcome indicators (e.g., species recovery, hydrological reconnection). Given the dynamic, linear, and hydrologically complex nature of freshwater systems, public support (e.g., LIFE, Horizon Europe) should develop cost-effective and replicable MRV systems.
- Launch targeted pilots: **Test nature-credit and results-based finance through carefully selected demonstration projects** focused on methodological learning, governance testing, buyer engagement, and MRV validation. Pilots should:

    - Focus on aggregated restoration portfolios rather than isolated projects.
    - Test different models (e.g., corporate contributions, PES, blended finance, green bonds, biodiversity credits).
    - Test appropriate claims language, with a strong preference for contribution claims and integration with already existing frameworks.
    - Each pilot should include clear baselines, additionality assessments, MRV protocols, verification processes, claims guidance, and long-term management plans.

- Allocate public funding to **de-risk the pipeline**: Use public funds for baseline studies, feasibility assessments, EIAs, permitting, stakeholder engagement, legal clarification, compensation assessments, MRV systems, and project aggregation. Where private finance is explored, consider guarantees, concessional loans, first-loss capital, technical assistance, and project preparation facilities.
- Develop **aggregation mechanisms**: Bundle barrier removals, floodplain reconnections, and river morphology restoration actions into coherent portfolios at regional, national, or river-basin scale. **Aggregation supports more efficient procurement, standardized MRV, better investor engagement, lower transaction costs, and stronger ecological outcomes, while enabling small landowners and local actors to participate**.
- Signal a strong support of nature credits to the markets. Support private investment with a **stable regulatory environment**, **reward/punishment mechanisms** and a **cohesive, integrated biodiversity strategy**.

As enabling conditions mature, the focus should shift toward scaling up implementation while maintaining the integrity of nature credit mechanisms. Member States should:

- **Prioritize** low-cost, high-impact barrier removal and floodplain reconnection opportunities, particularly obsolete or low-function barriers whose removal can restore connectivity over significant river stretches.
- Develop **freshwater-specific MRV guidance** addressing linear connectivity, lateral floodplain reconnection, hydrological variability, sediment dynamics, and species movement. **Generic biodiversity credit metrics are unlikely to be sufficient**; for river connectivity and floodplain function, MRV should combine indicators such as kilometres of river reconnected, barriers removed, floodplain area reconnected, hydrological function restored, target species recovery, water quality improvement, and sediment continuity. Before large-scale crediting is promoted, methodologies should be tested through pilots and subjected to independent review.

### Supplementary Research Needs

To support the long-term success of nature credits for Article 9, supplementary research should address the following priorities:

1. **Cost-Benefit Analysis of Barrier Removal**: Develop detailed cost models for different barrier types, sizes, and contexts, including indirect benefits (e.g., flood risk reduction, carbon sequestration) to **improve prioritization**.

2. **MRV Innovation for Freshwater Systems**: Investigate cost-effective MRV technologies for freshwater systems, including AI-driven remote sensing, eDNA protocols for flowing waters, and low-cost sensor networks.

3. **Additionality and Baseline Methodologies**: Develop EU-wide standards for counterfactual scenarios and additionality tests for freshwater restoration to ensure consistency and reduce greenwashing risks.

4. **Aggregation Models and Governance**: Study best practices for aggregating small-scale restoration projects, covering legal structures, financing mechanisms, and MRV standardization across **regional, national, and river-basin scales**.

5. **Market Demand and Buyer Engagement**: Analyse corporate and financial demand for nature credits (motivations, preferred claims, investment thresholds) to **inform pilot design and market development**.

6. **Long-Term Stewardship Mechanisms**: Explore financial and legal models for ensuring restoration durability, including **buffer funds, insurance mechanisms, and perpetual conservation easements**.

7. **Alignment with Other EU Frameworks**: Assess alignment of Article 9 nature credits with CRCF, CAP, WFD, and Floods Directive to identify synergies and conflicts.

8. **Social, Safety and Distributional Impacts**: Research social and economic impacts of freshwater restoration on farmers, landowners, and rural communities, and develop equitable compensation mechanisms. Address liability issues of restoration activities.

9. **Addressing Nature Market Specificities, Failures, and Solutions**: Investigate nature market specificities (voluntary vs. compliance, fragmentation, additionality challenges) and **failures in attracting private capital**. Compare successful models (e.g., US mitigation banking) with less successful experiments (e.g., voluntary carbon markets) to identify **transferable lessons, and develop policy recommendations to build investor confidence**.

10. **Competing Land-Use Demands**: Freshwater Restoration vs. Agriculture: Assess **how floodplain restoration can compete with agriculture, and evaluate incentives for farmers** (e.g., PES, biodiversity credits, CAP schemes, tax incentives, long-term contracts). Conduct economic modeling to compare opportunity costs (e.g., lost yields) with benefits (e.g., flood protection, carbon sequestration).

11. **Market Share of Freshwater Restoration in Biodiversity Credits**: Estimate freshwater restoration's realistic market share vs. forests, oceans, and agriculture. Analyse **investor preferences** (e.g., ESG priorities, regulatory mandates, co-benefits) and develop **projections under different scenarios**. Identify strategies to increase freshwater's market share (e.g., bundling with other ecosystem services, targeting water-dependent sectors, standardizing metrics).

# Annex I

This table outlines the key milestones in the evolution of biodiversity and nature credit markets, detailing the year, milestone, policy or contextual significance, and the region or continent where each development occurred. It provides a chronological overview of how market-based instruments for biodiversity conservation and restoration have emerged and evolved globally, with a focus on the European Union's growing role in this space.

| Year | Milestone | Policy/Context | Region/Continent |
|---|---|---|---|
| 1972 | Clean Water Act (Section 404) establishes wetland mitigation banking in the U.S. | Establishes wetland mitigation banking in the U.S. | United States |
| 1980 | Wetland mitigation banking formalized; first banks created to offset wetland destruction. | Formalizes wetland mitigation banking; first banks created to offset wetland destruction. | United States |
| 1992 | Convention on Biological Diversity (CBD) adopted at the Earth Summit in Rio de Janeiro. Foundation of principles and goals. | Foundation of principles and goals that later inspired and shaped the development of biodiversity credit markets. | Global |
| 1995 | California establishes the first conservation bank for endangered species habitat. | Establishes the first conservation bank for endangered species habitat. | United States (California) |
| 1997 | Kyoto Protocol introduces market-based mechanisms for carbon credits. | Introduces market-based mechanisms for carbon credits. | Global |
| 2005 | Millennium Ecosystem Assessment underpins that biodiversity is a critical asset... | Underpins that biodiversity is a critical asset underlying all ecosystem processes; rapid decline threatens human well-being. | Global |
| 2008 | Australia's Environmental Stewardship Program launches, paying farmers for biodiversity conservation. | Launches program paying farmers for biodiversity conservation. | Australia |
| 2010 | Nagoya Protocol adopted under CBD, emphasizing access and benefit-sharing for genetic resources... | Emphasizes access and benefit-sharing for genetic resources; enables developing nations to gain value from biodiversity. | Global |
| 2011 | EU Biodiversity Strategy to 2020 adopted. | First EU-wide targets to halt biodiversity loss; introduces green infrastructure concepts. | European Union |
| 2013 | UK Biodiversity Offsetting Pilot begins. | Early influence on EU discussions about market-based biodiversity tools. | United Kingdom |
| 2013 | UK Biodiversity Offsetting Pilot begins, testing compensation mechanisms. | Tests compensation mechanisms. | United Kingdom |
| 2015 | EU Action Plan for Nature, People, and the Economy emphasizes innovative financing. | Calls for biodiversity offsets and credits to bridge funding gaps. | European Union |
| 2016 | Business and Biodiversity Offsets Programme (BBOP) publishes standards for biodiversity offsets. | Publishes standards for biodiversity offsets. | Global |

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|---|---|---|---|
| 2019 | Taskforce on Nature-related Financial Disclosures (TNFD) conceptualized. | Conceptualizes TNFD. | Global |
| 2019 | Global Deal for Nature proposes protecting 30% of Earth's land and water by 2030... | Proposes protecting 30% of Earth's land and water by 2030; lays groundwork for the global "30x30" target. | Global |
| 2020 | EU Biodiversity Strategy for 2030 published as part of the European Green Deal. | Commits to protect 30% of EU land/sea, restore ecosystems, and explore biodiversity credits. | European Union |
| 2022 | EU Nature Restoration Law proposed. | Sets binding targets: restore 20% of EU land/sea by 2030; supports biodiversity credits. | European Union |
| 2022 | Global Biodiversity Framework (GBF) adopted at COP15, encouraging biodiversity credits. Target 19 aims to mobilize $200B per year for biodiversity. | Encourages biodiversity credits; Target 19 aims to mobilize $200B per year for biodiversity. | Global |
| 2023 | EU Taxonomy updated to include biodiversity criteria. | Enables investments in nature-positive projects, paving the way for nature credits. | European Union |
| 2023 | First major biodiversity credit transactions by companies like Shell, HSBC, and Salesforce. | First major biodiversity credit transactions. | Global |
| 2024 | Ursula von der Leyen's State of the Union speech highlights nature credits as a tool for biodiversity financing... | Signals EU's commitment to scaling up nature markets and integrating them into economic recovery and sustainability strategies. | European Union |
| 2024 | EU Nature Restoration Law finalized, requiring ecosystem restoration and nature credits. | Requires ecosystem restoration and nature credits. | European Union |
| 2025 | First national biodiversity credit markets emerge in Colombia, Costa Rica, and Australia. | First national biodiversity credit markets emerge. | Latin America, Australia |
| July 2025 | European Commission publishes Roadmap Towards Nature Credits. | Outlines pilot projects, certification standards, and alignment with global frameworks. | European Union |
| 2025–2026 | Pilot nature credit systems launched across the EU. | Tests credits for ecosystem restoration, pollinator support, and soil health. | European Union |
| 2026–2027 | EU allocates 10% of its budget to biodiversity; nature credits issued progressively. | Credits based on validated milestones; registry planned by December 2028. | European Union |
| 2026–2030 | Scaling up biodiversity credits; regulatory integration; AI and blockchain for transparency. | Scaling up biodiversity credits; regulatory integration; AI and blockchain for transparency. | Global |
| 2027 | Full EU Nature Credits Market targeted for launch. | Enables trading for companies, investors, and public authorities. | European Union |
| 2030 | EU aims to achieve 30% protection and 20% restoration targets. | Nature credits play a key role in financing and verifying progress. | European Union |
| Post-2030 | EU seeks to harmonize nature credit standards globally. | Supports the Global Biodiversity Framework and Paris Agreement. | European Union |

# Annex II

This table presents a compilation of river barrier removal case studies from the past decade, as documented by **Dam Removal Europe**. Each row details a specific project, including the year, country, barrier name, type, removal cost, funding sources, kilometres of river reopened, and a reference link. The data provides empirical examples that underpin the global estimation of dam removal costs, offering insights into the financial, ecological, and logistical aspects of such projects.

| Year | Country | Name | Type | Cost | Funding | Gain | Link |
|---|---|---|---|---|---|---|---|
| 2023 | France | River Tardoire | Weirs | 310,000 € | European Rivers Network (ERN) and Syndicat Mixte Bandiat Tardoire (SYMBA) partnered in this project which was funded 100% by Open Rivers Programme | 18.6 km | https://damremoval.eu/portfolio/river-tardoire-weirs-france/ |
| 2023 | France | Urrutienea Dam | Dam | 260,000 € | Various partners contributed financially to the project, sometimes by financing a specific part of the project. The funding partners were: Open River Programme, Agence de l'Eau Adour-Garonne, Fondation des Pêcheurs, Fédération de pêche des Pyrénées-Atlantiques and AAPPMA de la Nivelle. | 12 km | https://damremoval.eu/portfolio/urrutienea_dam_france/ |
| 2022 | France | Bellefontaine dam and its discharge weir | Dam + Weir | 161,110 € | The 70% of the cost was covered by the Artois-Picardy Water Agency and the remainder 30% by the Hauts-de-France Region. | 1.8 km | https://damremoval.eu/portfolio/bellefontainedam-france/ |
| 2022 | France | Lescoude Culvert and Gué d'Ahetze Dam | Culvert + Dam | 13,744 € | Culvert: Open Rivers Programme (10930 €) and the Fédération de pêche des Pyrénées-Atlantiques (840.84 €). Dam: AAPPMA Nivelle (250 €), Fédération de pêche des Pyrénées-Atlantiques (470 €) et compagnie privée (1290 €). | 4 km + 3 km | https://damremoval.eu/portfolio/guedahetzedam-france/ |
| 2021 | France | Dalloz Weir, River Grosdar | Weir | 110,000 € | French Water Agency and the Region | 3 km | https://damremoval.eu/portfolio/dalloz-france/ |
| 2019 | France | Selune River Dams | Dams | 60,000,000 € | NA | 90 km | https://damremoval.eu/portfolio/vezins-and-la-roche-qui-boit-dams/ |

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|---|---|---|---|---|---|---|---|
| 2022 | Spain | Molino Bajo and Molino del Cabrillas | Weirs | 86,432.90 € | Open Rivers program | 25 km | https://damremoval.eu/portfolio/molino-bajo-cabrillas-spain/ |
| 2022 | Spain | CH Matxategi Dam | Dam | 50,000 € | EU Horizon 2020 project MERLIN (Mainstreaming Ecological Restoration of freshwater-related ecosystems in a Landscape context: INnovation, upscaling and transformation) | NA | https://damremoval.eu/portfolio/matxategi-dam-deba-basque-country-spain/ |
| 2022 | Spain | Alzolabea and San Prudentzio dams | Dams | 61,680 € | EU Horizon 2020 project MERLIN | NA | https://damremoval.eu/portfolio/debariver-spain/ |
| 2021 | Spain | Matabosch Weir | Weir | 206,070 € | Catalan water agency | 700 m | https://damremoval.eu/portfolio/matabosch-spain/ |
| 2020 | Spain | Molló mini-hydropower dam | Dam | 282,510.09 € | Catalan Government | NA | https://damremoval.eu/portfolio/mollo-spain/ |
| 2018 | Spain | Yecla de Yeltes Dam | Dam | NA | LIFE + CIPRIBER project | 27 km | https://damremoval.eu/portfolio/yecla-de-yeltes-dam-spain/ |
| 2024 | Finland | Holstenkoski Dam | Dam | NA | Ministry of Agriculture and Forestry's Migratory Fish Stocks Revitalization Program NOUSU, the Open Rivers Program, City of Salo, WWF Finland, Raija and Ossi Tuuliainen Foundation, Valonia, Kisko Churchkake Treatment association, the Southwest Finland Fisheries Region and the Southwest Finland Nature Conservation District | 40 km | https://damremoval.eu/portfolio/holstenkoski-dam-removal-finland/ |
| 2023 | Finland | Ritakoski Dam | Dam | 750,000 € | Finnish Ministry of Agriculture and Forestry, the Rautjärvi Municipality, WWF, EKSPsäätiö, OP Etelä-Karjala, LähiTapiola, Tuuliaisen säätiö, the forest industrial companies UPM and Metsä Group, and the Open Rivers Programme. The project was also supported by private individuals | NA | https://damremoval.eu/portfolio/ritakoski-dam-river-hiitolanjoki-finland/ |
| 2019 | Finland | Tikkurila Dam | Dam | 800,000 € | NA | 30-40 km | https://damremoval.eu/portfolio/tikkurila-dam-vantaa-finland/ |

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|---|---|---|---|---|---|---|---|
| 2023 | Scotland | Cross mill Weir | Weir | 271000 £ | SEPA's Water Environment Fund, Scottish Government and the Open Rivers Programme | NA | https://damremoval.eu/portfolio/cross-mill-weir-removal-scotland/ |
| 2024 | Scotland | Morton Quarry Weir | Weir | 25000 £ | Open Rivers Programme | 5 km | https://damremoval.eu/portfolio/morton-quarry-weir-removal-case-study-forth-rivers-trust/ |
| 2022 | Scotland | Gateside Mills Weir | Weir | 387000 £ | Water Environment Fund | 17.6 km | https://damremoval.eu/portfolio/gateside-mills-weir-river-eden-scotland/ |
| 2022 | Scotland | Bronie Burn Weir | Weir | 301892.91 £ | Water Environment Fund | 22 km | https://damremoval.eu/portfolio/burnweir-scotland/ |
| 2025 | Sweden | Strutdammen | Dam | 14,700 € | European Maritime and Fisheries Fund | NA | https://damremoval.eu/portfolio/strutdammen-sweden/ |
| 2017 | Sweden | Klintarp Dam | Dam | 15,000 € | County Administrative Board | 2 km (if next dam removed) | https://damremoval.eu/portfolio/klintarp-dam-klova-creek-ronne-river-sweden/ |
| 2017 | Sweden | Sofieholm hydroelectric powerplant | Dam | 1,100,000 € | Hudiksvall Municipality, Swedish Environmental Protection Agency, Swedish Agency for Marine and Water Management and the Swedish Anglers Association | 90 km | https://damremoval.eu/portfolio/sofieholm-hydroelectric-powerplant-river-nianan/ |
| 2024 | Portugal | Perofilho weir | Weir | 27,000 € | Open Rivers Programme | 2.5 km | https://damremoval.eu/portfolio/perofilho-weir-portugal/ |

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|---|---|---|---|---|---|---|---|
| 2023 | Portugal | Vaqueiros Weir | Weir | 50,000 € | RIR (Reconnecting Iberian Rivers) program, which was funded by the MAVA Foundation and was then developed and finalized within the ROLLIN' RIVERS project – People, Knowledge and Action to Enhance River Restoration in Portugal, funded by DIMFE (The Donors' Initiative for Mediterranean Freshwater Ecosystems) | NA | https://damremoval.eu/portfolio/vaqueiros-weir-removal-portugal/ |
| 2023 | Portugal | Galaxes Weir | Weir | 50,000 € | Open Rivers Programme - 80%, World Fish Migration Foundation (WFMF) - 20% | 7.7 km | https://damremoval.eu/portfolio/galaxes-weir-removal-portugal/ |
| 2021 | Portugal | Pessegueiro multi-culvert road crossing | Culverts | 53,938 € | EU Cohesion Fund (85%) and the National Fund – Fundo Ambiental (15%) | 10 km | https://damremoval.eu/portfolio/pessegueiro-removals-portugal/ |
| 2022 | Luxembourg | Pétrusse Valley restoration project | Valley | 26,000,000 € | City of Luxembourg and the Water Management Fund | | https://damremoval.eu/portfolio/petrusse-valley-project-luxemburg/ |
| 2024 | Latvia | Beja Dam | Dam | 99,500 € | Open Rivers Programme | 20 km | https://damremoval.eu/portfolio/beja-dam-removal-latvia/ |
| 2015 | Latvia | Wooden dam | Dam | 4,000 € | EKOenergy's Environmental Fund | NA | https://damremoval.eu/portfolio/woodendam-latvia/ |
| 2023 | Ukraine | Bayurivka Dam | Dam | 20,000 € | NA | 27 km | https://damremoval.eu/portfolio/bayurivkadam-ukraine/ |
| 2019 | Ukraine | Danube Delta Dams | Dams | 28,000 € | 350 campaign donors - 20,000 €, Rewilding Europe and partners - 8000 € | 20 km | https://damremoval.eu/portfolio/danube-delta-ukraine/ |
| 2021 | Montenegro | Vezišnica barriers | Dams | 9,000 € | WWF NL, supported by TNC | 15 km | https://damremoval.eu/portfolio/vezisnica-barriers-river-vezisnica-montenegro/ |

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|---|---|---|---|---|---|---|---|
| 2022 | Norway | River Tromsa | Dam | 337,000 € | Norwegian Government | NA | https://damremoval.eu/portfolio/river-tromsa/ |
| 2022 | Slovakia | River Hučava weir | Weir | 12,000 € | Crowdfunding | 25 km | https://damremoval.eu/portfolio/river-hucava-slovakia/ |
| 2020 | Lithuania | Bražuolė Dam | Dam | 15,000 € | Crowdfunding | NA | https://damremoval.eu/portfolio/brazuole-dam-lithuania/ |
| 2024 | Poland | Bącznik Weir | Weir | 40,000 € | Forestry District of Kliniska | 20 km | https://damremoval.eu/portfolio/bacznik-weir-poland/ |
| 2020 | Poland | Biała Niżna, Florynka and Kąclowa weirs | Weirs | 9,248,826 € | EU Cohesion Fund - 7840375 €; Polish Government - 1408451 € | 80 km | https://damremoval.eu/portfolio/three-weirs-removed-on-the-biala-tarnowska-river-poland/ |
| 2024 | Ireland | Ballinglen Bridge weir | Weir | 130,000 € | IFI Salmon & Sea Trout Rehabilitation, Conservation & Protection Fund 2023 | 51 km | https://damremoval.eu/portfolio/ballinglen-bridge-weir-ireland/ |
| 2020 | Ireland | Brown's Beck Brook | Culvert | 50,000 € | Salmon Conservation Fund | NA | https://damremoval.eu/portfolio/browns-beck-brook-upper-slaney-donard-co-wicklow-ireland/ |
| 2019 | Estonia | Sindi Dam | Dam | 15,000,000 € | EU Cohesion Fund (85 %); Estonian Government (15%) | 3300 km | https://damremoval.eu/portfolio/sindi-dam-estonia/ |
| 2018 | Switzerland | The Sihlpost Dam | Dam | 420000 CHF | Federal Railways, Swiss government, the Canton and City of Zurich and the World Wide Fund for Nature (WWF) | NA | https://damremoval.eu/portfolio/the-sihlpost-dam-zurich-switzerland/ |
| 2024 | Wales | Erbistock Weir | Weir | 510000 £ | LIFEDeeRiver project, Welsh Government, Environment Agency, Dŵr Cymru/Welsh Water, Eryri | 4 km | https://damremoval.eu/portfolio/erbistock-weir-wales/ |

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|---|---|---|---|---|---|---|---|
| | | | | | National Park Authority, and the River Restoration Centre | | |
| 2024 | England | River Gelt weirs | Weirs | 64133 £ | Environment Agency Water Resources Decommissioning of Unused Assets Programme | NA | https://damremoval.eu/portfolio/river-gelt-weirs-england/ |
| 2022 | England | Bowston Weir | Weir | 545,000 € | European Agricultural Fund for Rural Development | NA | https://damremoval.eu/portfolio/bowston-england/ |
| 2021 | England | Hatchford Brook weirs | Weirs | 63000 £ | Environment Agency and the European Regional Development Fund | NA | https://damremoval.eu/portfolio/hatchford-brook-weirs-uk/ |
| 2016 | England | Babingley River Weirs | Weir | 15000 £ | Environment Agency Catchment Restoration Fund | NA | https://damremoval.eu/portfolio/babingley-river-weirs-norfolk-england/ |

# Annex III

| NRP Field Number | Field Description | Suggested Means of Financing |
|---|---|---|
| **Part A – Cross-Cutting Financial Information** | | |
| 4.3.1.1 | Estimated financial needs (EUR) for restoration measures (2020–2024, 2024–2032, 2032–2050), broken down by **one-off/project costs** and **annual running costs** (total and inside Natura 2000). | **Public**: LIFE Programme, Cohesion Policy Funds, InvestEU, National Water Agencies, National Biodiversity Funds. |
| | | **Private**: Green bonds, Sustainability-Linked Loans (SLLs), blended finance, corporate sponsorship, biodiversity/PES credits. |
| | | **Co-financing**: EU LIFE, InvestEU, Horizon Europe (for research-driven projects). |
| 4.3.1.2 | Estimated financial support to stakeholders (e.g., landowners, communities) affected by restoration measures. | **Public**: CAP Strategic Plans (agri-environment schemes), national compensation schemes. |
| | | **Private**: PES mechanisms, biodiversity credits, philanthropic grants. |
| | | **Blended**: Public-private partnerships (PPPs) for landowner compensation. |
| 4.3.1.3 | Indicative means of **intended public financing** (description and estimated value). | **Public**: EU LIFE, Cohesion Funds, Horizon Europe, CAP Strategic Plans, InvestEU, national budgets. |
| | | **Blended**: Combining EU funds with national/regional budgets. |
| 4.3.1.4 | **Indicative means of intended private financing** (description and estimated value). | **Private**: Green bonds, SLLs, blended finance, corporate sponsorship (e.g., Danone's water neutrality), biodiversity credits, carbon credits, tax incentives, impact-linked funding. |
| | | **Blended**: Public guarantees to de-risk private investment. |
| 4.3.1.5 | Intended **co-financing and financing with Union instruments** (description and estimated value). | **Public/Blended**: LIFE Programme, InvestEU, Horizon Europe, Cohesion Funds, EAFRD (CAP). |
| | | **Private**: Corporate ESG funds, impact investment. |
| **Part B – Article 9-Specific Fields** | | |

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|---|---|---|
| 9.1.1 | National approach to meeting **restoration targets for river connectivity and floodplain functions** (based on latest scientific evidence). | **Public**: Horizon Europe (research), InvestEU (loans for infrastructure). |
| | | **Private**: Impact investment, corporate sponsorship. |
| | | **Blended**: Public-private research partnerships. |
| **9.2.1. Plan for Removal of Artificial Barriers (until 2030)** | | |
| 9.2.1.1 | **Indicative net additional total length of free-flowing rivers** to be achieved by 2030 (accounting for new barriers). | **Public**: LIFE Programme, Cohesion Funds, national water agency budgets. |
| | | **Private**: Green bonds, SLLs, biodiversity credits, blended finance (for bundled barrier removal projects). |
| | | **Co-financing**: InvestEU, EIB loans. |
| 9.2.1.2 | **Indicative map of potential free-flowing rivers** to be restored (2020–2030). | **Public**: EU Copernicus data, national GIS tools (funded via Horizon Europe or LIFE). |
| | | **Private**: Corporate sponsorship for mapping tools (e.g., tech companies). |
| 9.2.1.3 | Best estimate of **free-flowing rivers in 2020** (baseline). | **Public**: Existing national/EU datasets (e.g., AMBER Project, JRC). |
| | | **Private**: Crowdsourced data (e.g., citizen science via AMBER app). |
| 9.2.1.4 | **Indicative map of free-flowing rivers baseline (2020)**. | Same as 9.2.1.2. |
| **9.2.2. Improvement of Natural Functions of Floodplains (until 2030)** | | |
| 9.2.2.1 | **Indicative total surface area** subject to restoration measures to improve floodplain functions. | **Public**: LIFE Programme, CAP Strategic Plans (for agroecological measures), Cohesion Funds. |
| | | **Private**: PES (e.g., flood resilience payments), carbon credits, corporate sponsorship. |
| | | **Blended**: InvestEU loans for large-scale floodplain restoration. |
| 9.2.2.2 | **Indicative map of potential areas** subject to floodplain restoration measures. | **Public**: National/regional GIS (funded via LIFE or Horizon Europe). |
| | | **Private**: Philanthropic grants for mapping (e.g., NGOs). |

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| **9.2.3. Maintenance of Connectivity and Floodplain Functions** | | |
| 9.2.3.1 | Summary of measures to **ensure long-term connectivity and floodplain function maintenance**. | **Public**: National maintenance budgets, LIFE Programme (for monitoring). |
| | | **Private**: Impact-linked funding (payments tied to verified outcomes). |
| | | **Blended**: Public-private maintenance contracts. |
| **9.3. Targets After June 2032 (Strategic Overview)** | | |
| 9.3.1.1 | **Indicative net additional length of free-flowing rivers** by 2040/2050 (accounting for new barriers). | **Public**: Long-term EU budgets (e.g., next MFF), national restoration funds. |
| | | **Private**: Green bonds, SLLs, biodiversity credits. |
| | | **Blended**: InvestEU, EIB green loans. |
| 9.3.1.2 | **Indicative maps of potential free-flowing rivers** after June 2032. | Same as 9.2.1.2. |
| 9.3.2.1 | **Indicative total surface area** for floodplain restoration after June 2032. | **Public**: Cohesion Funds, CAP Strategic Plans. |
| | | **Private**: Carbon credits, PES, blended finance. |
| | | **Blended**: EU-private sector partnerships. |
| 9.3.2.2 | **Indicative maps of potential areas** for floodplain restoration after June 2032. | Same as 9.2.2.2. |
| **Additional Information IV – Inventory of Artificial Barriers (Art. 15(3)(i) and (n))** | | |
| A4.1 | **Barrier ID** (unique identifier for each barrier). | **Public**: National inventories (funded via LIFE or national agencies). |
| | | **Private**: Corporate databases (e.g., energy companies for dam inventories). |
| A4.2 | **Water body information** (WFD water body ID or river/lake name). | **Public**: WFD reporting tools, national databases. |
| A4.3 | **Location of the barrier** (geospatial data: point, line, or polygon). | **Public**: Copernicus, national GIS (funded via Horizon Europe). |
| | | **Private**: Crowdsourced data (e.g., AMBER app). |
| A4.4 | **Barrier type** (dam, weir, culvert, etc.). | **Public**: National inventories (e.g., Dam Removal Europe database). |

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| | | **Private**: Corporate audits (e.g., hydropower companies). |
| A4.5 | **Connectivity dimension impacted** (longitudinal, lateral, vertical). | **Public**: Research projects (Horizon Europe). |
| | | **Private**: NGO-led assessments. |
| A4.6 | **Obsolete status of barrier** (yes/no/unknown). | **Public**: National assessments (funded via LIFE). |
| | | **Private**: Corporate due diligence (e.g., for ESG reporting). |
| A4.7 | **Use of the barrier** (if not obsolete: energy, navigation, flood protection, etc.). | **Public**: National registries. |
| | | **Private**: Corporate disclosures (e.g., hydropower operators). |
| **A4.8. Plan for Removal of Artificial Barriers** | | |
| A4.8.1 | **Is the barrier planned for removal?** (yes by 2030/2040/2050, no, unknown, under study). | **Public**: LIFE Programme, national restoration plans. |
| | | **Private**: Blended finance for prioritized barriers. |
| | | **Co-financing**: InvestEU for high-impact removals. |
| A4.8.2 | **Mitigation measures** for barriers not planned for removal (e.g., fish passages). | **Public**: WFD compliance funds, LIFE Programme. |
| | | **Private**: Corporate ESG investments (e.g., hydropower companies). |
| A4.8.3 | **Objective of barrier removal** (e.g., Art. 9(1): 25,000 km free-flowing rivers; Art. 4: habitat restoration). | **Public**: Aligned with NRP targets (funded via LIFE, CAP). |
| | | **Private**: Biodiversity credits, carbon credits (for co-benefits). |
| **Part C – Measures (Article 9-Relevant)** | | |
| 14.1.1 | **Name of the measure** (e.g., "Barrier Removal Programme 2024–2030"). | **Public/Private**: Project-specific funding (e.g., LIFE for public, green bonds for private). |
| 14.1.2 | **Main ecosystem type**: River, lake, alluvial, or riparian ecosystems. | **Public**: LIFE Programme, CAP (for agroecological measures). |
| | | **Private**: Biodiversity credits, PES. |
| 14.1.4 | **Scale of planning** (national, NUTS1/2/3, transnational). | **Public**: EU Cohesion Funds (for cross-border projects). |
| | | **Private**: Corporate multi-country initiatives. |
| 14.1.5 | **Current status** (planned, adopted, ongoing, implemented). | **Public**: National budgets. |
| | | **Private**: Corporate CSR programs. |
| 14.2.1 | **Implementation timeframe** (e.g., 2024–2032, 2032–2050). | **Public**: Aligned with EU budget cycles (e.g., MFF). |

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| | | **Private**: Green bond maturities. |
| 14.3.1 | **Description of the measure** (e.g., barrier removal, floodplain rewetting). | **Public**: LIFE Programme, InvestEU. |
| | | **Private**: Blended finance, impact funds. |
| 14.3.2 | **Contributions to targets** (e.g., Art. 9(2): removal of artificial barriers). | **Public**: Linked to NRP reporting (LIFE, CAP). |
| | | **Private**: Biodiversity credits (for verified removals). |
| 14.5.1 | **Estimated surface area or length** subject to the measure. | **Public**: National/regional assessments. |
| | | **Private**: Corporate sustainability metrics. |
| 14.5.2 | **Indicative map of potential areas** subject to the measure. | **Public**: Copernicus, national GIS. |
| | | **Private**: Corporate geospatial tools. |
| 14.5.3 | **Location relative to Natura 2000** (inside/outside/both). | **Public**: Natura 2000 reporting tools. |
| | | **Private**: NGO-led mapping (e.g., WWF). |
| 14.6.1 | **Estimated financial needs** for the measure (by period and ecosystem type). | **Public**: LIFE, CAP, InvestEU. |
| | | **Private**: Green bonds, SLLs, blended finance. |
| 14.6.2 | **Estimated financial support to stakeholders** (e.g., landowners). | **Public**: CAP agri-environment schemes. |
| | | **Private**: PES, biodiversity credits. |
| 14.6.3 | **Indicative public financing** for the measure. | **Public**: EU/National budgets (e.g., LIFE, Cohesion Funds). |
| | | **Blended**: Public-private co-financing. |
| 14.6.4 | **Indicative private financing** for the measure. | **Private**: Green bonds, SLLs, biodiversity credits, corporate sponsorship, impact-linked funding. |
| 14.6.5 | **Intended co-financing with Union instruments** (e.g., LIFE, InvestEU). | **Public/Blended**: LIFE, InvestEU, Horizon Europe, EIB loans. |

# Annex IV

Categorisation of 19 national frameworks into three **market archetypes**: **1) Principle driven** (government as regulator/enabler, with private sector handling most market functions), **2) Shared governance** (government provides regulatory oversight and administers key market functions alongside private actors), and **3) Centralised governance** (government manages the majority of market operations, potentially acting as regulator, administrator, and even buyer/seller of credits). These archetypes reflect the varying degrees of government involvement in shaping and operating nature credit markets globally.

| Archetype | Location | Framework Title | Use Case | Key Features |
|---|---|---|---|---|
| 1 | Canada | Conservation Exchange Pilot | Voluntary contribution | Government-backed certificates, collaborative approach with industry/Indigenous leaders, assessment on conservation benefits. |
| 1 | Japan | OECM Certificate Scheme | Voluntary contribution | Government-certified sites with public registry, legal recognition of OECMs, encourages biodiversity valuation and future credit issuance. |
| 1 | New Zealand | Voluntary Nature Credit Market | Voluntary contribution | Government-endorsed credits with high integrity, preferential integration with carbon credits, alignment with international principles (IAPB). |
| 1 | Niue | Ocean Conservation Commitments | Voluntary contribution | Innovative financing for marine conservation, sponsorship of 1 $km^2$ ocean with verified benefits, trust-funded endowment for long-term conservation. |
| 1 | Paraná State, Brazil | Certification of Private Protected Areas | Voluntary contribution | Focus on Private Reserves of Natural Heritage, state-wide policy, seed funding/audit support, online platform for project registration. |
| 2 | Brazil | Environmental Reserve Quota (CRA) | Compliance compensation | Largest forest trading market (potentially $10B), legal framework since 1936, Forest Reserve Credits for offsetting forest debt. |
| 2 | Colombia | Habitat Banking | Compliance compensation & voluntary contribution | Government-facilitated habitat banks, no net loss principle with 1:1 offset, multipliers for ecologically valuable habitats, registry of habitat banks. |
| 2 | England | Biodiversity Net Gain | Compliance compensation | 10% net gain addition, standardized biodiversity units (BUs), mandatory for new developments, Biodiversity Net Gain Register for tracking. |
| 2 | Finland | Voluntary Ecological Compensation | Voluntary compensation | Natural value hectare as unit, methodology for assessing natural value creation, registry for approved projects. |
| 2 | France | Natural Compensation, Restoration, and Renaturation Sites (SNCRR) | Compliance compensation & voluntary contribution | Decentralized framework, Natural Compensation/Restoration/Renaturation Sites (SNCRRs), certification by the state, pooling measures for ecological efficiency. |
| 2 | Germany | Habitat Banking | Compliance compensation | Impact Mitigation Regulation (IMR) requiring mitigation hierarchy, ex-ante credit production, 40+ state-specific approaches, voluntary standards for compensation pools. |

| | | | | |
|---|---|---|---|---|
| 2 | Jiangxi Province, China | Wetland Mitigation Banking | Compliance compensation | Focus on wetland protection/restoration, information management platform, phased objectives, transparent registration. |
| 2 | USA | Stream/Wetland Mitigation Banking | Compliance compensation | Largest by transaction volume ($3.6B/year), government oversight, three mitigation types, transparency via public registries. |
| 2 | USA | Conservation (Habitat) Banking | Compliance compensation | Government oversight, regulatory preference for banking, transparency via registries. |
| 2 | Victoria, Australia | Native Vegetation Credits | Compliance compensation | No net loss policy, native vegetation credits for offsets, permanent protection, Native Vegetation Credit Register. |
| 3 | Australia | Nature Repair Market | Voluntary contribution | Nationally regulated, scientific accuracy via Biodiversity Assessment Instrument, complements carbon markets, supports First Nations and conservation groups. |
| 3 | India | Green Credit Programme | Compliance compensation & voluntary contribution | Land bank platform for degraded forests, credits for restoration/maintenance over 10 years, focus on native species, national trading platform. |
| 3 | NSW, Australia | Biodiversity Offsets Scheme | Compliance compensation | Mandatory Biodiversity Offsets Scheme (BOS), ecosystem/species credits, investment strategy for 5-20 years, public registries for tracking. |
| 3 | South Africa | SANParks Biodiversity Offset Bank | Compliance compensation & voluntary contribution | First operational mechanism under South Africa's guideline, credits for 1 ha protected for 30 years, designed for compliance/voluntary markets, internal ledger for transactions. |

# Annex V

Overview of selected **biodiversity credit schemes** assessed for their applicability to European wetland restoration and conservation. It highlights each scheme's **type** (e.g., outcome-based standard or methodology) and **key features**, such as flexibility, scientific rigor, geographic focus, and market traction, offering a snapshot of their strengths in addressing the unique ecological and regulatory context of European wetlands.

| Scheme | Type | Key Features |
|---|---|---|
| **Accounting for Nature** | Outcome-based biodiversity credit standard | Flexibility, modularity, scientific MRV recognition, ex-post credit issuance, global applicability, project pipeline across 160,000+ hectares. |
| **Cercarbono** | Biodiversity Certification Programme | Speed, flexibility, interoperable biodiversity units, ICROA-certified, outcome-based credit issuance. |
| **CreditNature (NARIA Framework)** | Outcome-based biodiversity credit methodology | EU focus on temperate landscapes, ecosystem integrity, project pipeline in Europe, accredited by Accounting for Nature, infrastructure asset focus. |
| **OBC (Organization for Biodiversity Certificates)** | Practice-based methodology | EU/small land focus, country-based market entry, pilot projects in France, monitoring indicator flexibility. |
| **Plan Vivo (PV Nature)** | Outcome-based biodiversity credit standard | Market position, rigorous digital monitoring, unit interoperability, wide applicability, strong community participation, project pipeline across 240,000+ hectares globally. |
| **Social Carbon** | Nature Stewardship Framework | Speed, flexibility, composite stewardship index (biodiversity + socio-economic + governance), strong philanthropic focus. |
| **Verra (SD VISta Nature)** | Outcome-based biodiversity credit standard | Market position, wide applicability, unit interoperability, monitoring indicator flexibility, project pipeline across 175,000+ hectares globally. |
| **Wallacea Trust** | Open-source biodiversity credit methodology | Wide applicability, monitoring indicator flexibility, unit interoperability, project pipeline across 250,000+ hectares, open-source approach, independent academic validation. |

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