



Opportunities for Ecological Restoration

in the Voluntary Carbon Market

May 2024



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Foreword

At Meta, our commitment to reach net-zero emissions across our value chain in 2030 is the north star in our work to address climate change and operate sustainably. Meeting this goal entails decarbonization of every aspect of our business, from the responsible construction of our data centers to the computational efficiency of the code running our platforms. For any residual emissions, we rely on carbon removal projects to reach net zero.

While our carbon-focused commitment is an easily measured and time-bound goal, we acknowledge that carbon is just one lens of the multi-faceted nature of the climate crisis. As we engage with the voluntary carbon market, we see an opportunity to address climate beyond carbon mitigation alone. Carbon removal projects can be designed to support the ecosystem health of a region by restoring native species and biodiversity in degraded landscapes. Ecological restoration can have cascading socioeconomic benefits for people that live in these landscapes, and the resulting

benefits for people and nature can reinforce the sustained climate impacts of a well-designed project. For Meta, the opportunity to maximize positive environmental and social impacts through our carbon removal program connects our net-zero work to our broader mission to help communities and ecosystems thrive.

We are thrilled to have worked with Carbon Direct in this effort to identify and promote more ecological restoration in the voluntary carbon market. The climate and biodiversity crises are interlinked, and this study provides key recommendations on how to use carbon market finance to address both. We hope buyers and project implementers will use these findings to increase the number and quality of carbon projects that effectively prioritize ecological restoration, and we look forward to continuing to partner with many of you to reach that goal.

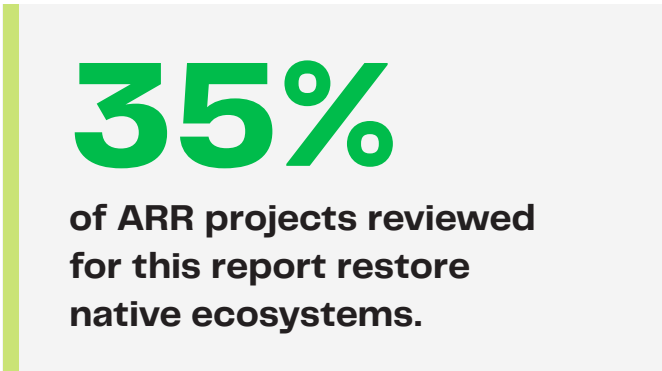


Executive summary

Buyers in the voluntary carbon market (VCM) increasingly seek out high-quality projects that provide biodiversity and ecological restoration benefits beyond climate change mitigation. These projects promote biodiverse, climate-stable, and adaptable ecosystems, both directly and indirectly. However, finding these projects can be challenging. Not all nature-based VCM projects are suited to optimize for both carbon sequestration and ecological restoration. While stand-out projects exist today that advance these dual objectives, relatively few projects meet this bar. This report explores that intersectionality and the state of ecological restoration in the VCM today, and identifies opportunities to unlock more of these projects in the carbon market.

For the purposes of this assessment, ecological restoration is defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. While ecological restoration can take many forms, the recommendations provided here focus on projects that support biodiverse native-species habitats. Biodiversity, or living variation, is a key factor underpinning the long-term functionality and maintenance of ecosystem services and processes, and their ability to adapt to pressures and changes, such as climate change. Consequently, this report uses biodiversity as a proxy for native-species restoration.

While some degree of ecological restoration is common within nature-based carbon projects, carbon market finance does not always facilitate restoration to the fullest extent possible and grassroots restoration organizations struggle to adapt to carbon markets. Specifically, there is significant room for improvement across many projects that plant forests where they currently do not exist, which is not always the best solution for climate or ecosystems. For example, some projects seek to plant trees in areas that were previously savannahs, mudflats, or other landscape types rather than restoring native ecosystems. Projects focused on restoring ecosystems to their prior states tend to result in greater accumulation of carbon over time, and in more resilient landscapes. Only 41% of afforestation, reforestation, and revegetation (ARR) projects reviewed for this report rely on a site-appropriate mix of species, and only 35% restore native ecosystems (i.e., the ecosystem that existed prior to degradation).

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35%

**of ARR projects reviewed
for this report restore
native ecosystems.**

The scarcity of ecological restoration projects in the VCM arises from four critical barriers:

1. **Time and cost:** Restoration-oriented approaches often generate credits more slowly and are currently more expensive than alternatives.
2. **Risk:** Restoration can be complex to implement with failure rates sometimes higher than alternatives. Consequently, restoration is often less bankable.
3. **Scale:** Restoration is highly site-specific and often best initiated at a local scale. However, a focus on the local can restrict implementation at larger scales, contributing to relatively higher pricing—smaller-scale projects typically cost more per tonne of carbon.
4. **Misaligned priorities:** Ecological restoration is multifaceted and involves balancing the priorities of nature and people within a landscape, an approach that may generate carbon credits on a slower timeline than projects focused primarily on carbon.

Nevertheless, buyer demand is motivating an increase in the number of carbon projects that prioritize biodiverse native-species habitats and ecosystem functionality. Some of the current challenges these projects face are structural and entrenched. However, others can be addressed with the help of informed buyers, implementers, registries, financiers, and other market participants.

As discussed in the final section of this paper, recommended actions to encourage more ecological restoration in the VCM include:

1. **Signaling clear buyer demand for ecological restoration projects**
2. **Mixing restoration-oriented and traditional approaches in innovative project designs**
3. **Building the “missing middle” between local implementers and buyers**
4. **Adapting rules that govern carbon projects to promote more restoration**
5. **Using de-risking tools such as blended finance vehicles**

Unlocking opportunities to promote biodiverse native-species restoration in VCM projects could help realize the potential of carbon finance to meet global climate mitigation goals while also supporting benefits that are critical for ensuring a healthy and productive planet.

Scarcity of ecological restoration projects in the voluntary carbon market



Ecological restoration is the ‘process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.’

— Gann et al. 2019 ¹

The voluntary carbon market (VCM) helps private actors secure carbon credits to meet their carbon management targets. Each credit represents the reduction, removal, or avoidance of one metric tonne of greenhouse gas emissions, or their equivalent in carbon dioxide. Carbon credits can be a component of reaching an organization’s net-zero emissions targets or other climate impact goals. Increasingly, buyers also seek to purchase carbon credits that deliver broader benefits, such as promoting biodiversity by protecting or restoring biodiverse native-species ecosystems. High-quality projects that meet these multifaceted requirements

can be difficult to find, and current project protocols are not designed to monitor a project’s broader ecosystem impacts beyond carbon storage and sequestration.

These difficulties raise questions such as:

- Is the VCM set up to accommodate both carbon and restoration goals?
- If so, how can buyers signal demand for and facilitate projects that pursue these dual goals?
- What are the barriers to ecological restoration in the VCM?
- What are the opportunities for ecological restoration in the VCM?

This report explores the intersecting priorities of carbon projects and ecological restoration. It examines barriers to and opportunities for promoting ecological restoration projects in the VCM from the perspective of ensuring quality and credibility, with a particular focus on the buyer’s perspective. For the purposes of this report, ecological restoration is broadly defined as activities

1. Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, et al. 2019. International principles and standards for the practice of ecological restoration. Second edition. Restoration Ecology. 27(S1):S1–S46. [doi:10.1111/rec.13035](https://doi.org/10.1111/rec.13035).

that further the recovery of degraded or damaged ecosystems toward a more ecologically and socially functional state. In this analysis, biodiversity uplift and protection, which are key factors underpinning ecosystem function, are used as proxies for restoration activities leading to ecosystem recovery.^{2, 3}

The conclusions resulting from this analysis are complex—while many carbon projects support elements of ecological restoration, carbon management, resilience, and biodiversity, they do not always align with the priorities and incentives for project design in the VCM (**table 1**). Buyer understanding of different drivers between carbon and biodiversity is key to making informed purchase decisions and prioritizing these project types. Carbon storage and sequestration are ecosystem services distinct from biodiversity uplift and protection. Carbon projects are designed to promote carbon storage and sequestration, although high-quality projects must, at a minimum, prevent harms to ecosystems and biodiversity. While biodiversity uplift and climate change

mitigation are inextricably linked at a global scale, carbon and biodiversity cannot always both be maximized in project design. Plantation forests, for example, are well-documented as sequestering carbon more rapidly and with more potential to scale than ecological restoration.⁴ A buyer or developer prioritizing carbon first may choose to pursue this type of intervention (remaining satisfied that no ecosystem harm has been done). Diverse native-species plantings, on the other hand, can sequester more carbon in the long-term and will have an improved capacity to adapt and respond to stressors, such as climate change.⁵ Each of these project types has an important role to play in climate mitigation. Understanding these nuances and accounting for their responsible and strategic deployment will be key to meeting global climate and biodiversity goals.⁶ Demand signals from buyers are helpful for spurring nature-based projects that support ecological restoration and offer high-quality carbon credits, but buyers need to be prepared to pay more for these types of projects and be willing to support projects on potentially longer timelines.

2. Gann GD, et al. 2019. International principles and standards.

3. Di Sacco A, Hardwick KA, Blakesley D, Brancalion PHS, Breman E, Cecilio Rebola L, Chomba S, Dixon K, Elliott S, Ruyonga G, et al. 2021. Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. *Global Change Biology*. 27(7):1328–1348. [doi:10.1111/gcb.15498](https://doi.org/10.1111/gcb.15498).

4. Bukoski JJ, Cook-Patton SC, Melikov C, Ban H, Chen JL, Goldman ED, Harris NL, Potts MD. 2022. Rates and drivers of aboveground carbon accumulation in global monoculture plantation forests. *Nat Commun*. 13(1):4206. [doi:10.1038/s41467-022-31380-7](https://doi.org/10.1038/s41467-022-31380-7).

5. Yang Y, Tilman D, Furey G, Lehman C. 2019. Soil carbon sequestration accelerated by restoration of grassland biodiversity. *Nat Commun*. 10(1):718. [doi:10.1038/s41467-019-08636-w](https://doi.org/10.1038/s41467-019-08636-w).

6. Ellis PW, Page AM, Wood S, Fargione J, Masuda YJ, Carrasco Denney V, Moore C, Kroeger T, Griscom B, Sanderman J, Atleo T. 2024. The principles of natural climate solutions. *Nature Commun*. 15(1):547. [doi:10.1038/s41467-023-44425-2](https://doi.org/10.1038/s41467-023-44425-2).

Table 1. Key characteristics and points of divergence between nature-based projects prioritizing carbon and those prioritizing ecological restoration

	Carbon	Restoration
Targets and commitments	Credits from carbon projects are often used to mitigate residual emissions as part of net-zero or other climate-related targets.	Companies are increasingly developing biodiversity and nature-positive commitments that may intersect with carbon goals. While some carbon projects encompass these types of nature-positive commitments, restoration goals are less frequently accompanied by measurable, time-bound targets.
Units of exchange	Carbon credits are generally treated as fungible.	Restoration outcomes are hyperlocal and site specific. They are not currently fungible and are difficult to measure.
Crediting and accounting	Myriad protocols and accounting methods exist for carbon projects, but there are some points of convergence such as the use of global warming potential equivalencies.	Restoration is complex. Measuring outcomes depends on a variety of factors underpinned by the goals of the intervention, which can be difficult to translate across geographies and projects. Project goals will determine the facets of biodiversity that should be monitored (e.g., taxonomic or functional). Project-specific complexities mean that crediting approaches are less standardized than those in the carbon space.
Scale	Nature-based carbon projects can be cost-effective and successful at scale. Currently, the majority of such projects focus on restoring low numbers of species, such as in commercial monoculture timber plantations.	Restoration targeting multi-species outcomes and specific habitat goals is highly site specific, can be expensive, and is often most effective at small scales.
Claims	While the quality of implementation varies, the outcomes of a carbon removal project—stored metric tonnes of carbon dioxide over a defined period of time—are accepted and largely verifiable.	Expansive restoration claims are hard to make credibly—clearly documenting gains in ecosystem recovery requires monitoring and measurement over a long time frame, and metrics and methodologies can be variable across projects and geographies.

Ecological restoration as an element of the voluntary carbon market

Ecological restoration is increasingly recognized as critical to global climate change mitigation because of the role it can play in recovering degraded lands and promoting resilient and productive landscapes.^{7, 8} The need for restoration is highlighted by major international efforts to secure commitments and pledges such as the Bonn Challenge, 1t.org, the African Forest Landscape Restoration Initiative, and the United Nations Decade on Ecosystem Restoration.^{9, 10, 11, 12} Corporates and organizations with multifaceted climate commitments that speak to these goals may seek to combine carbon and ecological restoration targets in the context of VCM purchases.

Broadly, elements of ecological restoration are evident in many nature-based projects in the VCM. These elements can include reducing disturbances and chemical inputs. However, high-quality project

design and measurable outcomes from both a carbon and restoration perspective can sometimes be difficult to reconcile. Restoration projects set targets and measure progress against a reference model. In this context, a reference model is based on an educated assumption of what the intact ecosystem would look like. Importantly, reference models are not static.¹³ Ecosystems are dynamic. Therefore, project targets and design must be adaptive to change (**table 2**). For carbon projects, where developers aim to deliver predictable volumes of carbon credits to buyers, a dynamic approach to ecosystem management can result in variable amounts of carbon storage. This can make it especially difficult to meet forward-looking, ex ante, buy-side expectations because outcomes (both in terms of restoration and carbon) can be a bit of a moving target.

7. Lewis SL, Wheeler CE, Mitchard ETA, Koch A. 2019. Restoring natural forests is the best way to remove atmospheric carbon. *Nature*. 568(7750):25–28. [doi:10.1038/d41586-019-01026-8](https://doi.org/10.1038/d41586-019-01026-8).

8. Mo L, Zohner CM, Reich PB, Liang J, de Miguel S, Nabuurs G-J, Renner SS, van den Hoogen J, Araza A, Herold M, et al. 2023. Integrated global assessment of the natural forest carbon potential. *Nature*. 624(7990):92–101. [doi:10.1038/s41586-023-06723-z](https://doi.org/10.1038/s41586-023-06723-z).

9. International Union for Conservation of Nature. 2020. Restore Our Future, The Bonn Challenge: Impact and potential of forest landscape restoration. [accessed 2024 Mar 02]. <https://www.bonnchallenge.org/sites/default/files/resources/files/%5Bnode%3Anid%5D/Bonn%20Challenge%20Report.pdf>.

10. A platform for the trillion trees community. | 1t.org. [accessed 2024 Jan 8]. <https://www.1t.org/>.

11. The African Forest Landscape Restoration Initiative (AFR100). [accessed 2024 Mar 3]. <https://afr100.org/>.

12. UN Decade on Restoration. [accessed 2024 Jan 8]. <https://www.decadeonrestoration.org/>.

13. Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, et al. 2019. International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*. 27(S1):S1–S46. [doi:10.1111/rec.13035](https://doi.org/10.1111/rec.13035).

Table 2. Key ecological attributes used to describe a reference ecosystem*

	Defintion	Example of activity to improve recovery
Absence of threats	Direct threats to the ecosystem such as over-utilization, contamination, or invasive species are absent.	Fence off regenerating areas to exclude livestock grazing.
Physical conditions	Environmental conditions required to sustain the target ecosystem are present. This includes the physical and chemical condition of soils, water, and topography.	Place infrastructure to limit erosion while plants establish root systems.
Species composition	Native species that are character-istic of the appropriate reference ecosystem are present and undesirable species are absent.	Plant a biodiverse mix of native species.
Structural diversity	An appropriate diversity of key structural components are present. This includes demographic stages, trophic levels, vegetation strata, and spatial habitat diversity.	Girdle trees to create snags for wildlife habitat.
Ecosystem function	Appropriate levels of growth and productivity, nutrient cycling, decomposition, species interactions, and rates of disturbances are present.	Introduce prescribed fire to improve forest understory conditions and reduce catastrophic fire risk.
External exchanges	The ecosystem is appropriately integrated into its larger landscape or aquatic context through abiotic and biotic flows and exchanges.	Designate wildlife habitat corridors connecting to high-quality neighboring habitat.

*These categories are deliberately broad in order to encompass a large range of ecosystems. At the project level, these are further refined to better describe the specific ecosystem. Adapted from Gann GD, et al. 2019. International principles and standards for the practice of ecological restoration. Original work licensed under CC BY 4.0.

How does restoration show up in the VCM?

Beyond carbon, nature-based projects potentially offer enormous benefits for the hundreds of millions of people who rely on forests and their associated ecosystem services—benefits and outcomes that are not well reflected or measured within carbon market systems. In 2022, nature-based projects represented about 17% of voluntary carbon credit issuances from the four largest registries.¹⁴ Project types with considerable potential to restore diverse forests comprised 13% of total projects issued.¹⁵ These project types—afforestation, reforestation and revegetation (ARR), wetland and mangrove restoration, and improved forest management (IFM)—are the focus of this report. Other project types that can help advance restoration include avoided forest loss, sustainable agriculture and grassland management, and improved cookstoves.¹⁶ However, the majority of projects transacted on the market (69%) are focused on renewable energy, avoidance of industrial gasses, and other project types that are not nature-based (figure 1).¹⁷

Not all carbon projects are created equal. Although all credits are meant to represent a tonne of carbon dioxide avoided, reduced, or removed, in practice, credits vary in terms of their climate benefits, durability, and other characteristics. In reviewing hundreds of projects, Carbon Direct has found that, across all project types, fewer than 10% of projects meet or exceed the quality criteria from the *Criteria for High-Quality Carbon Dioxide Removal*.¹⁸ These criteria are summarized in **table 3** and a fuller description of project additionality is provided in **box 1**. Projects also differ in the kinds of positive benefits they provide for nature and for communities. Increasing the number of high-quality, nature-based projects in the VCM is essential to ensuring climate impact, reducing reputational risks for market actors, and driving beneficial outcomes for nature and biodiversity.

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17%

**of 2022 VCM project
issuances were from
nature-based projects.**

14. Voluntary Registry Offsets Database. 2020–2023. V10. Berkeley Carbon Trading Project. [accessed 2024 Jan 8]. <https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database>.

15. “Issuances” refers to the number of projects that issued tonnes in 2022.

16. Voluntary Registry Offsets Database. 2020–2023. V10. Berkeley Carbon Trading Project. [accessed 2024 Jan 8]. <https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database>.

17. Voluntary Registry Offsets Database. 2020–2023. V10. Berkeley Carbon Trading Project.

18. Carbon Direct and Microsoft. 2023. Criteria for High-Quality Carbon Dioxide Removal. [accessed 2024 Mar 02]. <https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f>.

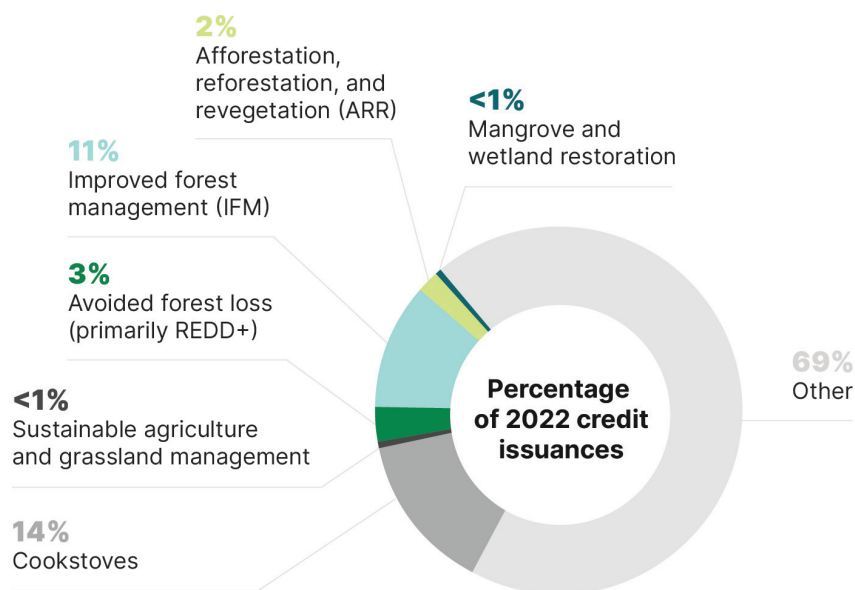


Figure 1. Nature-based projects within the Voluntary Carbon Market (VCM). Issuances percentages are based on issuances from the four largest VCM registries (Verified Carbon Standard, Gold Standard, American Carbon Registry, and Climate Action Reserve) and on data from the Voluntary Registry Offsets Database.

Note: "REDD+" stands for reducing emissions from deforestation and forest degradation in developing countries. The "+" stands for additional forest-related activities that protect the climate. Figure credit: Carbon Direct 2024

Project type and percentage of 2022 issuances	Number of projects with credits	Price, in US\$ per tCO ₂ e	Description	Subtypes	Primary locations of issued credits
ARR, 2%	35	15–40	Planting trees or promoting regrowth on land for a range of purposes	Native reforestation, agroforestry, commercial forestry	China, Latin America, Southeast Asia, Africa
Mangrove and wetland restoration, <1%	1	25–50	Promoting vegetation and rebuilding soils of semi-aquatic ecosystems	Mangrove, peatlands, temperate wetlands	China, Latin America, Southeast Asia, Africa
IFM, 11%	158	15–35	Altering management of harvested forest to store more carbon and promote a healthier or older forest	Extending harvest rotations, thinning for forest health	United States, Canada, Mexico
Avoided forest loss (primarily REDD+), 3%	45	10–30	Reducing deforestation pressures to lessen tree loss, often in the tropics; sometimes fosters natural regrowth or includes active restoration in parts	Tropical forest, peatland, mangrove, temperate forest	Brazil, Indonesia, other areas of the global south
Sustainable agriculture and grassland management, <1%	5	10–20	Altering crop or livestock systems to store more carbon in soils and improve soil health	Rotational grazing, reduced tillage, cover cropping	Australia, United States, Kenya
Cookstoves, 14%	202	5–20	Promoting switching to more efficient cooking systems that reduce fuelwood use, lessening pressure on forests	Increased efficiency stoves, clean fuel interventions	South Asia, Sub-Saharan Africa
Other, 69%	1000	3–20+	Myriad other carbon credit types that involve limited restoration	Renewable energy, F-gas avoidance, etc.	China, India, rest of the world

Table 3. Carbon Direct's criteria for high-quality carbon dioxide removal

Quality Criteria	Definition	Analysis
 Additionality and baselines	High-quality projects are additional. Projects are additional if carbon finance drives project activities to make a genuine impact against a counterfactual baseline (what would have occurred in the absence of carbon finance).	The analysis includes three modes of inquiry: financial additionality, regulatory additionality, and common practice. Baseline assessments consider what would have occurred in the absence of carbon finance.
 Leakage	High-quality projects avoid leakage. Projects cause leakage when, despite reducing emissions in the project area, they instigate an increase in emissions elsewhere due to economic and physical pressures.	The analysis considers whether the project conservatively accounts for the impacts of leakage or demonstrates that the project avoids leakage altogether.
 Carbon accounting and monitoring, reporting and verification (MRV)	High-quality projects have conservative accounting and robust MRV. Accounting is the process of quantifying greenhouse gas emissions and carbon sequestration associated with a project, often utilizing life cycle assessments and calibrated models; MRV is the continual process of evaluating the project over time.	The analysis evaluates whether carbon accounting and MRV are: (1) feasible; (2) repeatable, verifiable, and conservative; and (3) likely to accurately estimate the carbon dioxide and other greenhouse gas emissions.
 Durability	High-quality projects durably store carbon. Durability is the ability of a project to maintain the reduction or sequestration of greenhouse gases over time, avoiding potential reversals that lead to re-emissions into the atmosphere.	Durability is evaluated on two axes: (1) the likelihood of meeting the durability term of the project; and (2) the durability term of the project in comparison to others within the same technology space.
 Environmental justice	High-quality projects consider environmental justice, including the practice of ensuring fair treatment and inclusive involvement of stakeholders in the environmental decision-making process.	The analysis considers whether projects engage with and benefit communities. Two primary metrics used to evaluate this are procedural equity and distributive equity.
 Harms and benefits	High-quality projects minimize harms and maximize benefits. This focuses on the strategic approach of a project to minimize adverse effects and maximize positive outcomes for local communities and ecosystems, emphasizing justice, resilience, and biodiversity.	The analysis considers potential harm to local communities, ecosystems, and biodiversity; checks for risk mitigation strategies; and ensures transparent reporting of harms.

Box 1. Additionality of nature-based projects in the VCM

Additionality refers to how carbon finance enables project activities and climate impact. For high-quality carbon credits to be additional, the project's feasibility must be materially dependent on financial support from selling carbon credits. In such cases, the project's activities would not have occurred without carbon finance, i.e., the resulting climate benefits require carbon finance. Establishing additionality is important because it shows that carbon credits are the primary motivating force in sequestering atmospheric carbon dioxide.

However, a project with a diversity of revenue streams can still be additional. Restoration can be costly, especially if the site is highly degraded. Nature-based projects in the VCM often rely on diverse revenue streams beyond just carbon credits. These projects, especially those focused on forest restoration and conservation, can tap into multiple funding sources. For instance, they may receive grants from environmental non-governmental organizations (NGOs), government subsidies aimed at conservation efforts, or investments from private companies seeking to bolster their sustainability credentials. Some projects include economic activities that are compatible with restoration, such as the commercialization of wood products from intermittent forest thinnings. Diverse funding sources may represent project strength when it implies broader implementation experience, technical resources, and financial buffers against unexpected challenges that would otherwise lead to project failure.

The timing of project finance is also an important consideration. In the early-stages of nature-based projects, carbon finance may be several years away and many project costs are borne up front. For example, in forest restoration activities that are part of afforestation, reforestation, and revegetation projects, trees must be planted long before substantial verified carbon units (VCUs) are issued.¹⁹ In these cases, outside investors or organizations may finance the project expecting returns from VCUs. Projects might also expect eventual revenues from the commercialization of wood products. Even with substantial non-carbon finance support, projects can still be considered additional if carbon finance remains material for project implementation.

19. Verified Carbon Units (VCUs). Verra. [accessed 2024 Jan 8]. <https://verra.org/programs/verified-carbon-standard/verified-carbon-units-vcus/>.

A high-quality carbon project does not guarantee a high-quality restoration project

An ecological-restoration-oriented project with carbon credits issued in the VCM needs to meet certain standards to be considered a high-quality carbon project. However, that does not necessarily mean it meets expectations for high-quality

restoration outcomes. High-quality realization of native-species restoration (or any restoration) requires an approach that accounts for multifaceted aspects of biodiversity and the geographic and temporal scales that contribute to ecosystem function (**table 4**). All the project types considered for this report support some aspects of ecosystem services recovery, but **for the purposes of this report and supporting analysis, restoration of biodiverse forests with native species was used as a benchmark for high-quality restoration that more holistically meets restoration goals.**

Table 4. Elements of high-quality, biodiversity-focused restoration

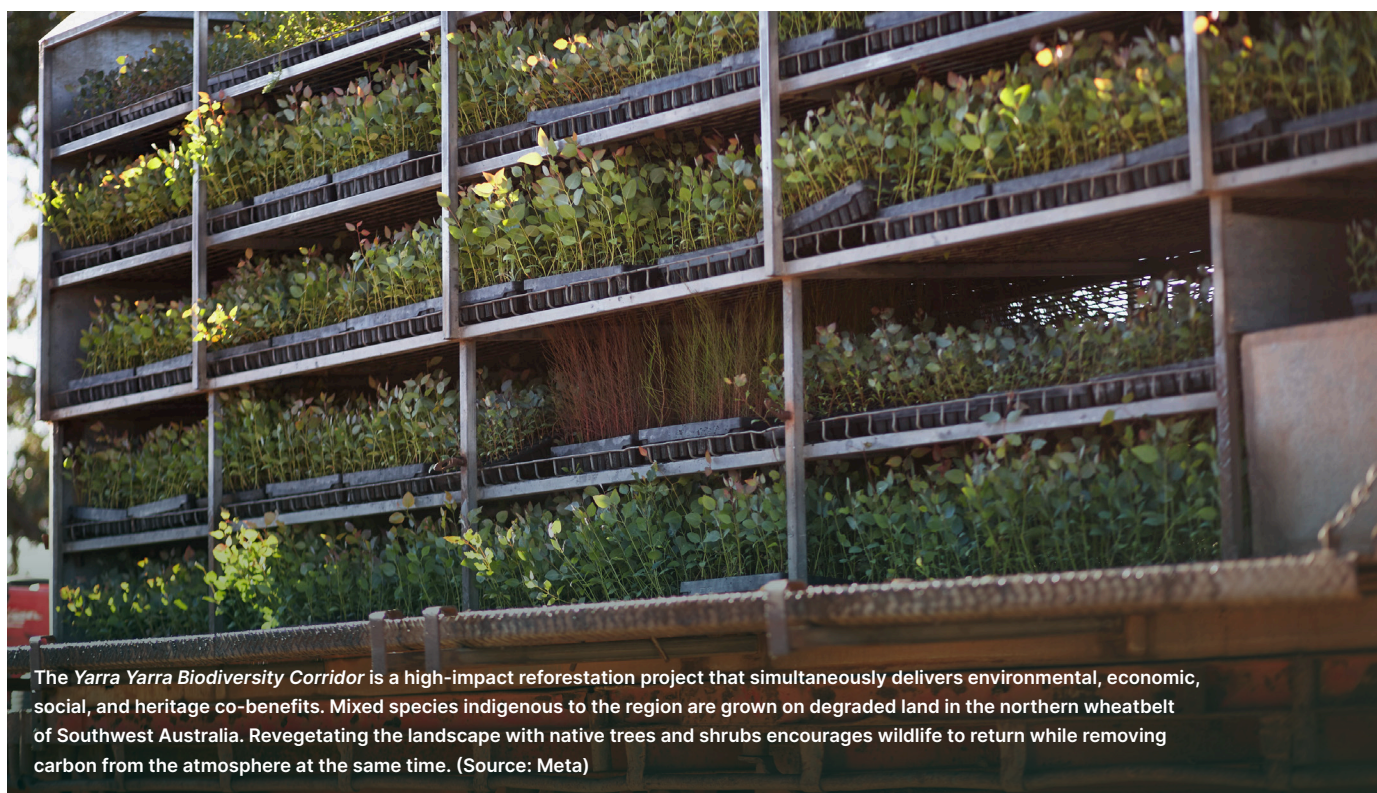
Scale	Representative questions
Genetic How does the project support the long-term success of populations and communities within the broader landscape?	Are seeds collected or sourced from local parent populations to ensure local adaptation?
	Are seeds collected from more distant provenances to match conditions under future climate scenarios?
Species Will land management support healthy, diverse, and sustainably functioning ecosystem services?	Are species regionally native or ecologically appropriate (e.g., naturalized) to current or future site conditions?
	Will a site-appropriate mix of species be used (either through maintenance, planting, or natural regeneration)?
Site Will target species support a diverse, ecologically relevant, and functional ecosystem?	Does the project plan to restore native ecosystems (e.g., if the previous ecosystem was a grassland, is the project restoring native grassland)?
	Does the project define goals for underpinning ecosystem functions and natural capital (e.g., improving pollinator community health, soil health, etc.)? This includes goals beyond provisioning of ecosystem services for human utilization such as biodiversity and other objectives.
Landscape Is there sufficient diversity to enable resilience in current and future climate conditions?	Do activities better connect and integrate the site into the larger landscape, if applicable (e.g., wildlife corridors, etc.)?
	Does the project modify existing disturbances to better resemble the reference condition, if appropriate (e.g., protect the site from fires, illegal harvests, etc.)?

Restoration looks different across projects types in the VCM

Along with carbon management, forest restoration projects can set goals to provide a variety of additional ecosystem services such as fiber, food, freshwater, soil retention, nutrient cycling, and others. An emphasis on ecosystem resilience and adaptability to change is key to ensuring that restoration goals will be met in the near-term and persist through time. A biodiverse ecosystem is a resilient and adaptable one. Therefore, biodiversity can be thought of as a key characteristic that underpins many of the ecosystem services aimed for in restoration projects. This analysis examined the barriers and opportunities for biodiverse native-

species ecological restoration projects in the VCM by conducting interviews with expert practitioners spanning project development, finance, and academia. Additionally, a survey of established projects was conducted, using practices that promote biodiversity as a proxy for restoration activities. Restoration attributes manifest differently across the evaluated project types, with varying degrees of impact.

Recovering and enhancing ecosystem services is central to restoration. For this reason, examining how projects positively influence biodiversity is a good proxy for the quality and degree of ecological restoration. This study assessed whether practices to support biodiversity were considered in project design across a wide range of scales from the genetic to the landscape-level (**figure 2**). Across project types, most projects source or encourage



The Yarra Yarra Biodiversity Corridor is a high-impact reforestation project that simultaneously delivers environmental, economic, social, and heritage co-benefits. Mixed species indigenous to the region are grown on degraded land in the northern wheatbelt of Southwest Australia. Revegetating the landscape with native trees and shrubs encourages wildlife to return while removing carbon from the atmosphere at the same time. (Source: Meta)

Category	Pre-project state and anticipated state	Relative changes	
		Carbon	Biodiversity
1. ARR: agroforestry			
2. ARR: diverse native-species reforestation			
3. ARR: commercial plantation (may include exotics)			
4. ARR: mangrove			
5. Wetland and peatland			
6. IFM: conservation and avoided degradation projects *			
7. IFM: structurally complex natural forest management †			
8. IFM: even-aged forest management ‡			

(a)

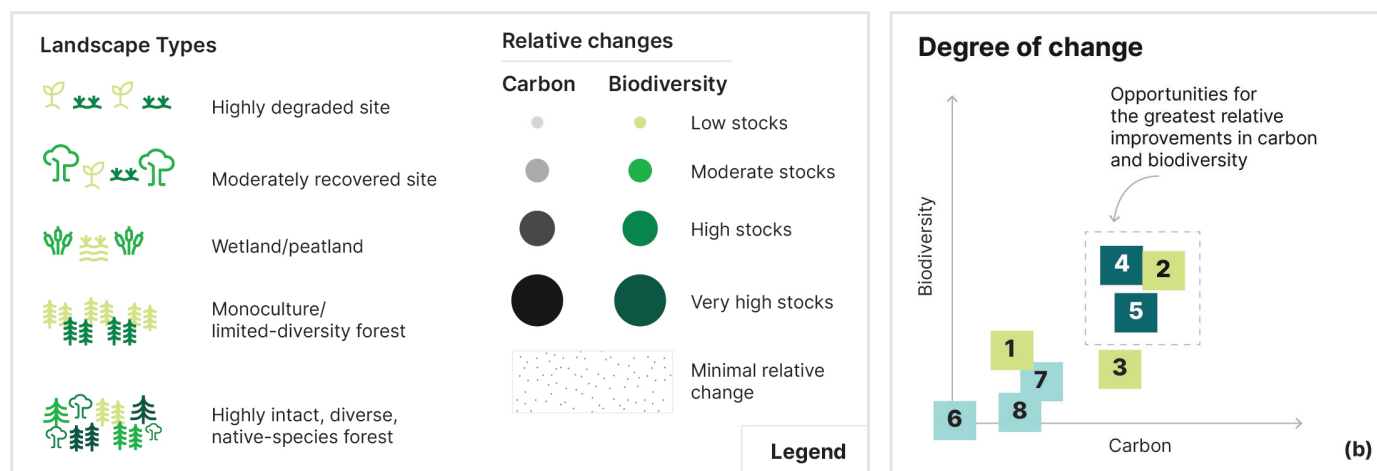


Figure 2. Restoration attributes of projects surveyed on the voluntary carbon market (VCM). The graphic shows activities for different types of projects reviewed in this study, with carbon and biodiversity characteristics. Not all possible project sub-types are shown. For example, a simple, non-diverse forest may be the first step toward development of a more complex ecology. In both China and Europe large areas have progressed in this fashion. Section (a) represents stock changes of carbon and biodiversity within VCM project sub-categories. Sizes of circles indicate approximate average stocks over typical project period, business as usual (pre-project) and anticipated project state. Section (b) depicts trade-offs between carbon sequestration and biodiversity enhancement across project types. Notes: ARR = afforestation, reforestation, and revegetation; IFM = improved forest management. * As referred to in Haya et al. (2023), most VCM credits from IFM projects are from activities that more resemble conservation or avoided degradation than improvements to forest management. † These are IFM projects utilizing approaches such as uneven-aged management with objectives of recovering broad ecosystem values, such as wildlife habitat, provisioning of diverse ecosystem services, and biodiversity. ‡ These are more intensively-managed working forests, which are owned or operated by industrial landowners. They typically utilize even-aged management, contain larger forest management units, and have a greater reliance on reforestation. Figure credit: Carbon Direct 2024. Concept adapted from figure 1 in Tedersoo et al. 2023. Towards a co-crediting for carbon and biodiversity. Original work licensed under CC BY 4.0.

some degree of biodiversity-enhancing practice, including; locally-appropriate genetics, promoting a mix of regionally native and appropriate species, planning to restore native ecosystems, defining goals pertaining to supporting ecosystem functions and biodiversity, mitigating disturbance, and promoting connectivity to the broader landscape. On the other hand, some recommended best-practices for restoration were notably absent from the reviewed projects, such as sourcing climate-adapted seeds or seedlings in anticipation of projected climate scenarios (**table 4**).

Most importantly, less than half of reviewed projects included monitoring for more than carbon. This is partly because monitoring biodiversity is a complex exercise including many metrics, but largely because biodiversity and restoration outcome monitoring is not a requirement of carbon project protocols. When ecosystem restoration activities are identified as part of a project's goals, they are often considered "co-benefits" to the project's primary benefit, which is mitigating greenhouse gas emissions and generating carbon credits. This is a critical example of how better alignment between a project's carbon- and biodiversity-related priorities can improve outcomes for ecological restoration in the VCM.

Overall, project analysis reiterated that features of high-quality restoration, such as the practices described above, are not necessarily associated with high-quality carbon projects.²⁰ Previous work by Carbon Direct found a general scarcity

of high-quality projects in the carbon market and this trend extends to the subset of projects aimed at advancing ecological restoration. Below is a breakdown of the three ecological restoration project types analyzed for this report: (1) ARR, (2) mangrove and wetlands, and (3) IFM.

Afforestation, reforestation, and revegetation

ARR credits come from a range of project-types, including commercial plantation monocultures, multi-species non-commercial plantations, assisted or natural regeneration of forests, and agroforestry projects. ARR projects generally support a greater degree of relative biodiversity and ecosystem service recovery compared to IFM (**figure 2**). However, the majority of reforestation projects in the VCM today are monoculture tree plantations. These projects tend to plant exotic, commercial tree species such as eucalyptus, acacia, or teak.²¹ While some measure of ecosystem recovery can occur with these projects, economic drivers behind carbon, timber, and other forest products align to prioritize single-age, commercial plantings with predictable growth rates. The incentives are typically not set up to encourage a focus on long-term biodiversity recovery, or the enhancement of ecosystem services. In these cases, the promotion of ecosystem services such as carbon sequestration and fiber run counter to promoting biodiversity. On the other hand, it is important to note that reforestation projects generally target plantings in highly degraded sites. At a project's

20. Both restoration and carbon quality were assessed based on a first-order analysis of project materials. Assessments sometimes change under more thorough analysis.

21. In [SOCIALCARBON's report "Seeing the forest from the trees,"](#) the authors found that only 18% of their sample of ARR projects planted 10 or more species. In contrast, 32% of ARR projects planted exclusively exotic species.



A forest of eucalyptus trees grows in Sao Paulo state, Brazil. (Source: Adobe Stock)

outset, these sites provide few ecosystem services and planting any trees can have a profound impact on ecosystem recovery, provided the project is moving the ecosystem closer to its natural state (i.e., reforestation is occurring in an area that was originally forested).

Biodiverse, multi-species forests are more successfully promoted via ARR projects that target uneven-aged native species (such as mangrove projects) or in projects where IFM incorporates mixed native species as part of the forestry management plan. Mixed native-species IFM projects typically maintain biodiversity at higher levels but, given the generally higher functionality of the ecosystem at the start, restoration of these

sites may mean fewer ecological restoration gains. Either project type—ARR or IFM—can be designed to promote biodiversity. However, making this choice in project design can compete with commercial returns, both in terms of forest products and carbon. This is because biodiversity-oriented reforestation is often slower growing, less predictable, and not always optimized for commercially-viable wood products.

Importantly, to contribute to recovery, ecological restoration must lead to the net recovery of natural conditions. Afforestation, or the “process of introducing forest in an area where forest did not formerly exist in the historical past,”²² can lead to the net loss of biodiversity and unique

22. Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, et al. 2019. International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*. 27(S1):S1–S46. [doi:10.1111/rec.13035](https://doi.org/10.1111/rec.13035).

ecosystems if introducing a forest moves the ecosystem further away from its natural state, such as a grassland or wetland. These practices do not align with ecological restoration. However, in practice, distinguishing between afforestation and reforestation or revegetation may be difficult. For example, if an area was used intensively for agriculture over centuries, determining whether forest stood on that land to begin with may be challenging. Further, climate change is altering the historic geographic range of many forest types.²³ Ultimately, any restoration efforts should aim to restore ecosystems to conditions as close as possible to their complex, biodiverse, pre-anthropogenic state.

Mature, exotic monocultures in the form of tree farms (i.e., the end state of many reforestation projects) generally have poor biodiversity outcomes compared to other forest types.²⁴ Additionally, due to the use of fertilizer and pesticides or the planting of water-hungry species, plantations may lead to negative ecological impacts.²⁵ However, reforestation with monoculture commercial plantation forests can still lead to some ecosystem recovery such as improving soil moisture and health, bolstering the economic health of local communities, and providing other benefits—especially on highly degraded sites. When managed sustainably, and integrated into a broader landscape, plantation forestry can help

reduce pressures on natural forests while efficiently meeting demand for harvested wood products. Substituting sustainably-produced timber for carbon-intensive products, such as concrete or steel, can also reduce embodied carbon and expand carbon storage beyond the landscape in built structures and other durable products.²⁶ In terms of ecosystem recovery, commercial plantations may serve as the first stage in successional growth, eventually leading to a more diverse forested system. Carbon projects, by enabling practices that might not be economically feasible without the support of carbon finance, can also nudge such systems toward further ecological restoration.

Agroforestry projects prevail in the context of smaller-parcel land ownership in the Global South. Typically, in these projects, stands and woodlots are planted alongside or intermixed with crops and livestock. Plantings may be species-diverse or they may be monocultures of eucalyptus or pine. Wood from these lots can substitute for material that might otherwise be taken from surrounding forests. In these cases, the project may benefit and enable landscape-level biodiversity even though the project activities do not resemble ecological restoration. Socioeconomic interests drive focus when it comes to recovering specific ecosystem services (**figure 3**). Biodiversity, economic health, livelihoods, and natural resource outcomes are all valid goals for ecological restoration projects.

23. Ren Z, Zhu H, Shi H, Liu X. 2021. Shift of potential natural vegetation against global climate change under historical, current and future scenarios. *The Rangeland Journal*. 43. [doi:10.1071/RJ20092](https://doi.org/10.1071/RJ20092).

24. Kanowski J, Catterall CP, Wardell-Johnson GW. 2005. Consequences of broadscale timber plantations for biodiversity in cleared rainforest landscapes of tropical and subtropical Australia. *Forest Ecology and Management*. 208(1):359–372. [doi:10.1016/j.foreco.2005.01.018](https://doi.org/10.1016/j.foreco.2005.01.018).

25. Yang G, Deng Y, Lan P, Xie L, He T, Su X, Shi X, Chen G. 2022. Estimation of evapotranspiration in Eucalyptus plantation and mixed forests based on air temperature and humidity. *Forest Ecology and Management*. 504:119862. [doi:10.1016/j.foreco.2021.119862](https://doi.org/10.1016/j.foreco.2021.119862).

26. Bukoski JJ, Cook-Patton SC, Melikov C, Ban H, Chen JL, Goldman ED, Harris NL, Potts MD. 2022. Rates and drivers of aboveground carbon accumulation in global monoculture plantation forests. *Nat Commun*. 13(1):4206. [doi:10.1038/s41467-022-31380-7](https://doi.org/10.1038/s41467-022-31380-7).

Encouragingly, the VCM appears to be motivating an increase in ambitious, large-scale native-species reforestation projects. Some examples include Brazil's reforestation projects Re.green (1 million hectares) and Mombak (100,000 hectares), and Pakistan's Delta Blue Carbon mangrove reforestation project (350,000 hectares). Historically, large-scale reforestation has been accomplished by government programs, most notably in China.²⁷ These more recent projects represent some of the largest known private-sector efforts outside of commercial forestry. Provided they meet quality criteria for restoration and carbon, these may represent how the VCM can play a role in furthering ecological restoration. It is unclear whether the VCM has a similar effect on smaller-scale restoration

projects, which face greater financial hurdles. These smaller-scale projects are often led by, or heavily influenced by, local community goals and needs. Generally, they are more likely to deliver the kinds of strong, positive, social impacts that are prioritized by these communities. If the VCM is unable to address these financial hurdles, it runs the risk of repeating previous failures by excluding projects grounded in local context, community priorities, and local leadership.

Mangrove and wetlands

Mangrove and wetland restoration projects²⁸ score strongly in terms of how much recovery they are anticipated to promote and the number of biodiversity-centric practices they integrate.

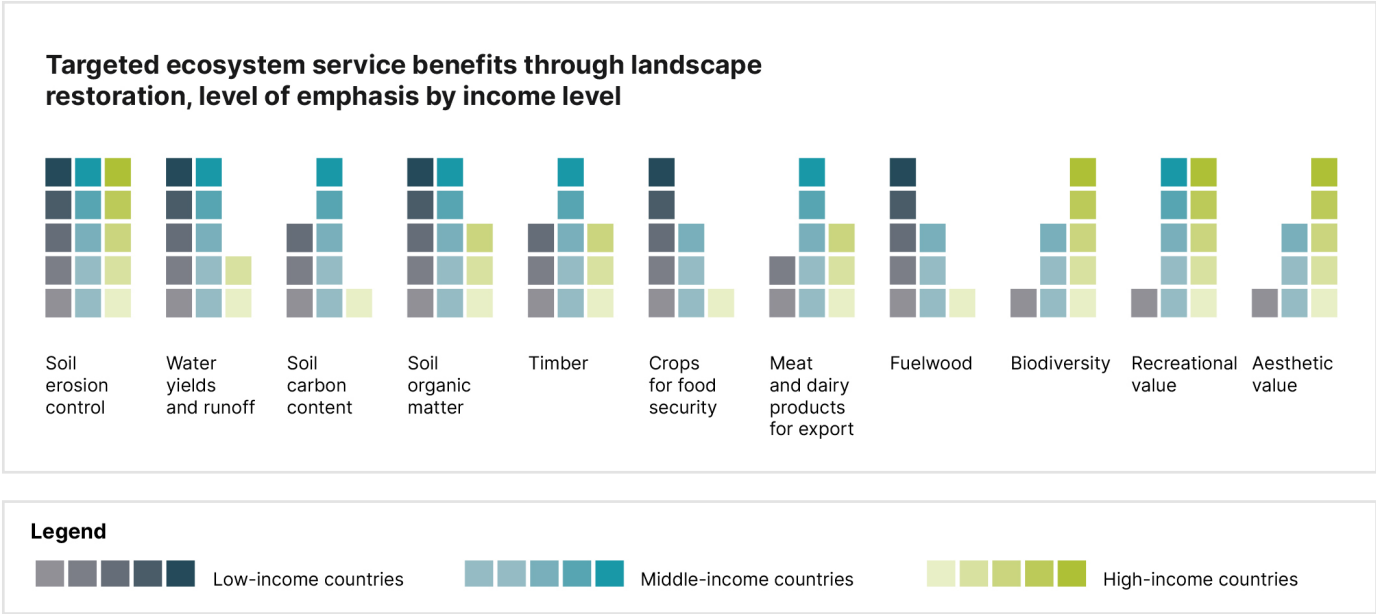


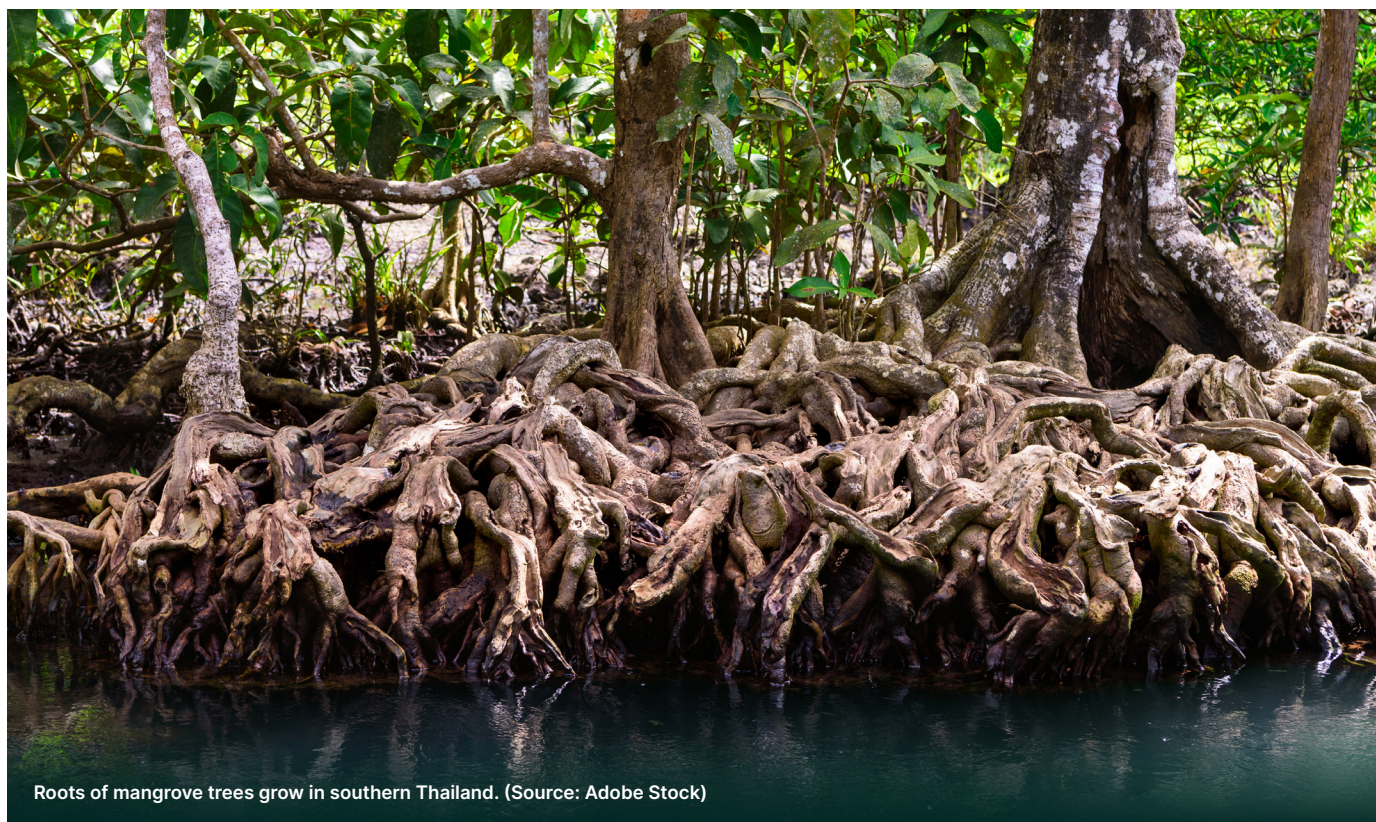
Figure 3. Targeted ecosystem benefits of restoration efforts in low-, middle-, and high-income countries. *Figure credit: Carbon Direct 2024, adapted from figure 3 in Ding et al. 2017. Climate Benefits, Tenure Costs. Original work licensed under CC BY 4.0.*

27. Zhai J, Wang L, Liu Y, Wang C, Mao X. 2023. Assessing the effects of China's Three-North Shelter Forest Program over 40 years. *Science of The Total Environment*. 857:159354. [doi:10.1016/j.scitotenv.2022.159354](https://doi.org/10.1016/j.scitotenv.2022.159354).

28. Some avoided mangrove deforestation projects also include a mangrove restoration component.

This is because they generally restore deforested coastal areas, such as former aquaculture ponds, to an ecosystem approximating a native mangrove forest. They include projects like the Livelihoods Fund mangrove projects in Senegal and Sumatra.²⁹ Less than a dozen mangrove and wetland restoration projects have issued verified credits to date. These projects can fall short of ecological restoration goals if they convert mudflats, focus on tree planting more than tree survival,³⁰ or use only one or two species instead of a species mix that mirrors intact mangrove forests. Mangroves are also uniquely vulnerable to, and provide a valuable adaptation to, rising sea levels. For this reason, it is important that projects have enough space

to accommodate forests moving upslope over time. Other critical elements of mangrove projects include accurate, conservative measurement of soil carbon (important for the integrity of carbon claims) and appropriate community engagement and buy-in. As an added factor, mangroves often straddle boundaries between privately-owned and government-owned land. Thus, land tenure and its intersection with mangrove projects can be complicated, such as when determining who “owns” the carbon and who has the right to transact credits for a given project. Parties disputing these claims can include the landholder, the project developer, Indigenous groups, and the national or subnational government.³¹



29. Mangrove Restoration–Livelihoods Funds. [accessed 2024 Mar 3]. <https://livelihoods.eu/project-type/mangrove-restoration/>.

30. Note that the carbon project context generally enables a focus on tree survival as opposed to massive tree planting initiatives.

31. Watanabe A, Kuwae T, Duarte CM, Kohsaka R, Quevedo JMD, and Nagai H. 2023. Blue Carbon Roadmap: Carbon Captured by the World's Coastal and Ocean Ecosystems (ICEF Innovation Roadmap Project). [accessed 2024 May 10]. https://www.icef.go.jp/wp-content/uploads/2024/02/icef2022_roadmap_Blue_Carbon.pdf.

Improved forest management

IFM projects take place in managed forests and encompass a range of approaches that include lengthening harvest rotations (a practice which stores more carbon by letting trees grow longer before they are harvested), reduced-impact logging, and other practices that increase the productivity of forests while increasing carbon stocks. Some of the projects are on land owned by large corporations, while others occur on lands held by small, private, non-industrial landowners or communally-owned lands (such as those owned by Mexican *ejidos*).³² Many projects involve native species—a common practice in North America, where most IFM projects occur. Planted forests in North America are reportedly 98% native species. In comparison, the opposite is true in South American planted forests, which are composed of majority non-native species.³³

The changes promoted by these projects generally lead to a lower magnitude of ecosystem recovery. That is, the gains to biodiversity and overall ecosystem services are more incremental in IFM projects than in either reforestation or mangrove projects—in part because they typically rely on native species and they occur on already-forested

landscapes with varying, but generally high, levels of ecosystem functionality compared to reforestation project areas.

The analysis done for this report also found that these projects include many biodiversity-oriented practices. While a lower level of ecosystem recovery may seem incongruous with an orientation toward biodiversity practices, these findings are a reflection of the balance between biodiversity and production goals found in IFM projects and the fact that these projects are initiated on already-forested lands. These forests integrate varying degrees of biodiversity conservation practices, along with production goals, to a much higher degree than reforestation projects, although their overall relative biodiversity gains are generally lower.



**of planted North American
forests are composed of
native species.**

32. Mexican projects, particularly under the Climate Action Reserve protocol, tend to have a unique profile that differs from US-based IFM projects.

33. de Jong W, Liu J, Long H. 2021. The forest restoration frontier. *Ambio*. 50(12):2224–2237. [doi:10.1007/s13280-021-01614-x](https://doi.org/10.1007/s13280-021-01614-x).

Barriers to ecological restoration in the voluntary carbon market

Many buyers seek high-quality carbon projects that also result in high-quality ecological restoration. Such projects are challenging to identify. Carbon projects can deliver on ecological restoration goals when incentives and protocol requirements are aligned, and these could potentially demand a price premium. So, why is it difficult to find high-quality, nature-based carbon projects incorporating a greater degree of ecosystem restoration? What is keeping more ecological restoration projects from benefiting from carbon finance in the VCM?

The barriers to effective scaling of ecological restoration in the VCM fall into four primary categories:

- 1. Time and cost**
- 2. Risk and bankability**
- 3. Scale**
- 4. Misaligned priorities**

1. Time and cost

Carbon credit revenues are generally insufficient to fully finance forest carbon projects on their own. Projects require upfront investment and expenditures, while carbon finance generally pays out on delivery of credits. This is especially challenging for project developers. Prioritizing ecosystem restoration outcomes alongside carbon sequestration targets may seem an unaffordable luxury in a purely practical sense. Planting approaches that further support ecosystem restoration—such as a focus on biodiverse native species—extend credit delivery timelines and are typically more expensive to manage than fast-growing, monoculture, plantation forests (**box 2**).

In principle, the outcomes of biodiversity-focused restoration and carbon projects can align. Mixed-species native forests tend to provide more ecosystem services and be more resilient to disturbance than exotic monocultures. Biodiverse plantings can be more productive and are expected to accumulate and store more carbon over time.³⁴ Yet, many commercial forestry companies continue to favor monoculture approaches due

34. Warner E, Cook-Patton SC, Lewis OT, Brown N, Koricheva J, Eisenhauer N, Ferlian O, Gravel D, Hall JS, Jactel H, et al. 2023. Young mixed planted forests store more carbon than monocultures—a meta-analysis. *Frontiers in Forests and Global Change*. 6. [accessed 2024 Jan 8]. <https://www.frontiersin.org/articles/10.3389/ffgc.2023.1226514>.

to well-established silvicultural practices, ease of management, and faster near-term carbon accumulation.³⁵ Most interviewees reported that ecological restoration with biodiverse native species is expensive and logistically difficult and that few resources exist to guide these practices.

This analysis looked at case studies specific to the VCM and found that biodiverse native-species approaches are generally more complex to execute than monoculture plantations. There are several potential reasons for this. Approaches using diverse species increase operational complexity, including in the production of tree seedlings. For example, commercial monoculture seedlings are typically grown from clones in a nursery; these have often been enhanced through decades of genetic trials in specialized breeding programs.³⁶ Once the clonal tree seedlings are produced in nurseries, they are planted at planting sites. Non-commercial plantings—like those needed for biodiverse native-species restoration—require additional, resource-intensive steps to source seeds and produce tree seedlings. These steps generally include mapping of and collection of wild seeds from parent populations, during which individual trees must be visited at specific times when seeds are ready for collection. Once collected, seeds must be stored

and germinated under specialized conditions, sometimes requiring infrastructure like cold-storage rooms.³⁷

Knowledge gaps represent a further barrier and cost for native restoration approaches. Where natural regeneration is not feasible, specialized seed collectors and nursery workers are needed to operationalize seed collection and seedling production. In many regions, forest-sector workers are familiar with implementing monoculture operations but training is needed for multi-species approaches. Thus, training and capacity-building costs are higher when executing restoration-oriented approaches.

Biodiverse native-species plantings were also found (in select case studies by Carbon Direct) to initially sequester carbon more slowly than fast-growing monoculture plantings.³⁸ These differences are especially pronounced in the early stages of a project.³⁹ Approaches that employ passive regeneration can be even slower to establish.⁴⁰ Performing small-scale trials to guide species selection and test the efficacy of proposed planting strategies further extends the project development timeline. The rewards, however, may pay off—over time, species-rich forests and ecosystems generally store more carbon than less diverse

35. Bukoski JJ, Cook-Patton SC, Melikov C, Ban H, Chen JL, Goldman ED, Harris NL, Potts MD. 2022. Rates and drivers of aboveground carbon accumulation in global monoculture plantation forests. *Nat Commun.* 13(1):4206. [doi:10.1038/s41467-022-31380-7](https://doi.org/10.1038/s41467-022-31380-7).

36. Optimized traits include volume gain, stem straightness, and disease resistance.

37. Collecting Native Seed. [accessed 2024 Mar 2]. https://www.fs.usda.gov/wildflowers/Native_Plant_Materials/developing/collecting.shtml.

38. Observations are based on insights from Carbon Direct's deep diligence case studies, which are validated against published datasets.

39. Bukoski JJ, Cook-Patton SC, Melikov C, Ban H, Chen JL, Goldman ED, Harris NL, Potts MD. 2022. Rates and drivers of aboveground carbon accumulation in global monoculture plantation forests. *Nat Commun.* 13(1):4206. [doi:10.1038/s41467-022-31380-7](https://doi.org/10.1038/s41467-022-31380-7).

40. Passive regeneration is a restoration strategy that relies on the natural establishment of species from populations in existing local vegetation (i.e., natural seed banks). Passive restoration is intended to ensure that establishing populations are regionally and climatically appropriate. The approach is most appropriate when the restoration site is co-located with healthy and non-depleted seed banks. Because it relies on the existence of diverse and robust seed banks, it is not always the most appropriate strategy. (Observations on passive regeneration are based on insights from Carbon Direct's deep diligence case studies, which are validated against published datasets.)

environments due to more efficient and complementary use of resources.⁴¹

While fewer data on cost were available in the case studies, in at least one case the biodiverse native-species planting approach was twice as expensive as the alternative scenario in the VCM. Similar cost barriers were identified by other authors. For example, scaling up silviculture using native

species in Brazil has higher capital requirements and longer payback periods.⁴² However, native-species reforestation can be worth the wait. Risk-adjusted returns on the silviculture of native species and agroforestry are comparable to those obtained from commercial plantations of exotic tree species, such as those commonly used in Brazil's forestry sector today, while sensitivity analysis showed a lower market risk.^{43, 44}



41. Bukoski JJ, Cook-Patton SC, Melikov C, Ban H, Chen JL, Goldman ED, Harris NL, Potts MD. 2022. Rates and drivers of aboveground carbon accumulation in global monoculture plantation forests. *Nat Commun.* 13(1):4206. [doi:10.1038/s41467-022-31380-7](https://doi.org/10.1038/s41467-022-31380-7).

42. Batista A, Calmon M, Lund S, Assad L, Pontes C, Biderman R. 2021. Investing in Native Tree Species and Agroforestry Systems in Brazil: An Economic Valuation. WRIPUB. [doi:10.46830/wript.18.00066en](https://doi.org/10.46830/wript.18.00066en).

43. Assessed risk variables included exchange rates, inflation, production volumes, and price volatility.

44. Based on expert knowledge and evaluation of anonymized projects in the VCM.

Box 2. Costs of restoration

The value of restoration is clear⁴⁵ but absolute costs are highly variable. Labor, land, and opportunity costs are significant determinants of restoration project economics. Indicative costs for forest landscape restoration range from US\$2,390–3,450 per hectare (**figure 4**),⁴⁶ though not all literature reports on continual maintenance costs or repeated costs associated with a restoration activity. In terms of costs per tonne of carbon sequestered, one illustrative comparative example can be found in South America where the average cost of reforestation per tonne can range between US\$45–90.^{47, 48}

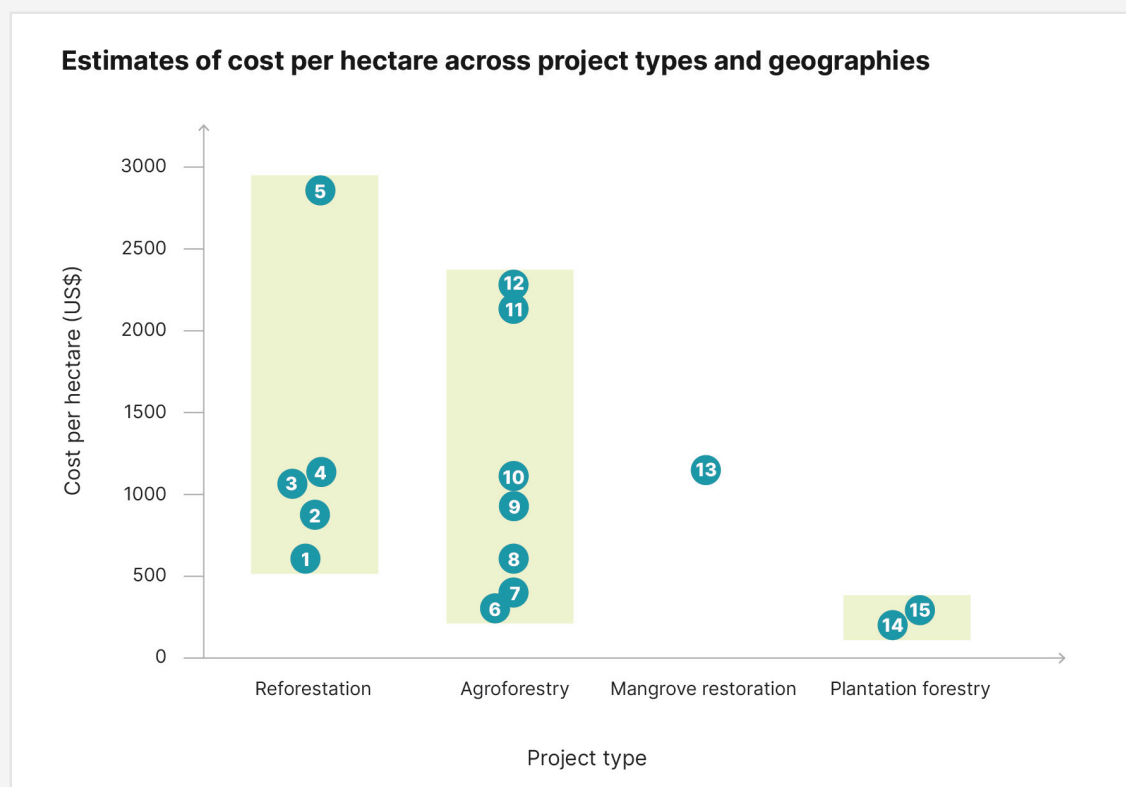


Figure 4. Estimates of cost per hectare (US\$) across project types and geographies (excludes annual maintenance costs per hectare).
Figure Notes: [1] Brazil. Source: Nunes et al. (2017). [2] Costa Rica. Source: Gómez and Reiche (1996). [3] Colombia. Source: CONIF (2012). [4] Chile. Sources CONAF (2011). [5] Brazil. Source: Brancalion et al. (2012). [6] Uganda. Source: MWE and IUCN (2016). [7] Malawi. Source: Republic of Malawi (2017). [8] Kenya. Source: Swinkels and Franzel (1997). [9] Costa Rica. Source: Gómez and Reiche (1996). [10] Ecuador. Source: Ramírez (2005). [11] Brazil. Source: Gama (2003). [12] Costa Rica. Gómez and Reiche (1996). [13] Global. Source: Su et al. (2021). [14] Madagascar. Source: Halloway et al. (2009). [15] Malawi. Source: Republic of Malawi (2017). Figure credit: Carbon Direct 2024, created using data from Ding et al. 2017. *Climate Benefits, Tenure Costs*. Original work licensed under CC BY 4.0.

45. Ding H, Faruqi S, Wu A, Altamirano JC, Ortega AA, Verdone M, Cristales RZ, Chazdon R, Vergara W. 2017. *Roots of Prosperity: The Economics and Finance of Restoring Land*. World Resources Institute. [accessed 2024 Mar 02]. https://files.wri.org/d8/s3fs-public/roots-of-prosperity_0.pdf.

46. The Economics of Ecosystems and Biodiversity (TEEB) for National and International Policy Makers. 2009. *The Economics of Ecosystems and Biodiversity—an Interim Report*. Brussels: European Commission. [accessed 2024 Mar 02]. https://wedocs.unep.org/bitstream/handle/20.500.11822/26490/TEEB_National_International.pdf?sequence=1&isAllowed=y.

47. Franklin Jr. SL, Pindyck RS. 2024. A Supply Curve for Forest-Based CO₂ Removal. [accessed 2024 April 19]. https://www.nber.org/system/files/working_papers/w32207/w32207.pdf.

48. This is in line with the US government's current valuation of the social cost of carbon (US\$51/tonne) but some research indicates that, to fully account for costs to society, this number should be much higher. The US Environmental Protection Agency has proposed raising it to US\$190/tonne. Buyers should carefully consider how they value carbon, the impacts that project funds will have on local communities, and how those funds will be equitably distributed.

2. Risk and bankability

Related to questions of time and cost are those around risk and bankability. The risk profile of restoration projects is increased by the unpredictability of project outcomes. This, coupled with a myriad of context-specific potential restoration approaches, makes predictable delivery a major barrier to project financing. The upfront financing required and the higher failure rates associated with restoration projects diminish their bankability and attractiveness to credit buyers seeking stable investments.

Project financiers favor faster carbon sequestration (e.g., from monoculture plantations) because fast sequestration yields faster returns in the form of saleable carbon credits.^{49,50} In addition to generating credits more quickly, well-understood commercial forestry approaches are perceived as being less risky investments overall.⁵¹ Factors contributing to this perception may include more established counterparties, experienced forest managers with equipment and staff, vetted and reliable methods, well-characterized value chains, and clear opportunities for additional revenue streams from forest products. This perception influences how projects are proposed, financed, and scaled.

Efforts to scale up biodiverse native-species projects are hampered by significant financial barriers.⁵² High capital costs, high-risk contexts (such as land tenure and local policy constraints), and long payback periods create hurdles to securing finance for these types of projects, which often require large initial investments with delayed and uncertain returns. This uncertainty is compounded by gaps in understanding of how restoration interventions can lead to carbon sequestration and of the challenges involved in quantifying biodiversity benefits.⁵³ Restoration projects are perceived as being complex to execute and economically risky.⁵⁴ There is also a notable discrepancy between the longer time horizons of restoration projects and the shorter-term perspectives of investors.

Project execution risk is significant, reflecting the inexperience of many project developers and the uncertainty surrounding their business models. Many projects fail to meet their predefined objectives. A comprehensive survey of 240 studies across various aquatic and terrestrial restoration projects found that while 35% documented complete recovery within 10–40 years, the remainder showed mixed results (35%) or no recovery at all (30%).⁵⁵ Additionally, historical data on coastal restoration projects report average failure rates that vary significantly by ecosystem—

49. Löfqvist S, Garrett RD, Ghazoul J. 2023. Incentives and barriers to private finance for forest and landscape restoration. *Nat Ecol Evol.* 7(5):707–715. [doi:10.1038/s41559-023-02037-5](https://doi.org/10.1038/s41559-023-02037-5).

50. Financing Nature: Closing the Global Biodiversity Financing Gap. Paulson Institute. [accessed 2024 Jan 8]. <https://www.paulsoninstitute.org/conservation/financing-nature-report/>.

51. Löfqvist S, et al. 2023. Incentives and barriers.

52. Bayraktarov E, Saunders MI, Abdullah S, Mills M, Beher J, Possingham HP, Mumby PJ, Lovelock CE. 2016. The cost and feasibility of marine coastal restoration. *Ecological Applications.* 26(4):1055–1074. [doi:10.1890/15-1077](https://doi.org/10.1890/15-1077).

53. Löfqvist S, et al. 2023. Incentives and barriers.

54. There are some corporate risk frameworks in place, which project developers may use to better understand how corporate entities are prioritizing and investing in nature. One example is the Taskforce on Nature-related Financial Disclosures (<https://tnfd.global/>).

55. Jones HP, Schmitz OJ. 2009. Rapid Recovery of Damaged Ecosystems. *PLOS ONE.* 4(5):e5653. [doi:10.1371/journal.pone.0005653](https://doi.org/10.1371/journal.pone.0005653).

35%

of aquatic and terrestrial restoration projects documented complete recovery within 10–40 years.

seagrass at 62%, while saltmarshes and corals have seen lower failure rates of 36%.⁵⁶ These statistics underscore the challenges projects face, which may include growing wood and fiber species that currently have underdeveloped markets compared to more established commodities like eucalyptus and pine. Current contractual practices in the industry, such as offtake agreements that defer payment until delivery of credits, place the burden of production risk on project developers.

In many places, the costs associated with executing restoration projects (**box 2**) are higher than those for a carbon credit project that is not prioritizing restoration. This impacts the pricing required for credits generated from such projects and means many restoration projects are economically unfeasible unless they enter new markets or receive subsidies. Landowners can still be hesitant to

make such multi-decadal commitments with their land in the face of a seemingly nascent and volatile carbon market. Project developers face challenging up-front time and resource demands before contracts with landowners are even finalized.

3. Scale

Ecological restoration that prioritizes biodiverse native-species plantings is highly site-specific. This means that projects are often approached as hyper-local units where each one requires a unique plan and approach, complicating the potential to achieve economies of scale or models for large-scale financing and implementation.⁵⁷

For example, scaling of seed supply is a critical supply chain bottleneck. For projects involving tree planting or direct seeding, appropriate infrastructure and seed supply systems are essential.⁵⁸ Obtaining climate-adapted seeds and planting stock for target species, from appropriate native sources and in the necessary quantities, is often challenging.⁵⁹

There are large-scale projects coming online in areas like the Brazilian Amazon and Atlantic Forest that are redefining the possibilities for restoration at large scales. However, projects of this scale and ambition remain the exception rather than the rule.

56. Duarte CM, Agusti S, Barbier E, Britten GL, Castilla JC, Gattuso J-P, Fulweiler RW, Hughes TP, Knowlton N, Lovelock CE, et al. 2020. Rebuilding marine life. *Nature*. 580(7801):39–51. [doi:10.1038/s41586-020-2146-7](https://doi.org/10.1038/s41586-020-2146-7).

57. Gann GD, McDonald T, Walder B, Aronson J, Nelson CR, Jonson J, Hallett JG, Eisenberg C, Guariguata MR, Liu J, et al. 2019. International principles and standards for the practice of ecological restoration. Second edition. *Restoration Ecology*. 27(S1):S1–S46. [doi:10.1111/rec.13035](https://doi.org/10.1111/rec.13035).

58. Di Sacco A, Hardwick KA, Blakesley D, Brancalion PHS, Breman E, Cecilio Rebola L, Chomba S, Dixon K, Elliott S, Ruyonga G, et al. 2021. Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. *Global Change Biology*. 27(7):1328–1348. [doi:10.1111/gcb.15498](https://doi.org/10.1111/gcb.15498).

59. Di Sacco A, et al. 2021. Ten golden rules for reforestation.

Challenges for smaller projects seeking to enter the carbon market are numerous. Transaction costs are high for nature-based carbon projects, which may preclude smallholder engagement.

Scale challenges apply at the organizational level too. Small restoration organizations are struggling to leverage the carbon market because of knowledge gaps, lack of organizational and financial capacity, and other reasons (**box 3**). The majority of restoration implementation and facilitation organizations do not have in-house carbon expertise and hire external experts to conduct feasibility studies and carbon project development. Feasibility studies, which can cost tens of thousands of dollars, lay the groundwork for the selection of an appropriate accounting methodology and help with conceptual project planning. Project development (including the initial development of the Project Design Document, validation, and verification can cost hundreds of thousands of dollars and some types of carbon projects (e.g., ARR) may not generate saleable credits for five or more years after the project initiation.

Legal complexities,⁶⁰ the non-bankability of contracts (even with offtake agreements),⁶¹ high up-front costs,⁶² risky project locations,⁶³ and lengthy payback periods^{64, 65, 66} serve as further deterrents for organizations considering carbon market projects.⁶⁷ Uncertainties in navigating changing regulations and variable buyer demand for credits, which may not materialize in significant quantities for a decade or more when many corporate net zero targets come into effect, further exacerbate perceived risks.

One solution available within select carbon credit registries are “grouped” project approaches, where additional landowners and project areas can be enrolled over time. Since ecological restoration occurs at many different spatial scales (from enhancing genetic flow to modifying ecosystem disturbances), grouped projects represent an opportunity to better coordinate restoration approaches across a larger spatial area, even if this approach adds to overall project costs and complexity.

60. Ding H, Faruqi S, Wu A, Altamirano JC, Ortega AA, Verdone M, Cristales RZ, Chazdon R, Vergara W. 2017. Roots of Prosperity: The Economics and Finance of Restoring Land. World Resources Institute. [accessed 2024 Mar 02]. https://files.wri.org/d8/s3fs-public/roots-of-prosperity_0.pdf.

61. Ding H, et al. 2017. Roots of Prosperity.

62. Financing Nature: Closing the Global Biodiversity Financing Gap. Paulson Institute. [accessed 2024 Jan 8]. <https://www.paulsoninstitute.org/conservation/financing-nature-report/>.

63. Ding H, Veit PG, Blackman A, Gray E, Reyta K, Altamirano JC, Hodgdon B. Climate Benefits, Tenure Costs: The Economic Case for Securing Indigenous Land Rights in the Amazon. World Resources Institute. [accessed 2024 Mar 02]. https://files.wri.org/d8/s3fs-public/Climate_Benefits_Tenure_Costs.pdf.

64. Löfqvist S, Garrett RD, Ghazoul J. 2023. Incentives and barriers to private finance for forest and landscape restoration. *Nat Ecol Evol*. 7(5):707–715. doi:10.1038/s41559-023-02037-5.

65. Ding H, et al. 2017. Roots of Prosperity.

66. Liagre L. 2015. Sustainable financing for forest and landscape restoration: opportunities, challenges and the way forward. Rome: United National Convention to Combat Desertification : Food and Agriculture Organization of the United Nations. <https://openknowledge.fao.org/items/acf03229-6853-45d6-9be9-f9f7877d39d2>.

67. Stances toward carbon offsets due to concerns about misuse of credits and moral hazard may also play a role in some organizations deciding not to pursue credit generation.

Box 3. Mangrove Action Project

Multiple interviewees cited Mangrove Action Project⁶⁸ as an example of an organization conducting high-quality restoration projects but not enrolling in the voluntary carbon market. Mangrove Action Project's 14-person team supports community-based environmental education and mangrove restoration projects across the pan-tropics. These projects employ site-specific regeneration to restore the ecology of degraded sites. Most sites are small (about 100 hectares), and natural regeneration is used extensively. The small scale of this work relative to the thousands of hectares preferred for carbon projects, as well as limitations placed on offerings for funding that focus on things like paying per seedling but not necessary for environmental education, local livelihoods, and long-term monitoring, have reportedly made carbon finance unattractive.



Fish and jellyfish swim among mangrove roots in the Caribbean. (Source: Adobe Stock)

68. Mangrove Action Project. [accessed 2024 Jan 8]. <https://mangroveactionproject.org/>.

4. Misaligned priorities

Carbon projects and restoration projects can have misaligned priorities. Ecological restoration is multifaceted and involves balancing the priorities of nature and people within a landscape, whereas the carbon market is primarily structured to reward carbon sequestration.

While there are areas of productive overlap between carbon and restoration (i.e., high-quality projects of both types are defined by high community engagement and long-term monitoring), the carbon market generally treats carbon outcomes as primary, with restoration viewed as a “co-benefit” that may provide a price premium. This prioritization of carbon leads to different outcomes than if carbon outcomes were balanced more holistically with other goals. For example, bamboo sequesters carbon rapidly and therefore risks being used for landscape or riparian restoration when a mix of other native species are likely more appropriate. In another example, second-growth tropical forests have the potential to remove very large amounts of carbon from the atmosphere⁶⁹ while restoring biodiversity and ecosystem function across vast areas.⁷⁰ However, on average, about 50% of naturally regenerating, tropical forests are cleared again after only 10 years of growth.⁷¹ This has led to the concept of “Peter Pan” forests (forests that never grow old). For these forests, their full carbon

sequestration and ecological restoration potential is never realized.⁷² The current methodological architecture of the VCM does not provide an avenue for generating carbon credits from activities that protect, manage, and extend the life of these forests. For land to be eligible for an ARR project, it must have almost zero carbon stocks at the beginning of the project. This requirement automatically disqualifies areas that are already undergoing early natural regeneration. Conversely, REDD+ methodologies require project areas to be forested for 10 years before the start of a project. This also disqualifies areas with early-stage, natural regeneration.

The particularities of the carbon market can also produce less-than-ideal outcomes. For example, carbon developers and buyers tend to prefer active restoration over passive restoration, perhaps because it is easier to build a narrative around “doing something.” However, passive regeneration can be a preferred approach for restoration projects, depending on initial site conditions. The preferences and logistical constraints of the carbon market can also narrow the perception of what is feasible. For the VCM, a project that is planting more than 12 species is considered species-diverse and there are no built-in incentives for planting a greater number of species, even though in some tropical forests it is possible to find more than 300 species of trees

69. Chazdon RL, Broadbent EN, Rozendaal DMA, Bongers F, Zambrano AMA, Aide TM, Balvanera P, Becknell JM, Boukili V, Brancalion PHS, et al. 2016. Carbon sequestration potential of second-growth forest regeneration in the Latin American tropics. *Science Advances*. 2(5):e1501639. [doi:10.1126/sciadv.1501639](https://doi.org/10.1126/sciadv.1501639).

70. Rozendaal DMA, Bongers F, Aide TM, Alvarez-Dávila E, Ascarrunz N, Balvanera P, Becknell JM, Bentos TV, Brancalion PHS, Cabral GAL, et al. 2019. Biodiversity recovery of Neotropical secondary forests. *Science Advances*. 5(3):eaau3114. [doi:10.1126/sciadv.aau3114](https://doi.org/10.1126/sciadv.aau3114).

71. Nunes S, Oliveira L, Siqueira J, Morton DC, Souza CM. 2020. Unmasking secondary vegetation dynamics in the Brazilian Amazon. *Environ Res Lett*. 15(3):034057. [doi:10.1088/1748-9326/ab76db](https://doi.org/10.1088/1748-9326/ab76db).

72. Swinfield T, Brancalion P, Balmford A, Wheeler C, Strassburg B. 2023. Carbon credits and the “Peter Pan” forests. [doi:10.33774/coe-2023-r06gw](https://doi.org/10.33774/coe-2023-r06gw). [accessed 2024 Apr 11]. <https://www.cambridge.org/engage/coe/article-details/6555f7302c3c11ed7182707b>.

per hectare.⁷³ Misalignment between the aperture of restoration and carbon projects can pose a problem. Quality restoration tends to target ecosystem services writ large and privileges outcomes that address the intersection of people and landscapes through sustainable livelihoods, agriculture, and conservation. Most restoration organizations do a lot of work that goes beyond simply planting trees (**box 4**). Carbon market projects, by design, have a narrower aperture of focus: greenhouse gas mitigation via carbon credits.

Attempting to isolate discrete benefits of an ecological restoration project into monetizable tokens can create issues. Often these benefits are fundamentally integrated with one another and difficult to differentiate. For example, efforts to distinctly monetize benefits from carbon, biodiversity, water, or other ecosystem services and tie them to stacked financing streams can be difficult. Disentangling what qualifies as truly additional can be thorny and may inadvertently perpetuate the prioritization of carbon over other local environmental and social outcomes in carbon project design.

Finally, the labels that advertise restoration attributes within carbon projects may fail to capture restoration quality. Qualitative descriptions of how projects advance Sustainable Development Goals (SDGs) or achieve Climate, Community and Biodiversity

Standard (CCB Standard) verification are the most frequent signifiers relating to biodiversity outcomes. These approaches have limitations. SDG checkboxes, for example, risk flattening the complex sociocultural and environmental context of a project to a series of weakly contextualized metrics. This analysis also finds that CCB projects do not necessarily rate more strongly on a blended biodiversity indicator compared to non-CCB projects. This may relate to the relatively small sample size of registered projects or to other factors, like insufficient monitoring, reporting, and verification (MRV) of biodiversity indices under the Standard or lack of financial incentive for high-biodiversity projects to pursue CCB certification due to the extra costs involved. Verra's recently released Sustainable Development Verified Impact Standard (SD VISta) Program Nature Framework is intended to address some of these gaps and provide more structured frameworks for approaching biodiversity-oriented projects.⁷⁴ Similarly, Plan Vivo is launching a biodiversity standard and the Ecosystem Restoration Standard seeks to develop a label indicating restoration quality, agnostic of carbon registry or protocol.^{75, 76} These nascent protocols and related projects are too early-stage for deep analysis but are an encouraging sign that projects and buyers may soon have more options for sharing and prioritizing restoration goals.

73. Jiménez JU, Fábrega J, Mora D, Tejedor N, Sánchez M. 2020. Composition, Diversity, and Tree Structure of a Tropical Moist Forest in Gamboa, Colon, Panama. *aswr*. 9(1). doi:10.1177/ASWR.S33960. [accessed 2024 Jan 8]. <https://bioone.org/journals/air-soil-and-water-research/volume-9/issue-1/ASWR.S33960/Composition-Diversity-and-Tree-Structure-of-a-Tropical-Moist-Forest/10.1177/ASWR.S33960.full>.

74. Call for Projects to Pilot SD VISta Nature Framework and Biodiversity Methodology. 2023 Jul 5. Verra. [accessed 2024 Mar 14]. <https://verra.org/call-for-projects-to-pilot-sd-vista-nature-framework-and-biodiversity-methodology/>.

75. Plan Vivo launch pioneering Biodiversity Standard. 2023 Dec 6. Plan Vivo Foundation. [accessed 2024 Mar 14]. <https://www.planvivo.org/news/plan-vivo-launch-biodiversity-standard>.

76. Ecosystem Restoration Standard (ERS). [accessed 2024 Jan 8]. <https://www.ers.org/>.

Unlocking ecological restoration projects in the voluntary carbon market



Seen from above, a river winds through a lush landscape. (Source: Adobe Stock)

There are actionable opportunities to unlock quality and credibility for both carbon and biodiverse native-species restoration in the VCM. Buyers of credits can play a particularly catalytic role in driving more holistic outcomes across both nature and carbon.

The barriers to ecological restoration identified in this report suggest cross-cutting opportunities to enable more effective restoration within the VCM. Key actors include buyers, project developers, standard-setters, policy-makers, and investors. The opportunities fall into five primary areas, which are detailed further below ([table 5](#)).

Table 5. Actors and opportunities for unlocking more ecological restoration projects in the voluntary carbon market

	Corporate buyers	Standard setters	Project implementers	Investors	Community stakeholders	Governments and regulators
1. Signal clear buyer demand for restoration projects	✓			✓		
2. Mix restoration-oriented and traditional approaches in innovative project design		✓	✓	✓	✓	
3. Build the “missing middle” between local implementers and international buyers	✓	✓			✓	✓
4. Adapt rules that govern carbon projects to promote more restoration		✓				✓
5. Use de-risking tools such as blended finance vehicles	✓			✓		

1. Signal clear buyer demand for restoration projects

Buyers are the strongest force within the VCM today. If more buyers prioritize restoration outcomes, projects will evolve in this direction. Buyers can signal demand by considering the recommendations listed below and detailed in **box 4**:

- **Commit to purchasing a certain percentage of restoration-oriented carbon credits** in service of global restoration goals such as the Bonn Challenge or the Global Biodiversity Framework’s 30×30 goals. For example, a buyer could commit

to sourcing a certain percentage of land area (e.g., 30% to meet 30×30 targets) in its carbon credit portfolio from high-quality, restoration-oriented projects. Buyers can additionally consider setting goals around biodiversity with clearly publicized specific, measurable, accepted, realistic, and time-bound (SMART) targets to clearly signal to project developers what their preferences are. Demand signals can be particularly impactful given the voluntary nature of the VCM.

- **Signal support for carbon projects with strong non-carbon benefits and public commitments, especially by being willing to wait longer or**

pay a premium. Nurturing healthy forests takes time, work, and risk. It involves more than just promoting carbon sequestration. Strong projects are neither cheap nor plentiful. Buyers considering 2030 or 2035 goals that incorporate both restoration and carbon could consider entering into offtake agreements now to help these projects get off the ground.

- Buyers with a connection to a specific landscape, for example, can explore supporting early-stage restoration activities in that area. They may also consider signaling long-term commitments in ways that allow for project developers to build for demand; buyers can create strong signals through public commitments on project profiles, quality criteria, credit volumes, price, and period of commitment.

- **Signal commitment by joining like-minded buyer's coalitions.** A coordinated buyer signal helps enable scale-up of projects, and encourages peer-to-peer learning. Initiatives like the Business Alliance to Scale Climate Solutions provide a foundation for this sort of work.⁷⁷ Where appropriate, buyers can also consider new, tailor-made approaches like shared commitments or pooled investment approaches, or coordinate their advocacy and communications strategies to support organizations that are at an earlier stage in their sustainability journey.



Carbon markets don't differentiate between biomass as sequestered in monoculture plantations or native ecosystems. From a climate perspective... that doesn't matter... carbon is carbon. From an ecological perspective, it's obviously very different.

—Interviewee (anonymous)

77. Business Alliance to Scale Climate Solutions | Collaborations | Sustainable Business Network and Consultancy | BSR. [accessed 2024 Jan 8]. <https://www.bsr.org/en/collaboration/groups/business-alliance-to-scale-climate-solutions>.

Box 4. Rules of thumb for seeking out ecological restoration projects

Seek out credits that are high-quality and suitable to the claims your organization wishes to make.⁷⁸ Look for credits that promote restoration or other goals. Preferences and contexts for restoration differ, but these rules of thumb serve as a potential jumping-off point. Many of these recommendations are adapted from Di Sacco, et al. (2021).⁷⁹

1. Take time and effort to understand project activities and project context. Ecological restoration lacks a common currency. To understand what constitutes ecological restoration at a specific site may take research and diligence. This includes understanding what is degrading the site, the characteristics of the target ecosystem, and what steps are appropriate to recover the ecosystem.
2. Find out if the project drives additional restoration beyond what would have occurred in a business-as-usual context (e.g., analogous to the concept of additionality in a carbon project). High-quality restoration projects should be able to demonstrate planned activities that are essential to the recovery of the ecosystem and that cannot occur without funding. Projects should also monitor outcomes to understand how they are performing and how to adapt to meet new challenges.
3. Focus on biodiversity. Biodiversity underpins many other ecosystem services. Within restoration projects, protect and foster extant ecosystems and islands of biodiversity where they occur. Do not deforest an area for the sake of easier restoration. Only plant trees where trees were previously part of the natural ecosystem.
4. Show preference for biodiverse native-species forests over other forest types, such as monocultures and exotics. Where planting occurs, seek out projects with plant material that is genetically appropriate to the site and to future conditions.
5. Prioritize community-based restoration. Ensure that projects serve communities and community livelihoods. Show preference for projects where a high proportion of benefits (in terms of project profits, jobs, and the benefits of ecosystem services) are going back to a broad swath of local people. In some contexts it may take significant stakeholder participation to understand community perceptions, needs, and motivations, and to motivate local action at the project level.
6. Remain open to projects that create conditions for natural regrowth in appropriate locations, not just those that are actively planting. The scale of needed restoration is vast and limited resources may be more effective when relying on natural processes as much as possible.

78. There are divergent perspectives among registries, guidance bodies, ratings agencies, and others on what constitutes a high-quality project and each may employ different weighting and value systems. That does not mean that all perspectives are equally robust.

79. Di Sacco A, Hardwick KA, Blakesley D, Brancalion PHS, Breman E, Cecilio Rebola L, Chomba S, Dixon K, Elliott S, Ruyonga G, et al. 2021. Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. *Global Change Biology*. 27(7):1328–1348. [doi:10.1111/gcb.15498](https://doi.org/10.1111/gcb.15498).

2. Mix restoration-oriented and traditional approaches in innovative project designs

Ecological restoration is dynamic and manifests differently across different geographic and temporal contexts. For example, a high-quality restoration project can mix passive and active restoration methods and involve thinning or harvest of trees at a later phase. The appropriateness of practices is dependent on context. Landscapes feature a dynamic mosaic of land uses. Restoration and production can be spatially separate but exist alongside each other, such as when concentrated production areas are interspersed with conservation or restoration areas. This is becoming increasingly common. Areas of commercial forestry may occur alongside regrowth of native forests and preservation of existing forests. Restoration and production can also spatially coexist. This occurs when forestry practices include more safeguards and practices aimed at maximizing biodiversity and ecosystem function. Mixing commercial plantation and non-commercial restoration is not only helpful for enabling more affordable restoration, but can also boost productivity in harvested areas.⁸⁰

- Commercial forestry operators generating ARR credits could **commit to a minimum percentage of the project area being planted as biodiverse native-species forest** and to using Forest Stewardship Council (FSC) certification (as FSC ensures a broader range of key criteria

such as an adherence to local law, stakeholder consultation, etc.). Buyers can similarly signal a demand for this type of practice and build assurances of maintaining that minimum percentage into offtake contracts.

- **Prioritize projects that have “uncredited carbon or biodiversity benefits”** that go beyond business-as-usual practices (e.g., protection of at-risk riparian forest outside of the main project area). To identify these candidate projects, buyers can cross-reference projects with biodiversity credit initiatives or look for typical hallmarks of restoration projects, such as biodiverse planting plans. To ensure beneficial outcomes, buyers should look for ways to incentivize monitoring of these uncredited benefits through, for example, contracting and price premiums. Monitoring for benefits beyond carbon is not always in place, even when those benefits are a project target.

3. Build the “missing middle” between local implementers and international buyers

Small and local implementers experience a mismatch between their scale and the expectations of the carbon market. Platforms, accelerators, advisors, and other actors in the VCM can help implementers understand and harness carbon market opportunities. These opportunities can take the form of initiatives like The Nature Conservancy’s

80. Zemp DC, Guerrero-Ramirez N, Brambach F, Darras K, Grass I, Potapov A, Röhl A, Arimond I, Ballauff J, Behling H, et al. 2023. Tree islands enhance biodiversity and functioning in oil palm landscapes. *Nature*. 618(7964):316–321. [doi:10.1038/s41586-023-06086-5](https://doi.org/10.1038/s41586-023-06086-5).



Integrating restoration with other activities may be a generally promising approach. Because then you don't need restoration to solve all of the challenges.

—Interviewee (anonymous)

Africa Forest Carbon Catalyst,⁸¹ World Wildlife Fund's Nature-Based Solutions Origination Platform,⁸² or the World Resources Institute's Global Restoration Initiative.⁸³ Sufficient experience in carbon asset development should be embedded within such efforts if they are aiming to bring carbon credits to market.

Catalytic initiatives should exist at multiple points within the VCM. For example, registries and guidance bodies could have philanthropy-backed efforts to identify barriers and facilitate access for grassroots restoration organizations. Other organizations could support implementer-to-implementer networks that build capacity and allow for lateral sharing of best practices.⁸⁴ Meanwhile, buyers should also be prepared to invest in working with less commercially-sophisticated providers.

- **Raise the profile of platforms and research institutions that support implementers and carbon markets.** Organizations like World Wildlife Fund, or the World Resources Institute, with expertise in forests, biological diversity, agroforestry, climate-smart agriculture, and sustainable livelihoods, among others, can be invaluable in supporting projects. Institutions or platforms like these can provide information, education, capacity-building, hand-holding through the carbon credit process, administrative support (e.g., best practices in accounting), peer-to-peer learning (including via funding “champions” who are existing implementers), or other functions for local implementers. These platforms can also serve as coordinators to link to governments and international buyers, helping further ensure enabling conditions.

81. Africa Forest Carbon Catalyst | The Nature Conservancy. [accessed 2024 Jan 8]. <https://www.nature.org/en-us/about-us/where-we-work/africa/forest-carbon-catalyst/>.

82. Nature-Based Solutions Origination Platform | Projects | WWF. [accessed 2024 Jan 8]. <https://www.worldwildlife.org/projects/nature-based-solutions-origination-platform>.

83. Global Restoration Initiative | World Resources Institute. [accessed 2024 Jan 8]. <https://www.wri.org/initiatives/global-restoration-initiative>.

84. One example is the Environmental Leader Training Institute at Yale University (<https://elti.yale.edu/>).



A good restoration project is able to respond or adapt to the ecosystem and its needs and this might not conform very well to outcome oriented financing frameworks.

—Interviewee (anonymous)

- **Pay attention to policy.** Buyers should look for opportunities that go beyond carbon credits where they have the latitude to do so, for example by removing damaging agricultural subsidies or supporting legal tenure for local communities. Although these policy initiatives might not directly result in carbon credits, they can have outsized impacts.
- **Prioritize measurable outcomes.** One of the biggest challenges for corporate buyers and projects is measuring and reporting against their ecosystem restoration goals.⁸⁵ Prioritize measurable outcomes when engaging with early-stage project implementation. Ensuring that these opportunities and their impacts are measurable and can be reported against will improve uptake of projects into the VCM, and enable buyers to signal compliance with voluntary commitments. Buyers can help ensure this requirement with clear signaling and early contracting.
- **Build internal capacities for assessing restoration quality or contract with trusted third-party advisors.** Restoration is complex and difficult to evaluate, especially given the potentially long timelines for implementation. Buyers can learn to read project documents with a critical eye. It is important to understand what form claimed restoration takes, whether the project developer provides credible benefits for local people and environments, and whether project benefits align with buyer goals and with the goals of local communities, non-governmental organizations, and academics. Buyers should consider investing in in-house expertise or external third-party advisory to meet these goals.

85. Lamont T, et al. 2023. Hold big business to task on ecosystem restoration. Science. 381,1053-1055(2023). [doi: 10.1126/science.adh2610](https://doi.org/10.1126/science.adh2610).

4. Adapt rules that govern carbon projects to promote more restoration

One challenge that buyers in the VCM currently face is the lack of widely-accepted labels or standards signaling how projects promote biodiverse native-species restoration or biodiversity generally. Overarching guidance, unassociated with a registry or protocol, that defines best-practices and principles of quality for dual promotion of carbon and biodiversity attributes in projects is needed. For tactical implementation, one solution would be a protocol and label that is not tied to a carbon registry and indicates biodiversity benefits.

The complexity that has evolved in the VCM, in part to help provide assurances of quality, has raised barriers to entry for small-scale projects and those that involve many smallholders. Protocols should be cognizant of scale barriers at all levels (e.g., cut-offs of landowner size, cut-offs of project size) that inadvertently privilege projects of a certain profile. Current efforts to fast-track robust, digital MRV for carbon outcomes has the potential to streamline elements of the MRV process.

Registries can also support buyer priorities by enabling clearer labeling and differentiation of project types. ARR, for example, covers a broad swath of potential implementation pathways.

For buyers looking to prioritize specific ARR approaches, easier screening on registries would facilitate purchases.

- **Support emerging efforts like the Ecosystem Restoration Standard,⁸⁶ Plan Vivo Nature,⁸⁷ Open Forest Protocol,⁸⁸ and SD VISTa⁸⁹ to fulfill their full potential through road testing and active use.** (Initiatives like the Ecosystem Restoration Standard are also becoming more prominent, but projects following these standards are still in pilot phases and cannot yet be evaluated.)
- **Support an NGO to develop a low-cost, add-on label that could provide all buyers with an understanding of likely ecosystem restoration benefits of a carbon project across any registry** (e.g., similar to an Energy Star assessment). This could give an indication of possible benefits to better inform purchasing and goal-setting in service to ecosystem restoration.
- **Work with registries to make it easier to identify restoration outcomes from projects listed on their databases** and to identify barriers to entry for small-scale restoration projects.
- **Work with registries to develop clearer labels or differentiators between the types of ARR or IFM projects.** For example, improved keywords and metadata for projects buyers who want to search for biodiverse native-species restoration could easily differentiate registry projects.

86. Ecosystem Restoration Standard (ERS). [accessed 2024 Jan 8]. <https://www.ers.org/>.

87. Plan Vivo Nature. [accessed 2024 April 10]. <https://www.planvivo.org/pv-nature>.

88. Open Forest Protocol. [accessed 2024, April 10]. <https://www.openforestprotocol.org/>.

89. SD VISTa (or SD VISTa Nature) ties project benefits to specific SDGs like SDG 14 (Life below Water). Projects certified with the SD VISTa Nature Framework focus on biodiversity contributions specifically.

- Work with registries, scientists, and NGOs to unlock the potential of natural and assisted natural regeneration approaches to restoration, ensuring that the ecological and land-use dynamics of young, tropical, second-growth forests are accounted for in protocols and methodologies. For example, Verra's VM0047 has already taken a step forward in this direction by dropping the requirement that a project area must be non-forested for a minimum of 10 years prior to the project start date.

5. Use de-risking tools such as blended finance vehicles

Finance is a critical barrier to ecological restoration projects. Restoration models are either too risky or not profitable enough for some traditional investors, and offtakes are not as readily bankable as other ecosystem services—though the proliferation of nature-based investment funds in recent years signals the landscape may be evolving. Traditional



I think there is a huge role for blended finance to play, but it has to be blended in the right way. . . sometimes you're just blending problems. Most of our projects are funded upfront with philanthropic capital and then they keep going with private capital [via] offtake agreements, with what you consider more to be investment or private capital.

—Interviewee (anonymous)

investors have not often been willing to sacrifice financial returns for environmental, social, and governance (ESG) benefits, and even many so-called impact funds still demand returns at a level and schedule that make restoration projects unable to access their resources. However, blended finance vehicles such as concessional finance via philanthropic program-related investment, dedicated finance vehicles from multilaterals (such as guarantees and risk insurance), and impact investment can provide favorable terms and take up first-loss positions in the project capital stack. It is common for philanthropic or impact-targeted capital to support high-risk restoration models before private investment steps in to maintain and scale the approach in a way that would not be possible with philanthropic capital alone.

- **A buyer coalition could explore concessionary financing instruments that can provide bridge or backstop funding for restoration-oriented carbon projects.** Potentially, this would allow projects to access commercial sources of capital that otherwise eschew carbon finance due to the high delivery risk. The World Bank's Multilateral

Investment Guarantee Agency's proposed backstop for carbon projects in regions with high political risk provides an analog, as does the Global Fund for Coral Reefs.⁹⁰

- Concessional finance is one of the most commonly used blended finance structures. Examples include accepting subordinate terms, e.g., first loss, compared to other investors.⁹¹ A buyers coalition could follow this model, accepting similar term structures to support project development, or explore building in contracting conditions that tie impact goals to investment, e.g., “impact-linked loans” (ensuring those terms are not prohibitively burdensome to the implementor.)
- **Fund marginal and measurable restoration benefits within carbon projects.** For example, support in-development carbon projects and adjust project plans to promote further restoration such as by selecting a slower-growing mix of native species. The results could count toward “nature net-positive” or other nature-oriented goals.

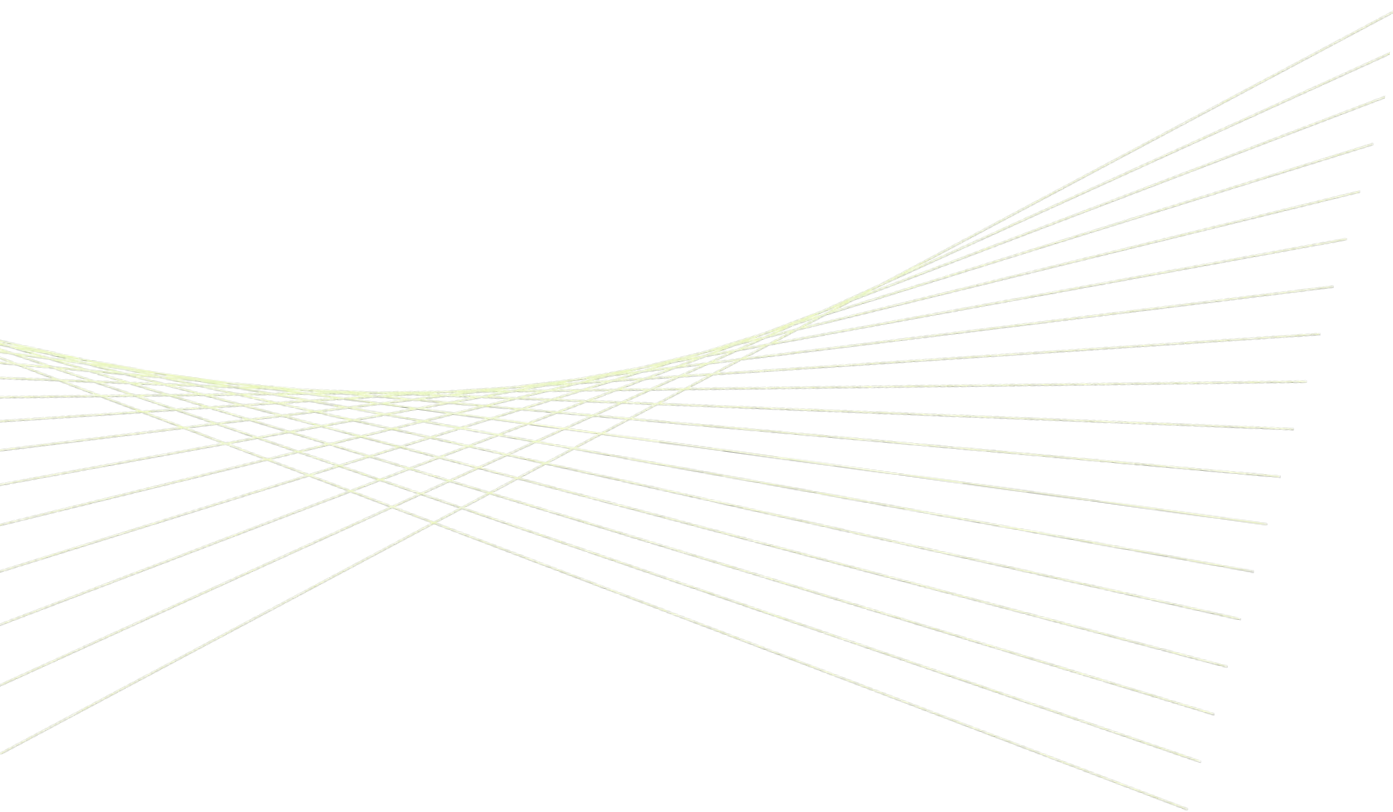
90. Editor. Multilateral Investment Guarantee Agency to protect carbon offset projects against political risks. [accessed 2024 Mar 3]. <https://www.green.earth/news/multilateral-investment-guarantee-agency-to-protect-carbon-offset-projects-against-political-risks>.

91. Earth Security | The Blended Finance Playbook for Nature-based Solutions. [accessed 2024 Mar 15]. <https://www.earthsecurity.org/reports/the-blended-finance-playbook-for-nature-based-solutions>.

Conclusion

Buyers are increasingly looking to purchase credits with benefits that reach beyond carbon, such as ecological restoration. High-quality ecological restoration is characterized by diverse and place-specific goals. This can make quantifying benefits, like biodiversity, and standardizing them into tradable credits difficult. Yet, there are patterns and commonalities to how ecological restoration manifests in carbon projects. This indicates an opportunity to encourage more restoration-oriented projects in the VCM. Today, the most frequently-cited barriers to increasing ecological restoration in VCM projects include

project time and cost; project complexity, scale, and risk; and misalignment between carbon and biodiversity goals within projects. A clear buyer signal demonstrating preference for restoration-oriented projects alongside a host of enabling actions such as restoration-focused carbon project protocols and clear definitions of quality, could help tip the scales toward projects with ecological restoration approaches. These approaches will help fight climate change while restoring resilient and productive landscapes that support the billions of people around the world who rely on the ecosystem services these landscapes provide.



Study methods

Overview of methods

This analysis pursued complementary research threads, each discussed further below:

- Interviews with 16 experts across academia, non-profit, finance, and project development
- Qualitative data analysis of 43 carbon credit projects to understand ways in which ecological restoration is represented in the VCM

Interviews

Objective: Understand priorities, opportunities, and barriers to restoration from key actors across sectors.

Interviewees: A total of twelve interviews were conducted, including three carbon project developers; four academic experts; and five representatives from foundations, NGOs, and other organizations. Some interviews involved multiple interviewees.

- Academic (restoration practitioners)
 - Oregon State University—Jacob Bukoski (Assistant Professor, Department of Forest Ecosystems and Society)
 - University of British Columbia—Alex Moore (Assistant Professor, Department of Forest and Conservation Sciences)
 - Yale University—Sara Kuebbing (Director of Yale Applied Science Synthesis Program)
 - ETH Zurich—Sara Lofqvist (PhD student in Environmental Science and Policy)
- Developer (Restoration financiers/buyers)
 - Arbor Day—Jeremy Manion (Managing Director, Carbon Markets) and Ben Wilinsky (Director of Partnerships and Innovation), Ali Loker (Science and Technical Lead), and Ben Paige (Senior Strategic Partnership Manager)
 - Climate Impact Partners—Valerie Morgan (Head of Nature Based Solutions) and Ben Gatley (Head of Commercial, Project Development)
 - BTG Pactual—Mark Wishnie (Chief Sustainability Officer and Head Impact Investment Management)

- Other (VCM project developer, foundation, NGO)
 - Agroicone—Laura Antoniazzi (Agriculture and Sustainability Specialist)
 - Good Energies—Mireille Perrin (Global Program Manager)
 - Doris Duke Foundation—Sacha Spector (Director, Environmental Program)
 - WWF—Stephanie Roe (Global Climate and Energy Lead Scientist)
 - Conservation International—Agustin Silvani (Chief Investment Officer and Impact Advisor)

Interviewee approach: Expert interviews were conducted by Carbon Direct staff (sometimes accompanied by Meta staff) using a semi-structured interview format, allowing for flexibility in conversation while ensuring that key topics and questions were covered consistently across all interviews.

Data analysis: A thematic analysis approach was used to identify common themes, patterns, and key takeaways from the interview data. The analysis was conducted in several steps:

- Meeting notes were coded by assigning labels to segments of text that represented specific concepts, ideas, or themes. Coding was both deductive (based on predefined topics from the interview questions) and inductive (allowing for the emergence of new themes).
- Codes were grouped into broader themes based on their similarity and relevance. Themes were refined through discussions among the research team.
- Relationships between themes and subthemes were mapped to create a comprehensive picture of the interview data.

Data analysis

Objective: To test and validate several hypotheses related to the design, practices, and anticipated outcomes of nature-based carbon projects.

Sampling: A random sample of nature-based projects across four major voluntary offset project registries (up to May 10, 2023) was extracted from the Voluntary Registry Offsets Database (n=37).⁹² Carbon Direct has previously found that few projects meet the *Criteria for High-quality Carbon Removal*.⁹³

92. Voluntary Registry Offsets Database. 2020–2023. V10. Berkeley Carbon Trading Project. [accessed 2024 Jan 8]. <https://gspp.berkeley.edu/research-and-impact/centers/cepp/projects/berkeley-carbon-trading-project/offsets-database>.

93. Carbon Direct and Microsoft. 2023. Criteria for High-Quality Carbon Dioxide Removal. [accessed 2024 Mar 02]. <https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RWGG6f>.

To facilitate quantitative analysis of carbon quality versus restoration quality, the random dataset was supplemented with additional projects (n=6) that had previously been reviewed by Carbon Direct to meet such criteria. This analysis was limited to IFM, ARR, and wetland/mangrove projects, in order to minimize confounding factors from divergent project practices within the small sample.

- Assessment and coding: A total of more than three dozen project features were scored for each project in the dataset. Project features were selected based on the literature review, expert interviews, and professional experience in order to assess likely project impacts on ecological restoration, including:
 - Project metadata and context (e.g., project ID, registry, degree of degradation, ongoing degradation processes, etc.)
 - Approaches to support natural capital/biodiversity (e.g., genetic, species, ecosystem, and landscape-scale practices and approaches)
 - Flows of ecosystem services changed by project
 - Sociocultural approaches (e.g., stakeholder engagement,⁹⁴ livelihood change)
 - Project type-specific practices (e.g., extended rotation age in IFM projects)

For each project, publically accessible project literature and data (e.g., project description and monitoring documents, geospatial data, etc.) were reviewed and indicators hand annotated and scored. Much of the detailed project documentation dates from at or before project inception. As such, this study does not assess restoration outcomes as much as the presence or absence of practices and elements of project design and implementation that are assumed to represent higher likelihoods of positive ecosystem recovery. For examples of indicators that measure restoration progress, see Dudley et al., 2018.⁹⁵ In cases where project literature did not explicitly mention whether an approach or practice was included in project design, scoring and coding was assigned to experts on the respective project type so as to be able to infer the presence or absence of relevant restoration approaches and practices from project design elements mentioned in the literature. Upon concluding a review of a project, the authors assigned to each project provided carbon integrity scores (if the project had not been previously assigned a score and scores ranged from 1–4). They also estimated the overall degree of ecological recovery and stakeholder livelihood change anticipated by elements of project design. Prior to data analysis most features were re-coded to be numerical and binary/ordinal.

94. Scored utilizing the International Association for Public Participation's modes of public participation (<https://organizingengagement.org/models/spectrum-of-public-participation/>).

95. Dudley N, Bhagwat SA, Harris J, Maginnis S, Moreno JG, Mueller GM, Oldfield S, Walters G. 2018. Measuring progress in status of land under forest landscape restoration using abiotic and biotic indicators. *Restoration Ecology*. 26(1):5–12. [doi:10.1111/rec.12632](https://doi.org/10.1111/rec.12632).

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About Carbon Direct

Carbon Direct Inc. helps organizations go from climate goal to climate action. We combine technology with deep expertise in climate science, policy, and carbon markets to deliver carbon emission footprints, actionable reduction strategies, and high-quality carbon dioxide removal. With Carbon Direct, clients can set and equitably deliver on their climate commitments, streamline compliance, and manage risk through transparency and scientific credibility. Our expertise is trusted by global climate leaders including Microsoft, American Express, and Alaska Airlines, as well as by the World Economic Forum, which selected Carbon Direct as an Implementation Partner for the First Movers Coalition. To learn more, visit www.carbon-direct.com.

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