Demystifying biodiversity finance

Harrison Carter [a,b†], Benjamin S. Thompson[c], Joseph W. Bull[b], Amy Dickman[a,d], Julia P.G. Jones[e,f], Siddarth Shrikanth[b] & Sophus O.S.E. zu Ermgassen[b,g, h]

[a] Wildlife Conservation Research Unit (WildCRU), Department of Biology, University of Oxford, Oxford, UK
[b] Nature-positive Hub, Department of Biology, University of Oxford, Oxford, UK
[c] School of Social Sciences, Faculty of Arts, Monash University, Melbourne, Victoria, Australia
[d] Lion Landscapes, Highcliffe, New Road, Teignmouth, TQ14 8UL
[e] School of Environmental and Natural Sciences, Bangor University, Bangor, UK
[f] Department of Biology, Utrecht University, Utrecht, Netherlands
[g] Leverhulme Centre for Nature Recovery, University of Oxford, Oxford, UK
[h] Oxford EARTH, University of Oxford, Oxford, UK

[†] Email: harrison.carter@biology.ox.ac.uk

Abstract
The importance of the financial sector to biodiversity conservation and restoration is increasingly recognised in international policy and practice. Alongside efforts to divert finance from harmful activities (‘greening finance’), increased finance is required to support biodiversity outcomes (‘financing green’). Beyond traditional public and philanthropic grants, return-seeking financial mechanisms are evolving that aim to finance positive biodiversity outcomes alongside financial returns for investors. Incomplete understanding of this fast-moving landscape limits the potential for conservation experts and other key stakeholders to meaningfully engage in the design of biodiversity finance mechanisms and provide effective scrutiny. In this Review, we examine return-seeking biodiversity finance mechanisms that raise money for up-front investment in conservation or restoration (loans, bonds and equity) or generate revenues directly linked with biodiversity outcomes (credits). The contribution of these mechanisms to overall conservation goals remains hotly contested; here, we focus on the practical commercial, ecological, and social risks that shape their viability. Scaling return-seeking biodiversity finance to deliver positive outcomes depends on improving investor returns while maintaining robust ecological and social oversight. Whether this is feasible is still unclear, and public investment and philanthropy will remain crucial to the biodiversity finance landscape, despite the promise of return-seeking mechanisms.

[H1] Introduction

Conservation and restoration efforts can be effective[17], but are currently not sufficient to halt and reverse biodiversity loss at scale[18] - in part owing to a lack of funding. The Kunming-Montreal Global Biodiversity Framework (GBF) aims to mobilise at least US$200 billion annually by 2030 and divert finance from harmful activities to help progressively reduce the biodiversity funding gap by 2050[20]. Alongside traditional funding such as philanthropy or direct funding from governments and multinational organisations[21], a range of financial mechanisms generating financial returns to their investors are evolving to help catalyse greater investment into biodiversity conservation and restoration, often targeting an increasing role for private investment[23]. However, a gap in financial understanding among conservationists and other key stakeholders is often mirrored by a lack of conservation expertise among financiers, which can limit collaboration and effective scrutiny of the real-world implications of these mechanisms[27,28]. An interdisciplinary bridge between sectors is required to ensure biodiversity finance can truly support biodiversity.

Financial mechanisms that aim to support environmental outcomes are sometimes referred to as ‘financing green’. However, the topic of biodiversity finance also includes ‘greening finance’ - that is, seeking to align the financial system with environmental sustainability through regulation and voluntary requirements to disclose and integrate biodiversity exposure and risk[30,31]. This greening of the financial system is crucial because nearly US$7 trillion in annual financial flows from public and private sector contributes directly to nature loss[20,21,32]. However, this Review focuses on the ‘financing green’ aspects of biodiversity finance.

Within ‘financing green’, the returns delivered by financial mechanisms can be either indirectly or directly linked with biodiversity outcomes. The vast majority of private financial activity referred to as investment in biodiversity is delivered through the purchase of market goods and services that aim to indirectly reduce biodiversity pressures, such as sustainable agriculture and certified forestry[33]. However, although these investments are important to reduce damage to nature by or from existing economic sectors[33], their financial returns are not directly tied to biodiversity improvements[34,35].

In this Review, we focus on the small but growing subset of biodiversity finance that aims to deliver returns directly linked with biodiversity outcomes through conservation and/or restoration. Specifically, we examine return-seeking mechanisms that primarily either raise funds (for example, equity, and debt-based funding, including loans, alongside various types of bonds) or generate revenue from direct improvements in biodiversity conservation and restoration (for example, nature-based carbon credits and biodiversity credits; Figure 1). We highlight the commercial, ecological and social risks of private investment in biodiversity, and explore potential ways of improving these financial mechanisms.

[H1] Up-front fundraising for biodiversity

The vast majority of current conservation effort is either publicly funded through government grants or subsidies to projects, or funded through philanthropic donations[21]. However, conservationists increasingly view the private sector as a source of additional finance[36]. Businesses seeking to raise money for investment they typically have three main options[37]: retaining revenue from their own business activities to reinvest (retained earnings); issuing new shares in the business for investors to purchase, which provides investors ownership stakes and a share in any future financial success (selling equity); or borrowing money from investors, with the promise to pay it back with interest (taking on debt). Equity and debt-based financing (the latter most often achieved through loan and bond instruments) have been used by various businesses to raise funding for conservation or restoration interventions[38-40]. Up-front investment creates a financial dependency between investors and the business that delivers conservation or restoration interventions. The business must be able to demonstrate a high likelihood of either higher future value (such that investors will want to buy equity) or revenue generation (which demonstrates an ability to repay any debts)[41]. This section breaks down the key similarities and differences between three key financial mechanisms (equity, loans and bonds) designed to deliver financial returns from the up-front funding of biodiversity conservation or restoration.

[H2] Equity

Equity-based investments can provide up-front finance to businesses carrying out conservation or restoration activities through the purchase of newly issued primary shares in exchange for a proportion of ownership[42] (Figure 2). Before investing, investors assess a business's structure, health and market growth potential, alongside other risk evaluations to ensure viability. Funding might come from one investor, or a syndicate of investors working together[41,43]. Private investment in a business can also be blended with public or philanthropic investment; the general aim of this approach is reducing risk for private investors and incentivising private investment where it might otherwise not have been deployed[44,45]. Up-front equity funding enables businesses to deliver or scale operational output without having to repay this funding later, as is common with debt-financing. Although equity is therefore more attractive than debt-financing for smaller businesses in biodiversity aligned markets, investors can gain ownership rights and influence decisions made in the invested business[46,47].

Investor returns are delivered by the commercial success of the invested business[41]. An investor's share in the business will increase in value in line with commercial success, and investors typically receive dividend payments periodically[48]. However, most investor returns are only realised when shares are sold at a profit to another investor, or when a private business lists its private shares on a public equity market[48]. As equity sales of this magnitude, often referred to as exit events, are relatively rare, invested capital can often be inaccessible to investors.

Although information about biodiversity-related equities is difficult to obtain, as most deals are private, occasional disclosures offer valuable insights (Flammer et al. 2025). Analysis of proprietary investment data from a biodiversity-focused private equity firm (who invest in private businesses using finance from investors and/or borrowed capital) showed that 33% of the investments they made (that is, deals) were financed entirely by equity investment (and did not include any borrowed capital), and many focused on forestry, agriculture, or soil management interventions[41], similar to what has been found in other investor surveys[42]. The average biodiversity financing 'deal size' (the overall investment opportunity) was US$22.8 million[41], which indicates that investors are generally targeting investments that are substantially bigger than ordinary conservation projects, primarily delivering market goods such as agricultural commodities with assumed nature-related co-benefits.

The viability of equity investments in biodiversity ultimately depends on the strength and reliability of the invested businesses' revenue streams. For example, over the past 50 years in the US, specialist timberland and rangeland-focused private equity firms have demonstrated this model of investment. These firms purchase relatively ecologically-degraded landholdings and build business models for managing these landholdings that generate revenue through the sale of credits into environmental markets, the acquisition of public subsidies, the selective acquisition and then sale of development rights to parts of the property, hunting licenses, and conventional commodity production[49]. These landholdings are then typically sold on to other investors after several years to deliver investors' return on their equity, which leaves the long-term ecological outcomes of these business models uncertain[49]. In another example more directly linked to biodiversity outcomes, some businesses that derive revenues primarily from biodiversity offsets are raising money via equity investment. For example, UK-based Gresham House (an alternative asset management company that makes investments on behalf of clients) recently launched a fund investing in a company managing private habitat banks that sell biodiversity units under England's Biodiversity Net Gain (BNG) policy[43]. Regulatory demand (enabled through the BNG Policy) provides investors greater certainty over future sales of offset units in England, making cash flows predictable enough that investors will deliver up-front equity investment to support habitat bank management.

[H2] Loans

Loans provide up-front funding for businesses carrying out conservation or restoration activities, which will later be repaid at an agreed periodic interest rate (Figure 3). Again, borrowers are subject to risk evaluations and due diligence before loans are offered, focusing on creditworthiness (for example, current debt levels and repayment history) and cash flows (income stability) to determine the likelihood of repayment. Loans can be made directly from one entity to another, or via a fund, to finance the delivery or scaling of interventions designed to derive biodiversity outcomes. However, unlike equity-based investments, investor returns are generally derived from the eventual repayment of the loan with interest[40].

In the context of biodiversity conservation and restoration, loans are commonly used to finance smaller projects or accompany other forms of finance in larger deals[39]. For example, loan-based finance was used to fund The Forest Resilience Bond in the US, which funded efforts to improve water quality and reduce fire risk in the Yuba River Watershed[50-52]. In this instance, two loans at below-market interest rates (1% annually) from philanthropic organisations helped the company secure two loans at standard commercial interest rates (4% annually), all of which together funded ecological project work [50-52]. The project generated revenue from utilities companies and local governments, who effectively paid for reductions in nature-related risks to their land and infrastructure. Other types of loan deals include those that can be structured to amend lending terms[53] (for example, whether the loan needs to be secured by another financial asset), amend repayment types[54] (for example, whether repayments have to be cash payments or in other forms of value like equity), or influence who gets repaid first when multiple lenders are involved[55]. In the context of biodiversity finance, these options mean that loans can be structured to ensure some investors take on more financial risk than others, making the transaction more favourable to attract private actors where commercial investment is otherwise unfeasible. This structuring of loans forms the basis of another form of blended finance, in which de-risking investment incentivises private finance where it might otherwise not have been deployed[44].

As with equity, the growth of loan-based investments in biodiversity is tied to the availability of predictable revenue streams that can enable debts to be repaid. Although loans are widely understood instruments and can be flexibly structured to meet borrower needs[39,53,54], their application to conservation and restoration is often constrained by the requirement for collateral (that is, assets given to the lender if the loan is not repaid), credit history (record of past borrowing and repayment), and a lack of reliable cashflows. As demonstrated in the Forest Resilience Bond, concessional or philanthropic loans have historically been important to attract commercial lenders[51,52].

[H2] Bonds

Bond-based investments are similar to loans, as they can provide up-front funding (the 'principal') for conservation activities in exchange for later repayment alongside an agreed periodic interest payment (the 'coupon') (Figure 4). However, although loans are typically borrowed from a single investor; bonds are 'issued' (that is, debt is made available to buy) by those seeking investment and commonly attract multiple investors. As such, these investments can be much larger than loans. The bond can provide up-front funding to deliver or scale project activities, and biodiversity outcomes of these activities are directly or indirectly linked with coupon payments to investors, alongside the repayment of the principal investment. Three types of bond structure typically fund conservation or restoration activities, and differ substantially in their financial structure and reliance on biodiversity outcomes for investor returns: use-of-proceed bonds, sustainability-linked bonds and impact bonds (Figure 4).

Use-of-proceeds bonds and sustainability-linked bonds are both forms of debt in which the issuing organisation is responsible for paying back investors[56,57]. In both cases, the issuer's own finances are on the line, and investors' returns are only indirectly tied to environmental, social, or governance (ESG) outcomes. Use-of-proceeds bonds dedicate the money raised to fund a sub-selection of specific green or sustainable activities presented up front, and repayment comes from the issuer's usual revenues. An example of a biodiversity use-of-proceeds bonds is the Green Bond for Working Forests (GBWF), the proceeds of which are used by the bond issuer to buy US forests at risk of conversion for residential, commercial and land use development. The bond issuer then establishes sustainable timber management plans and permanent conservation agreements, and repays investors through certified timber sales and the eventual resale of the forests to new owners for a higher price[40]. Sustainability-linked bonds, by contrast, do not restrict how the funds are spent. Instead, these bonds tie the interest rate the issuer pays to agreed sustainability performance targets: the rate falls if targets are met, and rises if they are missed. For instance, Uruguay's USD 1.5 billion sovereign sustainability-linked bonds, launched in 2022, aims to restore native forest cover to 2012 levels by 2034, and its base rate of 5.75% increases or decreases depending on progress[58].

Impact bonds deliver performance-based returns directly linked to ESG outcomes[40,50]. Social, environmental, and conservation impact bonds are examples of these types of bonds[40,50,52] (Figure 4). These investments are fundamentally different from use-of-proceeds bonds or sustainability-linked bonds, as investor returns are conditional on the delivery of biodiversity outcomes[iii][40,52]. Although the private investors can be similar to any other bond, the repayments are provided by a third-party 'outcome payer' (often the public or civil sector) that desires biodiversity outcomes. In theory, the risk of funding a failed project is therefore partially transferred from these traditional donors to the private investors, allowing the former to deploy their limited funds only when a project succeeds[40]. In practice, however, investors have tended to have the principal repaid by a third party even in the case of non-achievement of outcomes, with the coupon only affected by outcomes. If entities delivering conservation projects are not financially suitable to issue bonds, larger multilateral organisations often act as issuers. For example, in the case of The Wildlife Conservation Bond, the World Bank acted as the issuer to support Black Rhino conservation in two South African private conservancies[59], and the Global Environment Facility paid investor returns in line with conservation outcomes (that is, black rhino population growth rate) at bond maturity[59]. At bond maturity, investors will receive US$91.73 per US$1,000 invested if black rhino populations increase by 4% or more, US$73.38 per US$1,000 invested for growth between 2–4%, US$36.69 per US$1,000 invested for growth between 0–2%, and no payout if there is no population increase (SI Box 1). Similar to the Wildlife Conservation Bond, project activities might be funded through forgone coupon payments[60,61] or up-front investment[62,63]. In other deals, such as the Amazon Reforestation Linked Bond, outcome payments have included revenue from carbon credit sales developed through project work to repay investors through a circular funding model where no separate outcome payer is required[64].

The growth of bond-based investments in biodiversity likely relies on investors' confidence in underlying revenue mechanisms and the rigour of associated outcomes. The global market for bonds with some social, environmental or ecological purpose was around US$ 1 trillion in 2023, and the vast majority of bonds were issued as use-of-proceed bonds[57]. The amount dedicated to biodiversity investment represents a minute fraction of this[65]. These use-of-proceed bonds are attractive to investors because returns are derived from predictable commercial activities that have indirect links to biodiversity[40,66]. Use-of-proceeds bonds and sustainability-linked bonds remain structurally vulnerable to greenwashing because investor repayments are not directly dependent on verified biodiversity outcomes[67]. Impact bonds do link investor returns directly to biodiversity outcomes but are much less common. In 2024, just 11 bonds globally of all design were identified that specifically supported biodiversity restoration[68], broadly reflecting the high transaction costs, size constraints for issuers, and long lead times required for development[40]. In theory, impact bonds allow for the design of localised and context-specific activities to support biodiversity. However, in practice, effective engagement from local conservationists has been limited due to financial jargon[28], and private (that is, not accessible by the public) term sheets that outline key terms and conditions of the bond limit engagement from the wider academic community[40,69,70]. In addition, most bonds are inherently short-term mechanisms, creating long-term sustainability risks after bond maturity without a clear transition to revenue-generating activities or new funding[40]. The ecological outcomes and scalability of bond-based finance for biodiversity ultimately depends on stronger integration with conservation science and practice in the design and choice of outcome measures[40,71,72], alongside addressing the financial sustainability of bond-based finance[73].

[H1] Generating revenue from biodiversity

Equity, loan and bond investments can be used to raise funds up-front for biodiversity improvements. However, for most companies and projects that seek to improve the state of nature through an investable business model, the primary source of cash flows continues to be conventional market goods and services - such as sustainably harvested timber, agricultural commodities, non-timber forest products, and nature-based tourism. In these cases, buyers of goods and services implicitly support biodiversity[33], although biodiversity outcomes are often highly uncertain as the assumed mechanistic relationship between business performance and biodiversity outcomes might not operate in practice[40]. This section focusses on biodiversity and forest carbon credits, an evolving class of products that generate revenue from the sale of measurable nature outcomes resulting from the delivery of conservation or restoration interventions[74] (Figure 5). Although these mechanisms are not new[75] and have demonstrated limited growth over the past 50 years of their implementation[23,65,76], their inclusion in national conservation strategies and major international environmental policies such as the Paris Agreement and GBF is driving renewed interest and investment.

[H2] Biodiversity Credits

Biodiversity credits generate revenue through the sale of quantified avoided losses or improvements of biodiversity delivered through conservation or restoration interventions (Figure 5). Each biodiversity credit aims to represent a single measured unit of positive biodiversity outcome that is additional to what would have otherwise occurred[74]. Various types of project interventions and methods for measuring biodiversity outcomes exist[77-80]. Practical challenges and complex value judgements underpin decisions regarding how biodiversity credit methodologies quantify biodiversity (the metrics chosen to measure biodiversity) and how improvements are detected relative to what would have occurred without project intervention [79,81]. For biodiversity offsets, where credits are used to compensate for losses elsewhere, the metric used to measure biodiversity gain must be the same as the metric used for the associated biodiversity loss. By contrast, voluntary biodiversity credits are not associated with a loss elsewhere and metrics used for biodiversity gain are not required to be commensurable with biodiversity losses[82].

The vast majority of biodiversity credits are sold in offset markets as part of regional legislation that mandates the achievement of ‘no net loss’ of biodiversity or similar goals[83,84]. For example, biodiversity offset markets received an estimated $11.7 billion of investment in 2022[21], compared with an estimated $8 million of investment reported to date in voluntary international biodiversity credits[85]. The largest biodiversity offset markets by far are wetland compensation markets in the US, in which damage to streams or wetlands can be offset by the purchase of stream or wetland credits elsewhere, often provided by mitigation banks[21,86]. Biodiversity offset credit markets are used to mitigate the clearance of native vegetation in Australian states[87-89], while England requires most new developments to deliver a 10% 'Net Gain' in biodiversity as measured by a statutory biodiversity metric[90].

By comparison, voluntary biodiversity credit markets remain extremely limited[91]. Unlike carbon, for which voluntary offset demand is enabled by a globally fungible outcome metric (CO_2), no equivalent unit of nature exists that is fungible at scale[92]. Methods used to quantify and detect changes in biodiversity for voluntary biodiversity credit units vary widely[79,80]. The lack of fungibility in biodiversity measures and standardisation in measurement approaches means voluntary biodiversity credits are ill-suited for use in compensatory markets, which has constrained trading volumes to date[82]. Despite industry speculation about their future growth[91], drivers of demand for voluntary biodiversity credits outside of a regulatory market remain unclear, highlighting the need to understand whether and how these credits can deliver genuinely additional benefits for biodiversity[72].

Although the general contribution of biodiversity credits to the financing of biodiversity conservation and restoration to date has been minuscule in the context of wider capital flows, voluntary biodiversity credit and offset markets might still scale up in response to regulatory and political drivers[23]. Biodiversity offsets and voluntary credits are explicitly embedded in the GBF[93], and many countries are turning to these markets in the context of the prevailing, but highly contested, narrative that governments are unable to address biodiversity loss without financing from the private sector[76,94]. For example, the UK government's Nature Markets Framework represents a fundamental transformation in how biodiversity conservation is to be funded in England. By introducing a statutory regulatory driver of demand for biodiversity net gain offset units, and various other nature-related markets, the government aims to unlock £1 billion in private investment per year by 2030[95]. This contrasts with the UK's current public spending on biodiversity of approximately £870 million per year, and would reverse the historical pattern of conservation being nearly entirely publicly funded[21].

[H2] Forest Carbon Credits

Forest carbon credits generate revenue through the sale of avoided carbon emissions from forest conservation (Reducing Emissions from Deforestation and forest Degradation; REDD+) or increased carbon storage and sequestration (Afforestation, Reforestation, and Revegetation; ARR or Improved Forest Management; IFM)[96,97]; see Figure 5. Each carbon credit represents one metric ton of CO_2 (or CO_2 equivalent) that has either been avoided or removed through forest conservation or restoration interventions[96]. While the market for forest carbon credits is driven by their impact on climate mitigation, they can deliver biodiversity co-benefits by funding terrestrial conservation and restoration activities. Funded interventions can include increased enforcement of rules preventing deforestation, the creation of alternative livelihoods for communities who might engage in deforestation, tree planting initiatives, more sustainable forest management, or other activities that support the conservation or restoration of forests. Given the challenges of reestablishing diverse forest ecosystems, the biodiversity benefits from REDD+ projects might be expected to be greater than removal projects[98] because REDD+ involves retaining existing habitat complexity, species assemblages, and ecological processes of a forest. However, biodiversity outcomes from forest carbon projects are variable: of approximately 30,000 voluntary carbon projects analysed in 2025, on average habitat quality indicators worsened in project areas after registration[99].

Forest carbon credits are traded in both compliance carbon markets, where emissions reductions are mandated through regulatory caps, and voluntary carbon markets[100,101]. Their use in compliance markets is limited, subject to strict eligibility criteria[1-6](Box 1), and they are more widely traded in voluntary carbon markets. Within the voluntary carbon market, forest carbon credits accounted for approximately half of the market transaction value in 2024 (US$ 535 million), and over one-third of credit retirement value (US$ 980 million)[102,103]. Since the scandal associated with over-crediting associated of REDD+ credits in 2023[22] (Box 1), the price and volume of REDD+ credits sold has continued to fall. In 2024, REDD+ transactions were valued at US$82.1 million, representing a 63% decrease from 2023, while ARR transactions remained relatively stable at US$77.7 million, and IFM transactions increased substantially to US$132.3 million[103]. This divergence reflects a growing preference for removal-based credits over avoided-loss credits in general.

[H1] Risks from return-seeking financial mechanisms

Virtually every aspect of both the narratives that private finance is necessary for achieving global biodiversity goals, and the ecological effectiveness and social equity outcomes of private investments in biodiversity, are hotly contested. Various reviews have questioned the notion of the global biodiversity finance gap[94], scrutinised the ecological outcomes and social equity failures of for-profit conservation initiatives[14,40,50,104-107], described mismatches between the rhetoric of upscaling private investment in biodiversity relative to the realities of actual financial flows[76,108], and suggested that the promotion of private investment opportunities might reduce government action or public funding for addressing environmental or ecological crises[109]. This section does not focus on these systemic critiques but draws attention to the practical risks that affect individual return-seeking biodiversity investments, highlighting how commercial viability often depends on underlying (and often poorly considered) ecological and social risks. This section takes a pragmatic commercial perspective, highlighting the influence of project-level ecological and social risks on investor returns.

[H2] Commercial Risk

Investments in biodiversity, like any investment, carry the fundamental commercial risk of not making money. In particular, the commercial success in biodiversity markets is underpinned by enterprise risk (the ability of projects to deliver returns) and market risk (external factors affecting the value of returns)[40,110]. These risks tend to steer investment toward relatively stable and predictable markets, potentially away from those most important for delivering biodiversity outcomes[111]. To attract meaningful commercial capital, biodiversity investment needs to deliver risk-adjusted rates of return that are competitive with other (non-biodiversity-related) products available to investors.

In the context of return-seeking biodiversity finance mechanisms, enterprise risk is the risk that a conservation or restoration project does not deliver the expected investor returns. Unlike conventional commercial ventures, these projects often require long lead times before measurable outcomes are achieved, which means financial returns can be slow to materialise[15,111-113]. Alongside potential delays, biodiversity conservation and restoration trajectories are also inherently uncertain[112], and are particularly exposed to natural shocks such as wildfire, climate variability, and disease that can either increase delivery costs or undermine the project certainty[88]. Where natural conditions remain stable, a range of implementation challenges such as weak governance[114], limited technical capacity[115], or lack of trust and appropriate engagement with Indigenous Peoples and Local Communities (IPLCs)[116] can also undermine the delivery of effective projects[117]. Of course, principles of justice and equity that also require that IPLCs should benefit from biodiversity finance, beyond mitigating the commercial risk of private investment[118-120] (see Social risk section).

Market risk refers to factors outside the scope of a project that affect the value of the returns it delivers. These risks are especially relevant to mechanisms traded in open markets, for which value depends not only on ecological performance, but also on wider forces such as government policy[82,83] and currency of trade[121], alongside other supply and demand factors that shape market stability[24,40]. For example, global biodiversity offset transactions are almost exclusively driven by national compliance markets, in which policy design directly shapes supply and demand dynamics[23,122]. Under both the US wetland mitigation market and England's regulatory biodiversity net gain (BNG) market, developers are permitted to meet their biodiversity obligations either by buying credits or by undertaking their own mitigation, which is overseen by less rigorous standards and thereby minimises demand for off-site credits[123]. Market instability in the value of REDD+ credits owing to the over-crediting scandal[22] (Box 1) has limited the ability of voluntary forest carbon credits to attract large-scale investment relative to more stable commodities such as sustainable timber[40], although newer structures have incorporated carbon credits into repayment mechanisms for outcome-based bonds[64].

A range of mechanisms exists for mitigating commercial risks and encouraging greater return-seeking biodiversity finance[124]. All of these mechanisms alter the risk–return ratio for investors, either reducing risk or enhancing returns up to a level of risk-adjusted returns that are competitive with other investments in the market. A common business model is to use revenues from the provision of market goods (such as sustainable timber) in combination with the riskier alternative revenue of biodiversity improvements, as the overall project can deliver risk-adjusted returns sufficient to attract private investment [40]. For example, re.green (a company aiming to restore the Brazilian Atlantic Forest) attracts commercial investment through a business model combining timber sales and the sale of carbon credits[125]. Although carbon credit revenues are often deemed too volatile to attract substantial private investment[40], re.green has secured a number of advanced market commitments from major buyers who have committed to purchase a given number of credits once they are produced by the project[126]. Revenues from commodities coupled with such mechanisms for reducing market risk increases the expected risk-adjusted return of the project and enables private investment.

Insurance measures are another type of mechanism for mitigating risk, and involve 'underwriters' that cover a project's costs associated with a loss of assets (for example, losses associated with a forest fire), or 'guarantors' that cover cases of insufficient revenue generation (for example, guaranteeing to purchase a certain amount of sustainable timber)[40]. For example, in the Green Bond for Working Forests, a major investment bank underwrites forest assets to insure investors against loss[127,128]. Blended finance is also often cited as a mechanism for de-risking projects and channelling greater private finance toward activities in the public interest[51,129]. A 2025 analysis of the investments made by a biodiversity-focused private equity firm identified that the mean internal rate of return of investments that the firm chose to invest in without any other form of financial support was 14.7%; blended finance deals in which third parties adopted major project risks still required a mean rate of return of 11.9% [41]. Where volatile demand limits private investment, tools such as advanced market commitments[126], outcome payments[40], pre-sales[130], and derivatives such as options or futures contracts (that is, agreements that fix a price today of a future trade, either as a right or obligation)[131] could help to de-risk demand instability. Some forest carbon credit systems allow the pre-sale of Pending Issuance Units to generate revenue ahead of verification[130].

Increasingly complex financial structures are emerging to reduce commercial risk and scale nature finance. One example is the Tropical Forest Investment Fund (TFIF), recently launched at COP 30 alongside the Tropical Forests Forever Facility (TFFF) to fund annual payments to countries for conserving and restoring tropical and subtropical moist broadleaf forests[132]. The fund aims to raise US$25 billion in philanthropic or public capital as junior debt (that is, taking higher risk and lower priority of repayment), to leverage up to US$100 billion in senior debt (taking lower risk and higher priority of repayment) from other investors[133,134]. This combined pool will be invested in a diversified portfolio of public and corporate bonds, with stated intentions to exclude investments that cause significant environmental harm, including deforestation and greenhouse gas emissions. Income from these investments will first repay senior debt and sponsor capital, and the remainder (if there is any, depending on investment performance) will be used to finance annual forest payments to participating countries[133]. The fund's ultimate value will depend on retained earnings available once invested capital is returned after ten years, and the ecological integrity of investments chosen to deliver genuine long-term net benefits for nature.

[H2] Ecological Risk

Investments in biodiversity also carry the ecological risk of failing to deliver the promised biodiversity benefits. The few biodiversity-related markets globally that have been subject to impact evaluations have tended to substantially underdeliver on ecological outcomes[135]. Integrity issues can lead to serious devaluations in credit prices, threatening businesses reliant on those revenues[24] and linking ecological risk to commercial risk. Ecological risk is shaped by two core risks: impact risk (projects failing to achieve intended conservation or restoration outcomes) and measurement risk (outcomes being inaccurately assessed)[40].

Conservation outcomes are inevitably uncertain[17], and impact risk for a given project is unavoidable. The scandal in the voluntary carbon market, which led to a crash in the value and volume of traded REDD+ credits (Box 1), stemmed from a review of 26 projects across three continents that showed most had failed to reduce deforestation and others had overstated their impact[14]. Similar concerns have been raised over nature-based carbon offsets in Australia[9], species conservation banks in California[136], and biodiversity offsets in Victoria and New South Wales[88,89]. However, impact risks are not confined to crediting schemes: the use-of-proceeds Tropical Landscapes Finance Facility (TLFF) corporate sustainability bond has been criticised for its association with deforestation of Indonesian forests[137], despite the project's zero deforestation policy[138]. Project interventions designed to support a large-scale rubber monoculture reportedly engaged in substantial prior land clearing of forest systems to establish the monoculture, which subsequently affected the behaviour of local wildlife and drove conflict with local communities[137]. Without the delivery of genuine ecological gains, return-seeking mechanisms risk undermining both biodiversity goals and the legitimacy of biodiversity finance itself.

Measurement risk arises not from whether biodiversity impacts are delivered, but from how they are assessed. Measuring the outcome of an intervention is challenging as it requires the estimation of a counterfactual to determine what would have happened in the absence of the intervention[71]. This counterfactual is, by definition, unobservable[139] and difficult to estimate owing to the limited spatial and temporal resolution of most biodiversity datasets[140], and often also owing to lack of clarity of the treatment assignment mechanism (why some sites came to be exposed to the intervention and others did not)[141]. However, some comparisons that can be used to estimate the counterfactual are clearly more or less appropriate than others. For instance, black rhino population growth rates in the Wildlife Conservation Bond were benchmarked against continental averages rather than more suitable locally comparable sites, which may somewhat bias the assessment of project-level impacts[142]. The challenge of robust impact evaluation leads projects to rely on weak output indicators that can result in misleading claims of success[40].

Measuring the outcomes of biodiversity financing mechanisms requires a choice of metric; however, biodiversity metrics have limitations and can be categorized as, for example, 'premature', 'simple', 'vague', or 'coarse'[40]. Premature metrics focus on project outputs, such as tree planting as used in the TLFF[143,144], rather than outcomes such as long-term tree survival rates and changes in biodiversity or forest carbon stocks. Simple metrics rely on broad measures like the 'presence or absence of a key indicator species' as identified in the voluntary biodiversity credit market, which means they might not capture more complex ecological processes[79]. Vague metrics use non-specific terms such as 'to benefit' or 'to support', making outcomes difficult to measure or verify. Coarse metrics dilute the real value of biodiversity measured, as illustrated by the Wildlife Conservation Bond's use of a continental counterfactual, which produces a coarse measure of rhino population growth at project sites in South Africa[40].

Science can make an important contribution to reducing and managing ecological risks in return-seeking biodiversity finance. A growing "causal revolution" in conservation has expanded the use of robust impact evaluation and is helping to improve the measurement of biodiversity impacts[71], and focus on issues such as permanence (whether gains persist over time) and leakage (whether harm is displaced elsewhere) is increasing[72,145,146]. Technological innovation can also help plan, implement, and monitor conservation and restoration interventions[147,148]. Qualitative methods such as process tracing offer pragmatic alternatives for assessing performance, either in addition to quantitative evaluation methods or where quantitative methods are not possible[149-151]. Ultimately, science has a dual role: to advance methods that reduce ecological risks and to establish the limits of what claims can be made relating to different forms of biodiversity measurement.

[H2] Social Risk

Conservation and restoration interventions, including those funded through return-seeking biodiversity finance, take place within coupled human–natural systems in which social and ecological dynamics are deeply interdependent[152]**.** The social impacts of biodiversity finance models will depend on how these mechanisms are designed and, crucially, who has a voice in the design process. As well as being a moral and legal issue[153]**,** failure to address social risks can generate substantial commercial risks for investors by undermining long-term ecological outcome[101,154,155].

A key social risk is the potential for biodiversity finance models to sideline IPLCs, undermining principles of justice and equity[118-120,156]. Conservation interventions designed to maximise biodiversity gains can impact local livelihoods; for example, by restricting local hunting or agricultural expansion[157,158], or by increasing populations of potentially dangerous wildlife that can intensify conflict[159]. IPLCs frequently bear these costs locally, while financial benefits are often disproportionately distributed outside of project landscapes, reflecting underlying asymmetries in actor, institutional and structural power[160]**.** For example, the Kariba Forest Carbon Project generated a revenue of up to EUR 100 million from avoided deforestation carbon credits (REDD+) traded on the voluntary carbon market, but local reports suggest very little of this made it to the project site and benefited IPLCs[161]. Such inequities, long recognised in conservation practice, fuel local resentment toward developers[162], undermine trust[163], and project effectiveness[164]. The Kariba project was ultimately ended amid reputational fallout that also impacted buyers[165].

Although in theory clear land rights and local mandates are pre-conditions for attracting biodiversity finance[111], in practice land tenure is often complex, and projects can drive displacement and exacerbate conflict[166]. Complexity often stems from mismatches between legal (that is, de jure) land ownership and customary (that is, de facto) rights, especially when projects recognise the former and overlook the latter[167]. For example, independent reports from carbon projects in Uganda and Kenya describe IPLCs being violently displaced to clear land for project development[168-170]. Economic displacement, where rising land values or living costs associated with biodiversity finance have priced local people out of landscapes, has been observed in both high-income[171] and low and middle-income countries[137]. Although displacement and conflict are not unique to conservation funded through private investment and having characterised fortress conservation approaches for decades[172], the large-scale acquisition of land rights under biodiversity finance risks amplifying these inequities[173]. These cases highlight the risks biodiversity finance can pose to IPLC rights if poorly managed, underscoring the urgent need for effective local governance and social safeguards to support people alongside biodiversity[174,175].

To effectively address these risks, social equity must be embedded throughout the entire project lifecycle. Clarifying land rights and tenure is essential to enable IPLCs to attract and govern biodiversity finance on their own terms[111], but interpreting land rights in the context of local socio-economic and political system is equally important[167]. For example, in many high-biodiversity areas land ownership might not include ownership of the wildlife[176,177], creating additional complexity and contestation over financial rewards tied to wildlife presence[73]. Free, Prior and Informed Consent (FPIC) is a legal requirement for project actions that might affect Indigenous People or certain other groups[153], yet only around half of voluntary biodiversity credit providers have established comprehensive FPIC protocols[80]. Direct involvement of IPLCs in project design and management has resulted in interventions that are more likely to be locally appropriate and adopted[178,179]. When interventions deliver genuine value over time, co-designed approaches can also strengthen the permanence of outcomes and reduce leakage[180-182]. Ultimately, conservation practice must work both to clarify and strengthen land rights and to ensure the equitable engagement of IPLCs in project design, otherwise biodiversity finance is unlikely to deliver lasting gains and risks exacerbating inequity.

[H1] Summary and future directions

Understanding return-seeking biodiversity finance mechanisms will enable stakeholders (governments, regulators, conservation practitioners, academics, investors, public actors and IPLCs amongst others) to engage with the shifting landscape of biodiversity finance and provide effective scrutiny. This scrutiny is key to ensuring biodiversity finance mechanisms deliver on their proposed outcomes for biodiversity (reducing ecological risk), without harm to people (reducing social risk)[24,174]. Return-seeking biodiversity finance that generates commercial returns without delivering ecological outcomes is unsustainable[40], and failure to address social risks brings serious reputational and legal damage to the market as a whole. This commercial reality means that a valuable role exists for conservation science to apply ecological and social science expertise in shaping the future of these mechanisms.

Scaling these return-seeking mechanisms while ensuring they better contribute to meeting global biodiversity goals will require more attractive returns, lower risks, or both for investors, as finance is fuelled by its understanding of risk and the ability to price risk at an acceptable rate of return. Barriers to scaling include long project timelines, limited short-term returns and low capacity among early-stage developers[110]. Addressing these barriers would require diversified and predictable revenue streams, and targeted de-risking tools - such as advanced market commitments from major buyers. Whether this approach is feasible at scale is not yet clear, and a large proportion of biodiversity conservation and restoration projects are unlikely to attract commercial investment[183]. Although private finance has a role in funding conservation and restoration activities to achieve biodiversity goals, public investment and philanthropy will remain crucial within the biodiversity finance landscape even as new mechanisms are being developed.

References

1 Stapp, J. *et al.* Little evidence of management change in California's forest offset program. *Communications Earth & Environment* **4**, 331 (2023).

2 Engert, J. E. & van Oosterzee, P. Limits to the ability of carbon farming projects to deliver benefits for threatened species. *Nature Ecology & Evolution*, 1-8 (2024).

3 New Zealand Forest Service *How the ETS applies to forestry*, <https://www.mpi.govt.nz/forestry/forestry-in-the-emissions-trading-scheme/about-forestry-in-the-emissions-trading-scheme-ets/how-the-ets-applies-to-forestry/> (2023).

4 West, T. A., Monge, J. J., Dowling, L. J., Wakelin, S. J. & Gibbs, H. K. Promotion of afforestation in New Zealand's marginal agricultural lands through payments for environmental services. *Ecosystem Services* **46**, 101212 (2020).

5 Hong, M. *et al.* Application of integrated Korean forest growth dynamics model to meet NDC target by considering forest management scenarios and budget. *Carbon Balance and Management* **17**, 5 (2022).

6 Korea Forest Service *Overview of the Forest Carbon Offset Scheme*, <https://www.forest.go.kr/newkfsweb/html/HtmlPage.do?pg=/fcme/UI_FCS_161000.html&mn=KFS_35_16_10&orgId=fcme> (2014).

7 Korea Forest Service *Overview of the Forest Carbon Offset Scheme*, <https://www.forest.go.kr/newkfsweb/html/HtmlPage.do?pg=/fcme/UI_FCS_161000.html&mn=KFS_35_16_10&orgId=fcme> (2014).

8 Department of Climate Change, E., the Environment and Water , . *Safeguard Mechanism*, <https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism> (2025).

9 Macintosh, A. *et al.* Australian human-induced native forest regeneration carbon offset projects have limited impact on changes in woody vegetation cover and carbon removals. *Communications Earth & Environment* **5**, 149 (2024).

10 International Carbon Action Partnership *United Kingdom*, <https://icapcarbonaction.com/system/files/ets_pdfs/icap-etsmap-factsheet-99.pdf> (2022).

11 Bleuel, S. & Müller, C. Unlocking the potential: Expert insights on the long-term compatibility of forest carbon credits with the EU ETS. *Forest Policy and Economics* **162**, 103185 (2024).

12 Fankhauser, S. What next on net zero? *One Earth* **4**, 1520-1522 (2021).

13 Trencher, G., Blondeel, M. & Asuka, J. Do all roads lead to Paris? Comparing pathways to net-zero by BP, Shell, Chevron and ExxonMobil. *Climatic Change* **176**, 83 (2023).

14 West, T. A. *et al.* Action needed to make carbon offsets from forest conservation work for climate change mitigation. *Science* **381**, 873-877 (2023).

15 Löfqvist, S. & Ghazoul, J. Private funding is essential to leverage forest and landscape restoration at global scales. *Nature ecology & evolution* **3**, 1612-1615 (2019).

16 Ecosystem Marketplace. *New Report: The Voluntary Carbon Market Contracted in 2023, Driven by Drop-off in Transactions for REDD+ and Renewable Energy*, <https://www.ecosystemmarketplace.com/articles/report-the-voluntary-

carbon-market-contracted-in-2023-driven-by-drop-off-in-transactions-for-redd-and-renewable-energy/> (2024).

17 Langhammer, P. F. *et al*. The positive impact of conservation action. *Science* **384**, 453-458 (2024).

18 UNEP. *Protected Planet Report 2020*, <https://www.unep.org/resources/protected-planet-report-2020> (2021).

19 Greenfield, P. *Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows*, <https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe> (2023).

20 Convention on Biological Diversity. *The Biodiversity Plan for Life on Earth, 2030 Targets (with Guidance Notes)*, <https://www.cbd.int/gbf/targets/> (2023).

21 United Nations Environment Programme. *State of Finance for Nature: The Big Nature Turnaround – Repurposing $7 trillion to combat nature loss*, <https://wedocs.unep.org/handle/20.500.11822/44278> (2023).

22 Jones, J. P. Scandal in the voluntary carbon market must not impede tropical forest conservation. *Nature Ecology & Evolution*, 1-2 (2024).

23 Zu Ermgassen, S. O. *et al*. The current state, opportunities and challenges for upscaling private investment in biodiversity in Europe. *Nature Ecology & Evolution*, 1-10 (2025).

24 Swinfield, T., Shrikanth, S., Bull, J. W., Madhavapeddy, A. & zu Ermgassen, S. O. Nature-based credit markets at a crossroads. *Nature Sustainability*, 1-4 (2024).

25 ICVCM *About the Integrity Council. Setting the global standard for high integrity in international carbon markets.*, <https://icvcm.org/about-us/> (2025).

26 Carton, W., Asiyanbi, A., Beck, S., Buck, H. J. & Lund, J. F. Negative emissions and the long history of carbon removal. *Wiley Interdisciplinary Reviews: Climate Change* **11**, e671 (2020).

27 Scholtens, B. Why finance should care about ecology. *Trends in Ecology & Evolution* **32**, 500-505 (2017).

28 Medina, C. & Scales, I. R. Finance and biodiversity conservation: insights from rhinoceros conservation and the first wildlife conservation bond. *Oryx* **58**, 90-99 (2024).

29 Dooley, K. *et al*. The Land Gap Report. (2022).

30 WWF *Financing Green: Unlocking finance for nature and people*, <https://wwfint.awsassets.panda.org/downloads/wwf_financing_green_brochure_july_2023_lr.pdf> (2023).

31 UK Centre for Greening Finance and Investment *UK Centre for Greening Finance and Investment*, <https://eng.ox.ac.uk/media/6971/centre-for-greening-finance-investment-outline-optimized.pdf> (2021).

32 Svartzman, R. & Althouse, J. Greening the international monetary system? Not without addressing the political ecology of global imbalances. *Review of International Political Economy* **29**, 844-869 (2022).

33 Van Raalte, D. & Ranger, N. Financing Nature-Based Solutions for Adaptation at Scale: Learning from Specialised Investment Managers and Nature Funds. *Global Center on Adaptation and Environmental Change Institute, University of Oxford: Oxford, UK* (2023).

34 Matias, G., Cagnacci, F. & Rosalino, L. M. FSC forest certification effects on biodiversity: A global review and meta-analysis. *Science of the Total Environment* **908**, 168296 (2024).
35 Morgans, C. L. *et al.* Evaluating the effectiveness of palm oil certification in delivering multiple sustainability objectives. *Environmental Research Letters* **13**, 064032 (2018).
36 Barbier, E. B., Burgess, J. C. & Dean, T. J. How to pay for saving biodiversity. *Science* **360**, 486-488 (2018).
37 Jouffray, J.-B., Crona, B., Wassénius, E., Bebbington, J. & Scholtens, B. Leverage points in the financial sector for seafood sustainability. *Science Advances* **5**, eaax3324 (2019).
38 Karolyi, G. A. & Tobin-de la Puente, J. Biodiversity finance: A call for research into financing nature. *Financial Management* **52**, 231-251 (2023).
39 Meyers, D. *et al.* Conservation finance: a framework. *Conservation Finance Alliance*, 1-45 (2020).
40 Thompson, B. S. Impact investing in biodiversity conservation with bonds: An analysis of financial and environmental risk. *Business Strategy and the Environment* **32**, 353-368 (2023).
41 Flammer, C., Giroux, T. & Heal, G. M. Biodiversity finance. *Journal of Financial Economics* **164**, 103987 (2025).
42 Cooper, G., & Trémolet, S,. Investing in Nature: Private Finance for Nature-based Resilience., (The Nature Conservancy and Environmental Finance. London, United Kingdom., 2019).
43 Gresham House *Gresham House launches strategy to accelerate restoration of UK biodiversity and enhance natural capital*, <https://greshamhouse.com/news-media/gresham-house-launches-strategy-to-accelerate-restoration-of-uk-biodiversity-and-enhance-natural-capital/> (2024).
44 Flammer, C. *Financing biodiversity through private capital investments*, <https://www.unpri.org/academic-blogs/financing-biodiversity-through-private-capital-investments/11577.article> (2023).
45 Cao, S. S., Karolyi, G. A., Xiong, W. W. & Xu, H. Biodiversity entrepreneurship. *Review of Finance* **30**, 43-86 (2026).
46 Li, K., Ortiz-Molina, H. & Zhao, X. Do voting rights affect institutional investment decisions? Evidence from dual-class firms. *Financial Management* **37**, 713-745 (2008).
47 Baines, J. & Hager, S. B. From passive owners to planet savers? Asset managers, carbon majors and the limits of sustainable finance. *Competition & Change* **27**, 449-471 (2023).
48 BlackRock *What are equity investments?*, <https://www.blackrock.com/us/individual/education/equities> (2025).
49 Kay, K. A hostile takeover of nature? Placing value in conservation finance. *Antipode* **50**, 164-183 (2018).
50 Trotta, A. Environmental impact bonds: review, challenges, and perspectives. *Current Opinion in Environmental Sustainability* **66**, 101396 (2024).
51 Madeira, L. & Gartner, T. Forest resilience bond sparks innovative collaborations between water utilities and wide-ranging stakeholders. *Journal AWWA* **110**, 42-49 (2018).

52 Brand, M. W. *et al.* Environmental Impact Bonds: a common framework and looking ahead. *Environmental Research: Infrastructure and Sustainability* **1**, 023001 (2021).

53 Benmelech, E., Kumar, N. & Rajan, R. The decline of secured debt. *The Journal of Finance* **79**, 35-93 (2024).

54 Lyandres, E. & Zhdanov, A. Convertible debt and investment timing. *Journal of Corporate Finance* **24**, 21-37 (2014).

55 Anh, L. N. Q. in *Partial Identification in Econometrics and Related Topics* 417-435 (Springer, 2024).

56 International Capital Market Association *Sustainability Bond Guidelines*, <https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Sustainability-Bond-Guidelines-June-2021-140621.pdf> (2021).

57 The World Bank *Green, Social, Sustainability, and Sustainability-Linked (GSSS) Bonds, Market Update – July 2024*, <https://thedocs.worldbank.org/en/doc/dacb969cc71f53abde2d2758f1cc13ed-0340012024/original/GSSS-Quarterly-Newsletter-Issue-No-8.pdf> (2024).

58 MEF *Uruguay's Sovereign Sustainability-Linked Bond (SSLB) Annual Report 2025*, <https://sslburuguay.mef.gub.uy/innovaportal/file/30672/16/sslb-3rd-annual-report-may-2025_compressed.pdf> (2025).

59 World Bank Group *Wildlife Conservation Bond Boosts South Africa's Efforts to Protect Black Rhinos and Support Local Communities*, <https://www.worldbank.org/en/news/press-release/2022/03/23/wildlife-conservation-bond-boosts-south-africa-s-efforts-to-protect-black-rhinos-and-support-local-communities> (2022).

60 World Bank Group *Investors Support Amazon Reforestation Through Record Breaking USD 225 Million World Bank Outcome Bond*, <https://www.worldbank.org/en/news/press-release/2024/08/13/investors-support-amazon-reforestation-through-record-breaking-usd-225-million-world-bank-outcome-bond> (2024).

61 The World Bank *Wildlife Conservation Bond mobilizes private capital to protect critically endangered rhinos. Case Study.*, <https://thedocs.worldbank.org/en/doc/7039bd837e60e484fb3a93ea63951306-0340022022/original/CaseStudy-WildlifeConservationBond.pdf> (2022).

62 Atlanta Department of Watershed Management *Environmental Impact Bond (EIB) For Green Infrastructure In Proctor Creek Watershed*, <https://www.atlantawatershed.org/environmental-impact-bond/> (2019).

63 Quantified Ventures *Atlanta: First Publicly Offered Environmental Impact Bond*, <https://www.quantifiedventures.com/atlanta-eib> (2022).

64 World Bank Group *Investors Support Amazon Reforestation Through Record Breaking USD 225 Million World Bank Outcome Bond*, <https://www.worldbank.org/en/news/press-release/2024/08/13/investors-support-amazon-reforestation-through-record-breaking-usd-225-million-world-bank-outcome-bond> (2024).

65 Christiansen, J. *et al.* Off the charts? Reasons to be skeptical of the growth in biodiversity finance. *Current Opinion in Environmental Sustainability* **75**, 101544 (2025).

66 Flammer, C. Corporate green bonds. *Journal of financial economics* **142**, 499-516 (2021).

67 Baldi, F. & Pandimiglio, A. The role of ESG scoring and greenwashing risk in explaining the yields of green bonds: A conceptual framework and an econometric analysis. *Global Finance Journal* **52**, 100711 (2022).

68 Garvey, J. *et al.* Designing financial instruments for land-based ecological restoration: A review and future research Agenda. *Cleaner Production Letters*, 100089 (2024).

69 The International Capital Market Association *Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds*, <https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles-June-2022-060623.pdf> (2021).

70 The International Capital Market Association *Sustainability-Linked Bond Principles. Voluntary Process Guidelines.*, <https://www.icmagroup.org/assets/documents/Sustainable-finance/2024-updates/Sustainability-Linked-Bond-Principles-June-2024.pdf> (2024).

71 Jones, J. P. & Shreedhar, G. The causal revolution in biodiversity conservation. *Nature Human Behaviour*, 1-4 (2024).

72 zu Ermgassen, S. *et al.* Five golden rules for scientifically-credible nature markets. *SocArXiv.*, doi:10.31235/osf.io/37w8p_v1 (2025).

73 Carter, H. *et al.* Hopes and Fears for Incentivising Coexistence With Big Cats Through Innovative Market-Based Financial Mechanisms. *Wildlife Letters* (2025).

74 Biodiversity Credit Alliance. Definition of a Biodiversity Credit. *Issue Paper* (2024).

75 Damiens, F. L., Porter, L. & Gordon, A. The politics of biodiversity offsetting across time and institutional scales. *Nature Sustainability* **4**, 170-179 (2021).

76 Dempsey, J. & Suarez, D. C. Arrested development? The promises and paradoxes of “selling nature to save it”. *Annals of the American Association of Geographers* **106**, 653-671 (2016).

77 Marshall, E., Wintle, B. A., Southwell, D. & Kujala, H. What are we measuring? A review of metrics used to describe biodiversity in offsets exchanges. *Biological Conservation* **241**, 108250 (2020).

78 Borges-Matos, C., Maron, M. & Metzger, J. P. A review of condition metrics used in biodiversity offsetting. *Environmental Management* **72**, 727-740 (2023).

79 Wauchope, H. *et al.* What is a unit of nature? Measurement challenges in the emerging biodiversity credit market. *Proc. R. Soc. B***;291: 20242353** (2024).

80 Kim, E. H., Dellecker, A., Field, R., Stephenson, P. & Schrodt, F. Towards high-integrity biodiversity credits: balancing commensurability, ecological complexity and governance. *Proceedings B* **292**, 20250990 (2025).

81 Bull, J. W., Suttle, K. B., Gordon, A., Singh, N. J. & Milner-Gulland, E. Biodiversity offsets in theory and practice. *Oryx* **47**, 369-380 (2013).

82 Wunder, S. *et al.* Biodiversity Credits: An Overview of the Current State, Future Opportunities, and Potential Pitfalls. *Business Strategy and the Environment* (2025).

83 Bull, J. W. & Strange, N. The global extent of biodiversity offset implementation under no net loss policies. *Nature Sustainability* **1**, 790-798 (2018).

84 Maron, M. *et al.* 'Nature positive'must incorporate, not undermine, the mitigation hierarchy. *Nature Ecology & Evolution* **8**, 14-17 (2024).

85 World Economic Forum. *Biodiversity Credits: Demand Analysis and Market Outlook.* , <https://www3.weforum.org/docs/WEF_2023_Biodiversity_Credits_Demand_Analysis_and_Market_Outlook.pdf> (2023).

86 Vaissière, A.-C. & Levrel, H. Biodiversity offset markets: What are they really? An empirical approach to wetland mitigation banking. *Ecological Economics* **110**, 81-88 (2015).

87 Gordon, A. *et al.* Five years of offsetting native vegetation: The challenge of achieving no-net-loss. *Ecological Indicators* **179**, 114180 (2025).

88 Zu Ermgassen, S. O. *et al.* Evaluating the impact of biodiversity offsetting on native vegetation. *Global Change Biology* **29**, 4397-4411 (2023).

89 Gibbons, P., Macintosh, A., Constable, A. L. & Hayashi, K. Outcomes from 10 years of biodiversity offsetting. *Global change biology* **24**, e643-e654 (2018).

90 Duffus, N. *et al.* Metrics based on habitat area and condition are poor proxies for invertebrate biodiversity. (2024).

91 World Economic Forum. *Biodiversity Credits: Demand Analysis and Market Outlook.*, <https://www3.weforum.org/docs/WEF_2023_Biodiversity_Credits_Demand_Analysis_and_Market_Outlook.pdf> (2023).

92 Purvis, A. & Hector, A. Getting the measure of biodiversity. *Nature* **405**, 212-219 (2000).

93 Convention on Biological Diversity. *Biodiversity provides ecosystem goods and services essential to human health and well-being*, <https://www.cbd.int/health/> (2024).

94 Gonon, M., Svartzman, R. & Althouse, J. Bridging the Gap in Biodiversity Financing: A review of assessments of existing and needed financial flows for biodiversity, and some considerations regarding their limitations and potential ways forward. . *(UCL Institute for Innovation and Public Purpose, Working Paper Series 2024-14). UCL Institute for Innovation and Public Purpose (IIPP): London, UK.* (2024).

95 Department for Environment, F. R. A. *Nature Markets Framework progress update March 2024. Policy paper.*, <https://www.gov.uk/government/publications/nature-markets-framework-progress-update-march-2024/nature-markets-framework-progress-update-march-2024#:~:text=The%202023%20Nature%20Markets%20Framework,nature%20markets%20across%20the%20UK.> (2024).

96 Jones, J. P. & Lewis, S. L. Forest carbon offsets are failing. *Science* **381**, 830-831 (2023).

97 Baral, S., Lamichhane, S. & Koirala, A. Current status of improved forest management carbon offset projects in the US voluntary market. *Forest Policy and Economics* **178**, 103567 (2025).

98 Aguirre-Gutiérrez, J., Stevens, N. & Berenguer, E. Valuing the functionality of tropical ecosystems beyond carbon. *Trends in ecology & evolution* **38**, 1109-1111 (2023).

99 Zhou, Z. Y. & Almond, D. Biodiversity Co-Benefits in Carbon Markets? Evidence from Voluntary Offset Projects. *Review of Finance*, rfaf066 (2025).

100 van der Gaast, W., Sikkema, R. & Vohrer, M. The contribution of forest carbon credit projects to addressing the climate change challenge. *Climate Policy* **18**, 42-48 (2018).

101 Ecosystem Marketplace *NEW! State of the Voluntary Carbon Markets 2023 finds VCM demand concentrating around pricier, high-integrity credits*, <https://www.ecosystemmarketplace.com/articles/new-state-of-the-voluntary-carbon-markets-2023-finds-vcm-demand-concentrating-around-pricier-high-integrity-credits/> (2024).

102 Sylvera. *The State of Carbon Credits. Report.*, <https://info.sylvera.com/hubfs/The%20State%20of%20%20Carbon%20Credits%202025%20Report%20-%20Sylvera.pdf?hsLang=en> (2025).

103 Ecosystem Marketplace *State of the Voluntary Carbon Market. Meeting the Moment, Renewing Trust in Carbon Finance.*, <https://3298623.fs1.hubspotusercontent-na1.net/hubfs/3298623/SOVCM%202025/Ecosystem%20Marketplace%20State%20of%20the%20Voluntary%20Carbon%20Market%202025.pdf> (2025).

104 zu Ermgassen, S. O. S. E., Utamiputri, P., Bennun, L., Edwards, S. & Bull, J. W. The role of “no net loss” policies in conserving biodiversity threatened by the global infrastructure boom. *One Earth* **1**, 305-315 (2019).

105 Wunder, S. *et al.* Modest forest and welfare gains from initiatives for reduced emissions from deforestation and forest degradation. *Communications Earth & Environment* **5**, 394, doi:10.1038/s43247-024-01541-1 (2024).

106 Josefsson, J. *et al.* Compensating for lost nature values through biodiversity offsetting–Where is the evidence? *Biological Conservation* **257**, 109117 (2021).

107 Maron, M. *et al.* Biodiversity offsets, their effectiveness and their role in a nature positive future. *Nature Reviews Biodiversity*, 1-14 (2025).

108 Evans, M. C. *et al.* “Trends in Biodiversity Finance Terminology, Actors and Networks over Two Decades.”. *SocArXiv. February 12. doi:10.31235/osf.io/awqzp_v1.* (2025).

109 Carton, W., Hougaard, I. M., Markusson, N. & Lund, J. F. Is carbon removal delaying emission reductions? *Wiley Interdisciplinary Reviews: Climate Change* **14**, e826 (2023).

110 Kedward, K., Zu Ermgassen, S., Ryan-Collins, J. & Wunder, S. Heavy reliance on private finance alone will not deliver conservation goals. *Nature Ecology & Evolution* **7**, 1339-1342 (2023).

111 Löfqvist, S., Garrett, R. D. & Ghazoul, J. Incentives and barriers to private finance for forest and landscape restoration. *Nature ecology & evolution* **7**, 707-715 (2023).

112 Maron, M. *et al.* Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biological conservation* **155**, 141-148 (2012).

113 Dempsey, J. & Bigger, P. Intimate mediations of for-profit conservation finance: Waste, improvement, and accumulation. *Antipode* **51**, 517-538 (2019).

114 Myers, R. *et al.* Messiness of forest governance: How technical approaches suppress politics in REDD+ and conservation projects. *Global Environmental Change* **50**, 314-324 (2018).

115 Hahn, N. R., Bombaci, S. P. & Wittemyer, G. Identifying conservation technology needs, barriers, and opportunities. *Scientific Reports* **12**, 4802 (2022).

116 Brondízio, E. S. *et al.* Locally based, regionally manifested, and globally relevant: Indigenous and local knowledge, values, and practices for nature. *Annual Review of Environment and Resources* **46**, 481-509 (2021).

117 Davis, A. & Goldman, M. J. Beyond payments for ecosystem services: considerations of trust, livelihoods and tenure security in community-based conservation projects. *Oryx* **53**, 491-496 (2019).

118 Zabel, A., Nanhthavong, V. & Epprecht, M. Gaps between demand and supply of biodiversity impact finance in the Global South. *Current Opinion in Environmental Sustainability* **76**, 101568 (2025).

119 Milner-Gulland, E. Now is the time for conservationists to stand up for social justice. *PLoS biology* **22**, e3002657 (2024).

120 McDermott, M., Mahanty, S. & Schreckenberg, K. Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. *Environmental science & policy* **33**, 416-427 (2013).

121 Keith, H., Vardon, M., Stein, J. A., Stein, J. L. & Lindenmayer, D. Ecosystem accounts define explicit and spatial trade-offs for managing natural resources. *Nature Ecology & Evolution* **1**, 1683-1692 (2017).

122 Wunder, S., Cecilia Fraccaroli, Joseph W. Bull, Trishna Dutta, Alison Eyres, Megan C. Evans, Bo J. Thorsen, Julia P.G. Jones,Martine Maron, Bart Muys, Andrea Pacheco, Asger Strange Olesen,Thomas Swinfield, Yitagesu Tekle Tegegne, Thomas B. White, Han Zhang and Sophus O.S.E. zu Ermgassen. Biodiversity Credits: Learning Lessons from Other Approaches to Incentivize Conservation. *OSF Preprints. February 26. doi:10.31219/osf.io/qgwfc.* (2024).

123 Rampling, E. E., Zu Ermgassen, S. O., Hawkins, I. & Bull, J. W. Achieving biodiversity net gain by addressing governance gaps underpinning ecological compensation policies. *Conservation Biology* **38**, e14198 (2024).

124 Polzin, F., Egli, F., Steffen, B. & Schmidt, T. S. How do policies mobilize private finance for renewable energy?—A systematic review with an investor perspective. *Applied Energy* **236**, 1249-1268 (2019).

125 re.green *What We Do*, <https://re.green/en/what-we-do/> (2025).

126 Segal, M. *Microsoft Signs Forest Restoration Deal to Remove 3.5 Million Tons of CO2*, <https://www.esgtoday.com/microsoft-signs-forest-restoration-deal-to-remove-3-5-million-tons-of-co2/> (2025).

127 The Conservation Fund *Taxable Green Bonds (Working Forest Conservation Program), Series 2019*, <https://www.conservationfund.org/wp-content/uploads/2024/08/2019-9-19_TCF_Final_Offering_Memorandum-1.pdf> (2019).

128 The Conservation Fund *Green Bond Impact Report*, <https://www.conservationfund.org/wp-content/uploads/2024/09/TCF24-Green-Bond-Report-Rebrand-052024-1.pdf> (2022).

129 Flammer, C., Giroux, T. & Heal, G. Blended finance. (National Bureau of Economic Research, 2024).

130 Woodland Carbon Code *What you can buy*, <https://woodlandcarboncode.org.uk/buy-carbon/what-are-woodland-carbon-units> (2019).

131 Golub, A. A. *et al.* Escaping the climate policy uncertainty trap: options contracts for REDD+. *Climate Policy* **18**, 1227-1234 (2018).

132 COP 30 *Tropical Forests Forever Fund boosts international support and positions itself as a new global model for climate finance.*, <https://cop30.br/en/news-about-cop30/tropical-forests-forever-fund-boosts-international-support-and-positions-itself-as-a-new-global-model-for-climate-finance> (2025).

133 Tropical Forest Forever Facility *An innovative financing mechanism to incentivise long-term forest conservation at scale. Concept note 3.0.*, <https://tfff.earth/wp-content/uploads/2025/08/TFFF-Concept-Note-3.0-202508-FINAL.pdf> (2024).

134 Ceccon, M. *Less stage, more handshakes: Climate Week NYC shifts focus from pledges to partnerships*, <https://nature4climate.org/less-stage-more-handshakes-climate-week-nyc-shifts-focus-from-pledges-to-partnerships/> (2025).

135 zu Ermgassen, S. O. S. E. *et al.* Five rules for scientifically credible nature markets. *Nature Ecology & Evolution* **10**, 181-192, doi:10.1038/s41559-025-02932-z (2026).

136 Sonter, L. J., Barnes, M., Matthews, J. W. & Maron, M. Quantifying habitat losses and gains made by US Species Conservation Banks to improve compensation policies and avoid perverse outcomes. *Conservation Letters* **12**, e12629 (2019).

137 Otten, F., Hein, J., Bondy, H. & Faust, H. Deconstructing sustainable rubber production: contesting narratives in rural Sumatra. *Journal of Land Use Science* **15**, 306-326 (2020).

138 WWF *WWF & MICHELIN PARTNERSHIP PROGRESS REPORT 2014 / 2018*, <https://www.wwf.fr/sites/default/files/doc-2019-07/20190726_Partnership_Pogress_Report_Michelin_WWF-min.pdf> (2019).

139 Ferraro, P. J. Counterfactual thinking and impact evaluation in environmental policy. *New directions for evaluation* **2009**, 75-84 (2009).

140 Wauchope, H. S. *et al.* Evaluating impact using time-series data. *Trends in Ecology & Evolution* **36**, 196-205 (2021).

141 Ferraro, P. J. & Hanauer, M. M. Advances in measuring the environmental and social impacts of environmental programs. *Annual review of environment and resources* **39**, 495-517 (2014).

142 Jeffries, G., Withers, O., Barichievy, C. & Gordon, C. The rhino impact investment project—a new, outcomes-based finance mechanism for selected AfRSG-rated 'key'black rhino populations. *Pachyderm* **60**, 88-95 (2019).

143 Convergence Finance *TLFF Inaugural Transaction: Corporate Sustainability Bond for Natural Rubber Production*, <https://www.convergence.finance/api/file/5781b6c042d88e7bf518d56945b13b7f:27a34eafd585375a2bd2b910c6bb10b6634617b731653c3b1565216d0421227139f8064021afaffd1470b014b70a0f0bf345a81393c6e59e937230be090278684cbdaf26b22f8e915ae8bf76a10d7a1ff60966953e382f9758c302b21d6dd3d3530b2b83391a3dae6117076518e597d77957d32e056dd56d01f6fe0cc6ac06dd664a3396996623b364a4f8ecd3a542db78828d5c37cff4943e556b945d95a893> (2019).

144 ADM Capital *Long-term Financing for Green Growth*, <https://www.blendedfinance.earth/blended-finance-funds/2020/11/16/tropical-landscape-finance-facility> (2024).

145 Balmford, A. *et al.* PACT Tropical Moist Forest Accreditation Methodology v2. 0. (2023).

146 Balmford, A. *et al.* Time to fix the biodiversity leak. *Science* **387**, 720-722 (2025).

147 Coldrey, J. J. & Thompson, B. S. Evaluating stakeholder perceptions on drone use in forest restoration using a social–ecological systems framework. *People and Nature* **6**, 1624-1639 (2024).

148 Ford, H. V. *et al.* A technological biodiversity monitoring toolkit for biocredits. *Journal of Applied Ecology* **61**, 2007-2019 (2024).

149 Grace, M. K. *et al.* Building robust, practicable counterfactuals and scenarios to evaluate the impact of species conservation interventions using inferential approaches. *Biological Conservation* **261**, 109259, doi:https://doi.org/10.1016/j.biocon.2021.109259 (2021).

150 Bull, J. W., Strange, N., Smith, R. J. & Gordon, A. Reconciling multiple counterfactuals when evaluating biodiversity conservation impact in social-ecological systems. *Conservation Biology* **35**, 510-521 (2021).

151 Sharkey, W. *et al.* The value of qualitative approaches to impact evaluation in biodiversity conservation. *Conservation Science and Practice*, e70102 (2025).

152 Berkes, F., Folke, C. & Colding, J. *Linking social and ecological systems: management practices and social mechanisms for building resilience*. (Cambridge University Press, 2000).

153 Newing, H. *et al.* Conservation and Human Rights: an introduction. The Interdisciplinary Centre for Conservation Science (ICCS), Oxford UK and Forest Peoples Programme (FPP), Moreton in Marsh, UK. (2024).

154 Kigonya, R. Aspirations and realities of biodiversity offsetting: Social and ecological transformations of the Gangu Central Forest reserve in Uganda. (2024).

155 Löfqvist, S. *et al.* How social considerations improve the equity and effectiveness of ecosystem restoration. *BioScience* **73**, 134-148 (2023).

156 Biodiversity Credit Alliance *International Advisory Panel on Biodiversity Credits, World Economic Forum. High-level Principles to Guide the Biodiversity Credit Market.*, <https://www.biodiversitycreditalliance.org/wp-content/uploads/2024/11/BCA_High-level-Principles-to-Guide-the-Biodiversity-Market-working-paper-EN_ES_FR.pdf> (2024).

157 Bidaud, C., Schreckenberg, K. & Jones, J. P. The local costs of biodiversity offsets: Comparing standards, policy and practice. *Land Use Policy* **77**, 43-50 (2018).

158 Tupala, A.-K., Huttunen, S. & Halme, P. Social impacts of biodiversity offsetting: A review. *Biological Conservation* **267**, 109431 (2022).

159 Dickman, A. J. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal conservation* **13**, 458-466 (2010).

160 Shackleton, R. T. *et al.* Navigating power in conservation. *Conservation science and practice* **5**, e12877 (2023).

161 Blake, H. *The Great Cash-for-Carbon Hustle*, <https://www.newyorker.com/magazine/2023/10/23/the-great-cash-for-carbon-hustle> (2023).

162 Redpath, S. M. *et al.* Understanding and managing conservation conflicts. *Trends in ecology & evolution* **28**, 100-109 (2013).

163 Saif, O., Keane, A. & Staddon, S. Making a case for the consideration of trust, justice, and power in conservation relationships. *Conservation Biology* **36**, e13903 (2022).

164 Dawson, N., Martin, A. & Danielsen, F. Assessing equity in protected area governance: approaches to promote just and effective conservation. *Conservation Letters* **11**, e12388 (2018).

165 Ben, E., Alastair, M. & and Max, d. H. *Faulty Credits Tarnish Billion-Dollar Carbon Offset Seller*, <https://www.bloomberg.com/news/features/2023-03-24/carbon-offset-seller-s-forest-protection-projects-questioned?embedded-checkout=true&leadSource=uverify%20wall> (2023).

166 Rakotonarivo, O. S. *et al.* Resolving land tenure security is essential to deliver forest restoration. *Communications Earth & Environment* **4**, 179 (2023).

167 Robinson, B. E. *et al.* Incorporating land tenure security into conservation. *Conservation Letters* **11**, e12383 (2018).

168 Cavanagh, C. & Benjaminsen, T. A. Virtual nature, violent accumulation: The 'spectacular failure'of carbon offsetting at a Ugandan National Park. *Geoforum* **56**, 55-65 (2014).

169 Lyons, K. & Westoby, P. Carbon colonialism and the new land grab: Plantation forestry in Uganda and its livelihood impacts. *Journal of Rural Studies* **36**, 13-21 (2014).

170 Mukpo, A. *Report clears Kenyan conservancy of community abuse, but advocates cry foul*, <https://news.mongabay.com/2022/06/report-clears-kenyan-conservancy-of-community-abuse-but-advocates-cry-foul/> (2022).

171 Gallent, N., Purves, A. & Gabrieli, T. Reflections on 'land value recovery'for UK rural areas, and its implications for housing affordability, wealth-building, rural land use, and community wellbeing. *Habitat International* **153**, 103204 (2024).

172 West, P., Igoe, J. & Brockington, D. Parks and peoples: the social impact of protected areas. *Annu. Rev. Anthropol.* **35**, 251-277 (2006).

173 Greenfield, P. *The new 'scramble for Africa': how a UAE sheikh quietly made carbon deals for forests bigger than UK*, <https://www.theguardian.com/environment/2023/nov/30/the-new-scramble-for-africa-how-a-uae-sheikh-quietly-made-carbon-deals-for-forests-bigger-than-uk> (2023).

174 Chausson, A. *et al.* Balancing Bankability and Integrity: Fostering Investment-Ready Nature-based Solutions., (WWF-UK. Woking, United Kingdom., 2025).

175 Poudyal, M. *et al.* Can REDD+ social safeguards reach the 'right'people? Lessons from Madagascar. *Global Environmental Change* **37**, 31-42 (2016).

176 Bond, J. & Mkutu, K. Exploring the hidden costs of human–wildlife conflict in northern Kenya. *African Studies Review* **61**, 33-54 (2018).

177 Naughton-Treves, L. & Sanderson, S. Property, politics and wildlife conservation. *World development* **23**, 1265-1275 (1995).

178 Denninger Snyder, K. & Rentsch, D. Rethinking assessment of success of mitigation strategies for elephant-induced crop damage. *Conservation Biology* **34**, 829-842 (2020).

179 Bowie, M. J., Dietrich, T., Cassey, P. & Veríssimo, D. Co-designing behavior change interventions to conserve biodiversity. *Conservation Science and Practice* **2**, e278 (2020).

180 Fleischman, F. *et al.* Pitfalls of tree planting show why we need people-centered natural climate solutions. *BioScience* **70**, 947-950 (2020).
181 Hayes, T., Murtinho, F., Wolff, H., López-Sandoval, M. F. & Salazar, J. Effectiveness of payment for ecosystem services after loss and uncertainty of compensation. *Nature Sustainability* **5**, 81-88 (2022).
182 Dawson, N. M. *et al.* Reviewing the science on 50 years of conservation: Knowledge production biases and lessons for practice. *Ambio* **53**, 1395-1413 (2024).
183 Sinacore, K. *et al.* Mixed success for carbon payments and subsidies in support of forest restoration in the neotropics. *Nature communications* **14**, 8359 (2023).

Acknowledgments

H.C. is supported by the UKRI's Engineering & Physical Sciences Research Council's Doctoral Training Programme. A.D. acknowledges support from a Recanati Kaplan Fellowship and Panthera. BST acknowledges his DECRA fellowship (DE240100092) awarded by the Australian Research Council (ARC). J.P.G.J. is supported by the Prince Bernhard Chair Foundation and an Oxford Martin School fellowship. SOSEzE and JWB are supported by EU Horizon 2020 project SUPERB (Systemic solutions for upscaling of urgent ecosystem restoration for forest-related biodiversity and ecosystem services; Ref.: GA-101036849). S.O.S.E.z.E. is supported by the Natural Environment Research Council (NERC) [grant number NE/W004976/1] as part of the Agile Initiative at the Oxford Martin School.

Author contributions

H.C. and S.O.S.E.z.E. researched data for the article. H.C., B.T., J.W.B., J.P.G.J., S.S. and S.O.S.E.z.E. wrote the manuscript. All authors substantially contributed to discussion of content and reviewed and/or edited the manuscript before submission.

Competing interests

Siddarth Shrikanth holds a role on the investment team at Just Climate LLP, but this article does not represent the views of the organisation or have any impact on Just Climate’s activities.

Peer review information

Nature Reviews Biodiversity thanks Julian Clifton and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

Related links

Kunming-Montreal Global Biodiversity Framework: https://www.cbd.int/gbf

Display items

Boxes

Box 1: Forest Carbon Credits and their role in compliance and voluntary markets: scale and potential for growth

> The use of forest carbon credits to offset emissions within compliance markets is rare and eligibility is subject to strict limitations[1-6]. For example, California's cap-and-trade program allows companies to offset a small percentage of their emissions using forest carbon credits; this percentage will increase from 4% to 6% between 2026 and 2030[1]. Other countries have also permitted forest carbon credits in compliance markets[2,3,7]. For instance, Australia's Safeguard Mechanism allows regulated facilities to use Australian Carbon Credit Units (ACCUs) derived from native forest regeneration[8] (although the additionality of ACCUs derived from native forest regeneration has been limited[9]). By contrast, both the UK and the EU Emissions Trading Scheme prohibits the use of forest carbon credits for regulatory emission compliance[10,11].
>
> Forest carbon credits have had a prominent role in the voluntary carbon market, where demand is driven by corporate net-zero and ESG commitments[12-15]. REDD+ credits (carbon credits generated from reducing deforestation and forest degradation) dominated sales in the early 2020s[16]. However, following revelations of over-crediting of REDD+ credits[14],[19], more than US$1 billion of value as wiped off the voluntary carbon market in 2023[16,22].
>
> A number of initiatives are working to address integrity concerns with forest carbon credits and stimulate demand for forest carbon credits from both compliance and voluntary carbon markets[24] [25]. If concerns regarding integrity, and appropriate use of these credits (the trencher ref), can be addressed, the potential exists for upscaling forest carbon credits to fund forest conservation and restoration as international net zero policies (like the Paris Agreement) are heavily reliant on offsetting[20,23,26]. Such upscaling could provide a substantial funding for forest conservation and restoration. However, there are important caveats as delivering current government pledges for carbon dioxide removal would require around 1.2 billion hectares of land, roughly equal to the world's total cropland area[29] , emphasising that forest carbon offsets are no replacement for emission reductions.

Figure legends

Figure 1. 'Financing green' mechanisms aim to deliver returns (that is, make money) directly linked with biodiversity outcomes through conservation and/or restoration. These mechanisms aim to achieve either up-front fundraising (through loans, bonds or equity) or revenue generation (via credits). These mechanisms are shown in the context of the wider landscape of 'financing green' mechanisms for conservation or restoration interventions, including traditional philanthropic and government fundraising approaches, alongside market goods and services (out of scope, shown in desaturated hues).

Figure 2: Financial flows involved in equity-based, up-front fundraising investments in biodiversity. These investments have the potential to fund direct or indirect biodiversity outcomes, depending on the commercial practice of the business. Investors first assess the viability of potential businesses before purchasing equity (a share in ownership), which provides funding for the businesses' conservation and/or restorations activities. These activities generate revenue, and investors can receive returns via increases in the share value, dividend payments, and ultimately sale of their equity.

Figure 3: Financial flows involved in loan-based up-front investments in biodiversity. These investments have the potential to fund direct or indirect biodiversity outcomes, depending on the commercial practice of the borrower; see Box 6 in the SI for case study example. Investors first assess the viability of potential businesses before providing a loan, which funds the businesses' conservation and/or restorations activities. Revenue generation through these activities funds interest payments from the business to the lender, and enables the business to pay off the principal loan.

Figure 4: Financial flows in three types of bond-based investments. These investments have the potential to fund direct or indirect biodiversity outcomes, depending on the structural nature of the bond; see Boxes 1–5 in the SI for case study examples. Following assessment of the businesses' viability, investors purchase bonds (often issued by entities such as governments or international organisations). Use-of-proceeds bonds can fund biodiversity interventions, but repayments to investors are not directly tied to biodiversity outcomes (part a). Sustainability-linked bonds can finance biodiversity interventions or other activities, with repayments adjusted according to performance against biodiversity or other sustainability targets (part b). Impact bonds fund biodiversity interventions, with investor returns conditional on the verified achievement of biodiversity outcomes (part c).

Figure 5: General financial flows involved in biodiversity or forest carbon credit projects. These investments derive revenues from the sale of quantified outcomes (forest conservation or restoration, or biodiversity conservation and/or restoration); see Box 7 in the SI for case study example. Project developers manage conservation and/or restoration activities under a given credit standard, implemented on land where owners have agreed to participate in the project. These activities generate biodiversity or carbon credits, which are verified by a independent third party prior to issuance. Credits are then sold to buyers by the project developer or through intermediaries, generating revenue linked to environmental outcomes.

Author Statement:

The role of finance in biodiversity is growing, yet gaps between financial and conservation expertise limit effective scrutiny. This Review demystifies biodiversity finance mechanisms such as equity, loans, bonds and credits, showing how commercial viability is shaped by ecological and social risks and highlights the barriers to scaling.