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Review article

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Demystifying biodiversity finance

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Abstract

The importance of the financial sector to biodiversity conservation and restoration is increasingly recognized 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.

Sections

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Introduction

Conservation and restoration efforts can be effective[1] but are currently not sufficient to halt and reverse biodiversity loss at scale[2] – in part owing to a lack of funding. The Kunming-Montreal Global Biodiversity Framework (GBF) aims to mobilize at least US $200 billion annually by 2030 and divert finance from harmful activities to help to progressively reduce the biodiversity funding gap by 2050 (ref. 3). Alongside traditional funding such as philanthropy or direct funding from governments and multinational organizations[4], a range of financial mechanisms that generate 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[5]. 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[6,7]. 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[8,9]. 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[3,4,10]. 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[11]. However, although these investments are important to reduce damage to nature by or from existing economic sectors[11], their financial returns are not directly tied to biodiversity improvements[12,13].

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; Fig. 1). We highlight the commercial, ecological and social risks of private investment in biodiversity, and explore potential ways of improving these financial mechanisms.

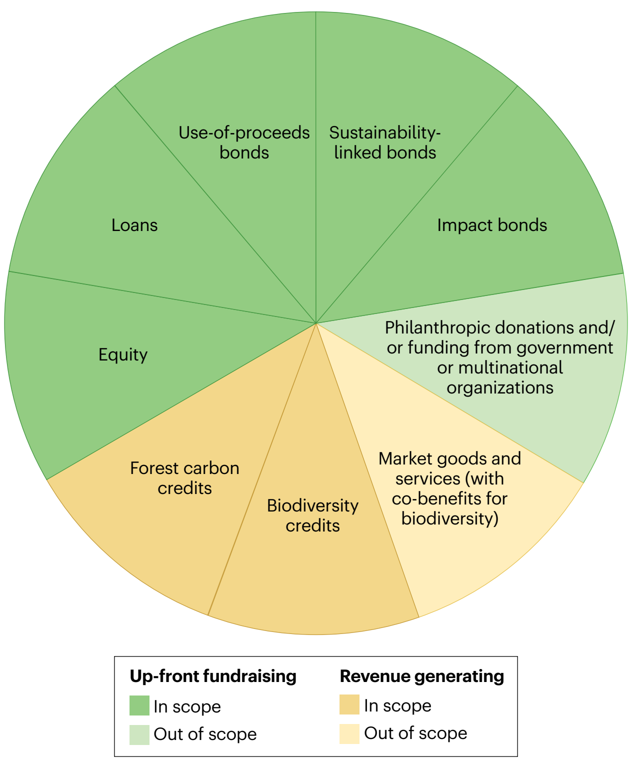

Fig. 1 | 'Financing green' biodiversity finance mechanisms. 'Financing green' mechanisms aim to deliver returns (that is, make money) directly linked with biodiversity outcomes through conservation and/or restoration. These mechanisms aim to achieve either up-front fundraising (through loans, bonds or 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).

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[4]. However, conservationists increasingly view the private sector as a source of additional finance[14]. Businesses seeking to raise money for investment typically have three main options[15]: 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[16–18]. 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)[19]. 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.

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[20] (Fig. 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[19,21]. Private investment in a business can also be blended with public or philanthropic investment; the general aim of this approach is to reduce risk for private investors and incentivizing private investment in areas in which it might otherwise not have been deployed[22,23]. 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[24,25].

Investor returns are delivered by the commercial success of the invested business[19]. An investor's share in the business will increase in value in line with commercial success, and investors typically receive dividend payments periodically[26]. However, most investor returns are only realized when shares are sold at a profit to another investor or when a private business lists its private shares on a public equity market[26]. 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[19]. 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[19], similar to what has been found in other investor surveys[20]. The average biodiversity financing 'deal size' (the overall investment opportunity) was US $22.8 million[19], which indicates that investors are generally targeting investments that are substantially bigger than ordinary conservation projects, primarily delivering market goods such as agricultural commodities that have 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 USA, 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 licences, and conventional commodity production[27]. 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[27]. 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[21]. 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.

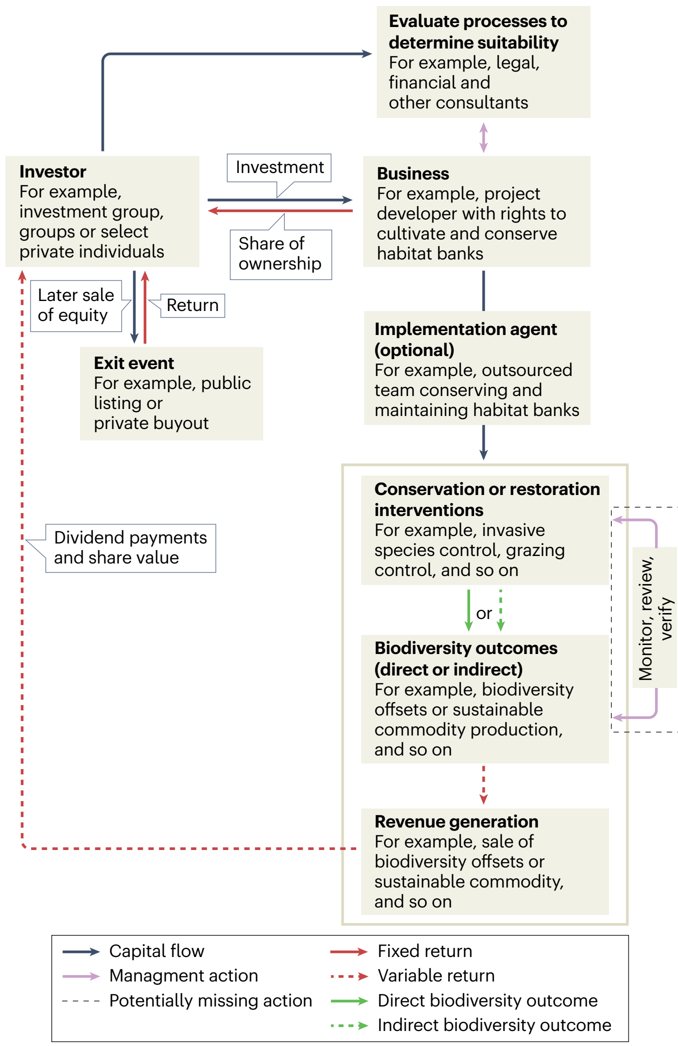

Fig. 2 | Financial flows involved in equity-based, up-front fundraising investments in biodiversity. These investments have the potential to fund direct or indirect biodiversity outcomes, depending on the commercial practice of the business. Investors first assess the viability of potential businesses 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.

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 (Fig. 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[18].

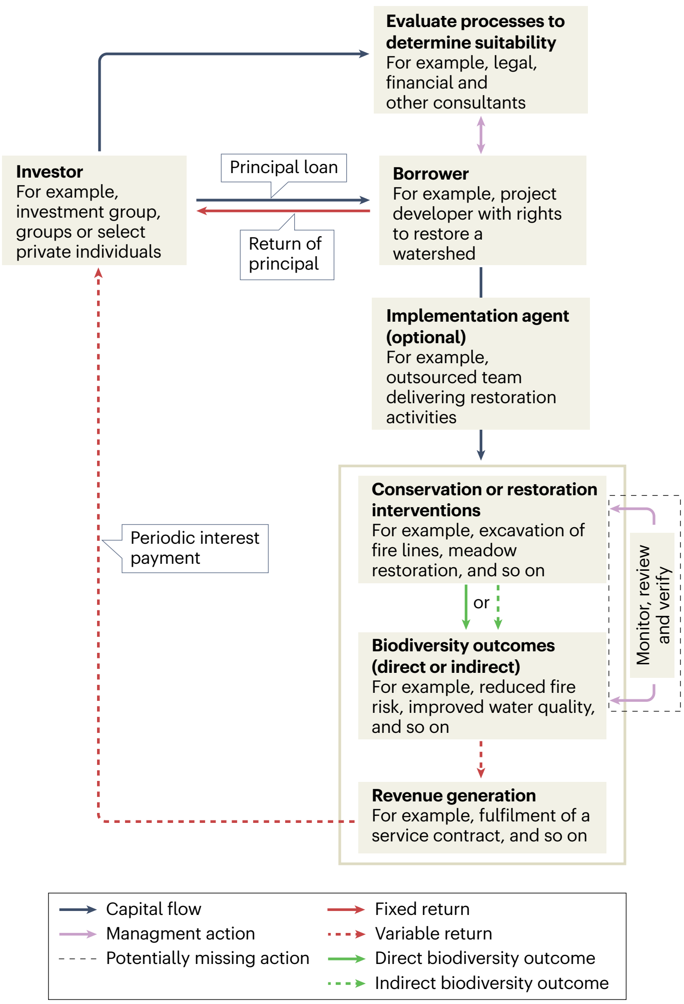

Fig. 3 | Financial flows involved in loan-based, up-front investments in biodiversity. These investments have the potential to fund direct or indirect biodiversity outcomes, depending on the commercial practice of the borrower; see Supplementary Box 6 for a case study example. Investors first assess 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.

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[17]. For example, loan-based finance was used to fund The Forest Resilience Bond in the USA, which funded efforts to improve water quality and reduce fire risk in the Yuba River Watershed[28–30]. In this instance, two loans at below-market interest rates (1% annually) from philanthropic organizations helped the company to secure two loans at standard commercial interest rates (4% annually), all of which together funded ecological project work[28–30]. 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[31] (for example, whether the loan needs to be secured by another financial asset), amend repayment types[32] (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[33]. In the context of biodiversity finance, these options mean that loans can be structured to ensure that some investors take on more financial risk than others, making the transaction more favourable to attract private actors when commercial investment is otherwise unfeasible. This structuring of loans forms the basis of another form of blended finance, in which de-risking investment incentivizes private finance when it might otherwise not have been deployed[22].

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[17,31,32], 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), by credit history (record of past borrowing and repayment) and by a lack of reliable cashflows. As demonstrated in the Forest Resilience Bond, concessional or philanthropic loans have historically been important to attract commercial lenders[29,30].

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') (Fig. 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-proceeds bonds, sustainability-linked bonds and impact bonds (Fig. 4).

Use-of-proceeds bonds and sustainability-linked bonds are both forms of debt in which the issuing organization is responsible for paying back investors[34,35]. 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, 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[18]. 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 US $1.5 billion sovereign sustainability-linked bond, 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[36].

Impact bonds deliver performance-based returns directly linked to ESG outcomes[18,28]. Social, environmental, and conservation impact bonds are examples of these types of bonds[18,28,30] (Fig. 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[18,30]. 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[18]. 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 organizations 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[37], and the Global Environment Facility paid investor returns in line with conservation outcomes (that is, black rhino population growth rate) at bond maturity[37]. 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% and 4%, US $36.69 per US $1,000 invested for growth between 0% and 2%, and no payout if there is no population increase (Supplementary Box 1). Similar to the Wildlife Conservation Bond, project activities might be funded through forgone coupon payments[38,39] or up-front investment[40,41]. 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 in which no separate outcome payer is required[38].

The growth of bond-based investments in biodiversity probably 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-proceeds bonds[35]. The amount dedicated to biodiversity investment represents a minute fraction of this total[42]. These use-of-proceeds bonds are attractive to investors because returns are derived from predictable commercial activities that have indirect links to biodiversity[18,43]. Use-of-proceeds bonds and sustainability-linked bonds remain structurally vulnerable to greenwashing because investor repayments are not directly dependent on verified biodiversity outcomes[44]. 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[45], broadly reflecting the high transaction costs, size constraints for issuers and long lead times required for development[18]. In theory, impact bonds allow for the design of localized and context-specific activities to support biodiversity. However, in practice, effective engagement from local conservationists has been limited due to financial jargon[7] 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[18,46,47]. 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[18]. 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[18,48,49], alongside addressing the financial sustainability of bond-based finance[50].

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[11], although biodiversity outcomes are often highly uncertain as the assumed mechanistic relationship between business performance and biodiversity outcomes might not operate in practice[18]. This section focuses 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[51] (Fig. 5). Although these mechanisms are not new[52] and have demonstrated limited growth over the past 50 years of their implementation[5,42,53], their inclusion in national conservation strategies and major international environmental policies such as the Paris Agreement and GBF is driving renewed interest and investment.

Biodiversity credits

Biodiversity credits generate revenue through the sale of quantified avoided losses or improvements of biodiversity delivered through conservation or restoration interventions (Fig. 5). Each biodiversity credit aims to represent a single measured unit of positive biodiversity outcome that is additional to what would have otherwise occurred[51]. Various types of project interventions and methods for measuring biodiversity outcomes exist[54–57]. 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[56,58]. For biodiversity offsets, in which 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[59].

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[60,61]. For example, biodiversity offset markets received an estimated US $11.7 billion of investment in 2022 (ref. 4), compared with an estimated US $8 million of investment reported to date in voluntary international biodiversity credits[62]. The largest biodiversity offset markets by far are wetland compensation markets in the USA, in which damage to streams or wetlands can be offset by the purchase of stream or wetland credits elsewhere, often provided by mitigation banks[4,63]. Biodiversity offset credit markets are used to mitigate the clearance of native vegetation in Australian states[64–66], whereas England requires most new developments to deliver a 10% 'Net Gain' in biodiversity as measured by a statutory biodiversity metric[67].

By comparison, voluntary biodiversity credit markets remain extremely limited[62]. Unlike carbon, for which voluntary offset demand is enabled by a globally fungible outcome metric (CO_2), no equivalent

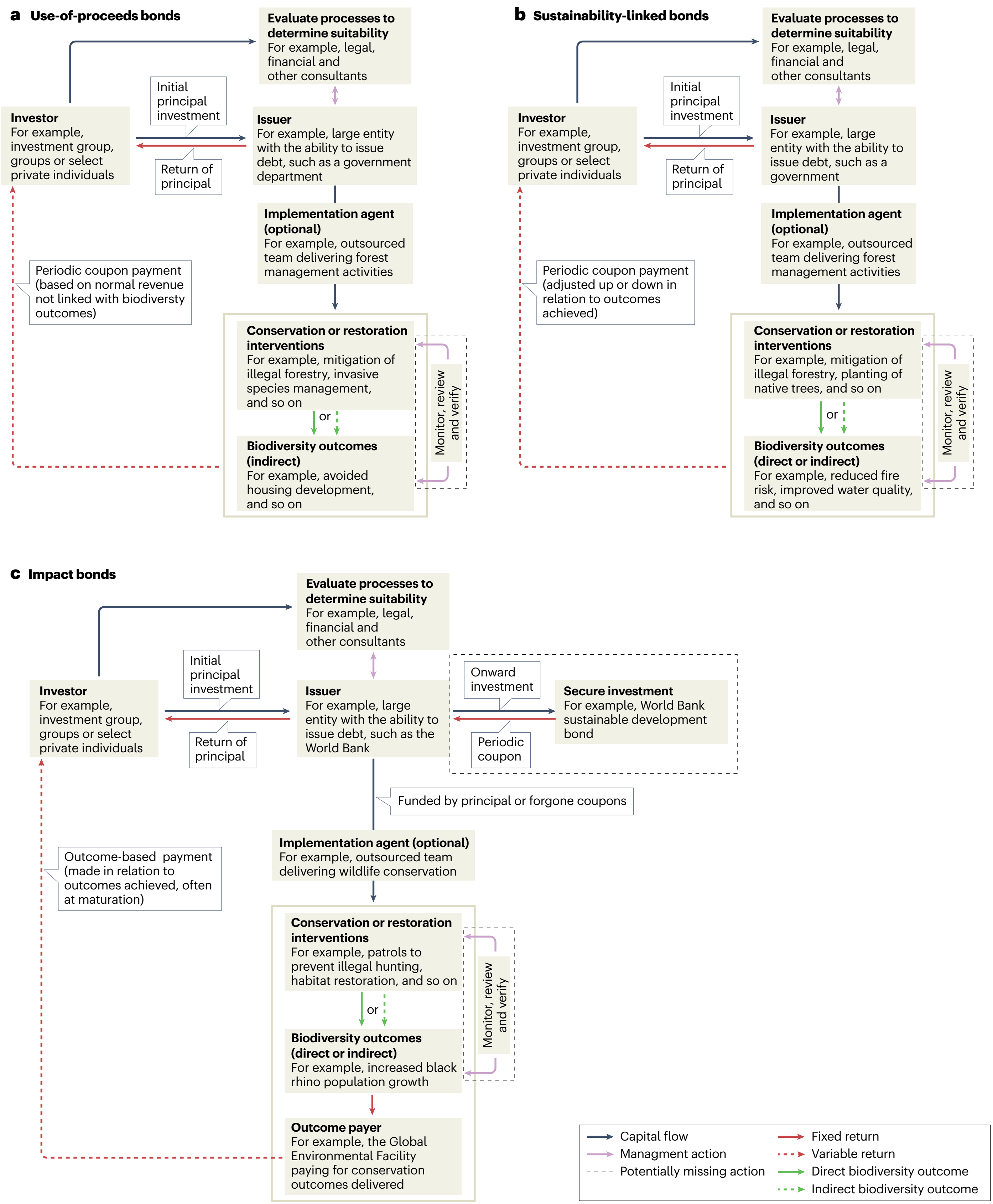
a Use-of-proceeds bonds
Evaluate processes to determine suitability
For example, legal, financial and other consultants
Investor
For example, investment group, groups or select private individuals
Initial principal investment
Return of principal
Issuer
For example, large entity with the ability to issue debt, such as a government department
Implementation agent (optional)
For example, outsourced team delivering forest management activities
Periodic coupon payment (based on normal revenue not linked with biodiversty outcomes)
Conservation or restoration interventions
For example, mitigation of illegal forestry, invasive species management, and so on
or
Biodiversity outcomes (indirect)
For example, avoided housing development, and so on
Monitor, review and verify
b Sustainability-linked bonds
Evaluate processes to determine suitability
For example, legal, financial and other consultants
Investor
For example, investment group, groups or select private individuals
Initial principal investment
Return of principal
Issuer
For example, large entity with the ability to issue debt, such as a government
Implementation agent (optional)
For example, outsourced team delivering forest management activities
Periodic coupon payment (adjusted up or down in relation to outcomes achieved)
Conservation or restoration interventions
For example, mitigation of illegal forestry, planting of native trees, and so on
or
Biodiversity outcomes (direct or indirect)
For example, reduced fire risk, improved water quality, and so on
Monitor, review and verify
c Impact bonds
Evaluate processes to determine suitability
For example, legal, financial and other consultants
Investor
For example, investment group, groups or select private individuals
Initial principal investment
Return of principal
Issuer
For example, large entity with the ability to issue debt, such as the World Bank
Onward investment
Periodic coupon
Secure investment
For example, World Bank sustainable development bond
Funded by principal or forgone coupons
Implementation agent (optional)
For example, outsourced team delivering wildlife conservation
Outcome-based payment (made in relation to outcomes achieved, often at maturation)
Conservation or restoration interventions
For example, patrols to prevent illegal hunting, habitat restoration, and so on
or
Biodiversity outcomes (direct or indirect)
For example, increased black rhino population growth
Monitor, review and verify
Outcome payer
For example, the Global Environmental Facility paying for conservation outcomes delivered
Capital flow
Managment action
Potentially missing action
Fixed return
Variable return
Direct biodiversity outcome
Indirect biodiversity outcome

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

unit of nature exists that is fungible at scale[68]. Methods used to quantify and detect changes in biodiversity for voluntary biodiversity credit units vary widely[56,57]. The lack of fungibility in biodiversity measures and standardization in measurement approaches means voluntary biodiversity credits are ill-suited for use in compensatory markets, which has constrained trading volumes to date[59]. Despite industry speculation about their future growth[62], 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[49].

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[5]. Biodiversity offsets and voluntary credits are explicitly embedded in the GBF[69], 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[53,70]. 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 (ref. 71). 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[4].

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))[72,73] (Fig. 5). Each carbon credit represents one metric tonne of CO_2 (or CO_2 equivalent) that has either been avoided or removed through forest conservation or restoration interventions[72]. Although the market for forest carbon credits is driven by their effect 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 those from removal projects[74], because REDD+ involves retaining the 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[75].

Forest carbon credits are traded in both compliance carbon markets, in which emissions reductions are mandated through regulatory caps, and voluntary carbon markets[76,77]. Their use in compliance markets is limited and subject to strict eligibility criteria[78–82] (Box 1), and forest carbon credits 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)[83,84]. Since the scandal associated with over-crediting of REDD+ credits in 2023 (ref. 85) (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 (ref. 84). This divergence reflects a growing preference for removal-based credits over avoided-loss credits in general.

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[70], scrutinized the ecological outcomes and social equity failures of for-profit conservation initiatives[18,28,86–90], described mismatches between the rhetoric of upscaling private investment in biodiversity and the realities of actual financial flows[53,91], and suggested that the promotion of private investment opportunities might reduce government action or public funding for addressing environmental or ecological crises[92]. 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.

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)[18,93]. These risks tend to steer investment towards relatively stable and predictable markets, potentially away from those that are most important for delivering biodiversity outcomes[94]. 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

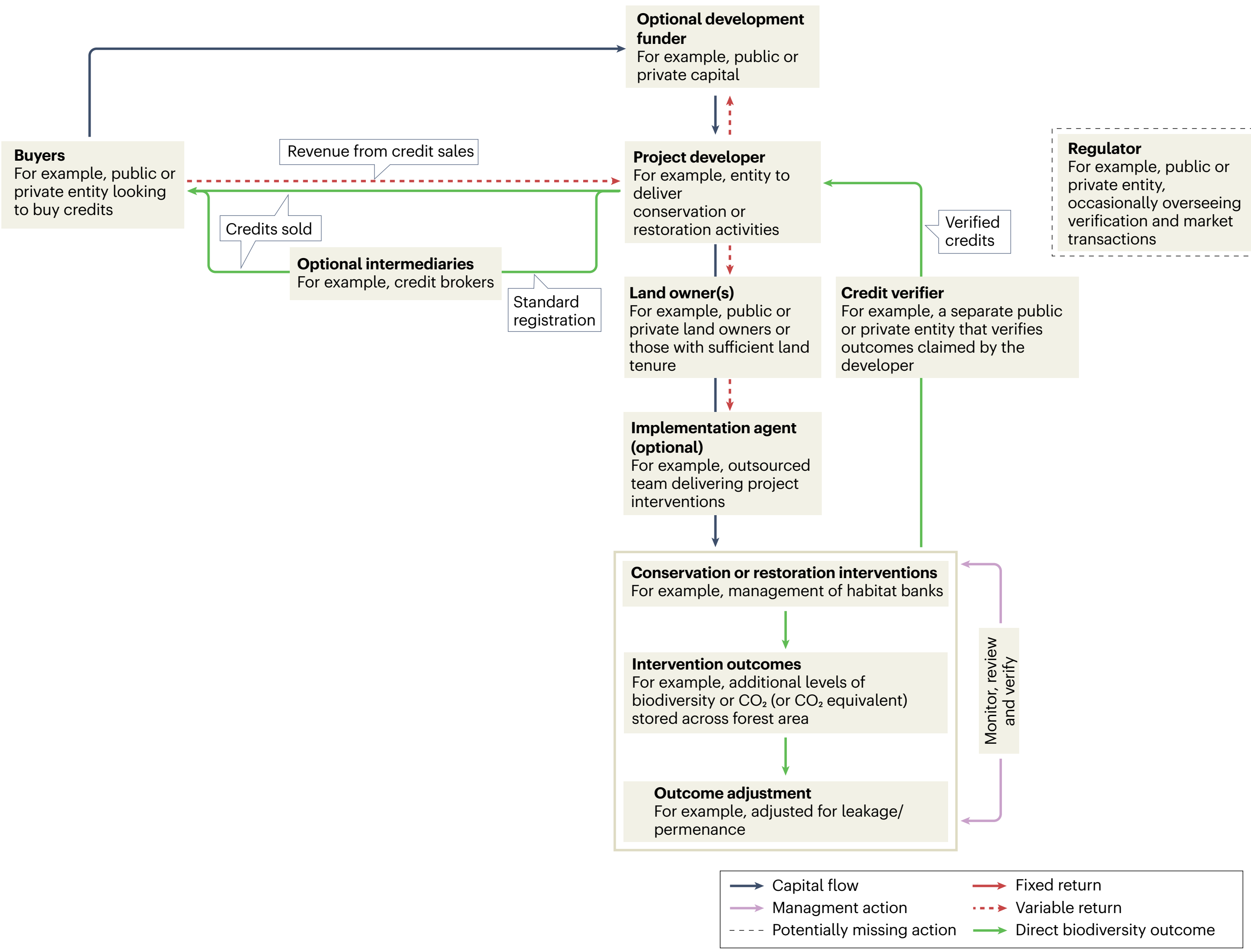

Fig. 5 | General financial flows involved in biodiversity or forest carbon credit projects. These investments derive revenue from the sale of quantified outcomes (forest conservation or restoration, or biodiversity conservation and/or restoration); see Supplementary Box 7 for a case study example. Project 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 an 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.

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 materialize[94–97]. Alongside potential delays, biodiversity conservation and restoration trajectories are also inherently uncertain[96], 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[65]. Where natural conditions remain stable, a range of implementation challenges such as weak governance[98], limited technical capacity[99], or lack of trust and appropriate engagement with Indigenous peoples and local communities (IPLCs)[100] can also undermine the delivery of effective projects[101]. Of course, principles of justice and equity also require that IPLCs should benefit from biodiversity finance, beyond mitigating the commercial risk of private investment[102–104] (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[59,60] and currency of trade[105], alongside other supply-and-demand factors that shape market stability[18,106]. For example, global biodiversity offset transactions are almost exclusively driven by national compliance markets, in which policy design directly shapes supply-and-demand dynamics[5,59]. Under both the US wetland mitigation market and England's regulatory 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 minimizes demand for off-site credits[107]. Market instability in the value of REDD+ credits owing to the over-crediting scandal[85] (Box 1) has limited the ability of

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[78–82]. For example, California's cap-and-trade programme 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 (ref. 78). Other countries have also permitted forest carbon credits in compliance markets[52,53,56]. For instance, Australia's Safeguard Mechanism allows regulated facilities to use Australian Carbon Credit Units derived from native forest regeneration[168] (although the additionality of Australian Carbon Credit Units derived from native forest regeneration has been limited[119]). By contrast, both the UK and the European Union (EU) Emissions Trading Scheme prohibits the use of forest carbon credits for regulatory emission compliance[169,170].

Forest carbon credits have had a prominent role in the voluntary carbon market, in which demand is driven by corporate net-zero and environmental, social or governance commitments[86,95,171,172]. REDD+ credits (carbon credits generated from reducing deforestation and forest degradation) dominated sales in the early 2020s (ref. 173). However, following revelations of over-crediting of REDD+ credits[86,174], more than US $1 billion of value was wiped off the voluntary carbon market in 2023 (refs. 85,173).

A number of initiatives are working to address integrity concerns relating to forest carbon credits and stimulate demand for forest carbon credits from both compliance and voluntary carbon markets[106,175]. If concerns regarding integrity and appropriate use of these credits[172] can be addressed, the potential exists for upscaling forest carbon credits to fund forest conservation and restoration as international net-zero policies (such as the Paris Agreement) are heavily reliant on offsetting[3,5,176]. Such upscaling could provide substantial funding for forest conservation and restoration. However, important caveats exist, 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[177]), emphasizing the fact that forest carbon offsets are no replacement for emission reductions.

voluntary forest carbon credits to attract large-scale investment relative to more stable commodities such as sustainable timber[18], although newer structures have incorporated carbon credits into repayment mechanisms for outcome-based bonds[38].

A range of mechanisms exists for mitigating commercial risks and encouraging greater return-seeking biodiversity finance[108]. All of these mechanisms alter the risk–return ratio for investors, by 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[18]. 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[109]. Although carbon credit revenues are often deemed too volatile to attract substantial private investment[18], 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[110]. Revenues from commodities coupled with such mechanisms for reducing market risk increase the expected risk-adjusted return of the project and enable private investment.

Insurance measures are another type of mechanism for mitigating risk, and they 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)[18]. For example, in the Green Bond for Working Forests, a major investment bank underwrites forest assets to insure investors against loss[111,112]. Blended finance is also often cited as a mechanism for de-risking projects and channelling greater private finance towards activities in the public interest[29,113]. A 2025 analysis of the investments made by a biodiversity-focused private equity firm determined 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% (ref. 19). When volatile demand limits private investment, tools such as advanced market commitments[110], outcome payments[18], pre-sales[114] 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)[115] 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[114].

Increasingly complex financial structures are emerging to reduce commercial risk and scale nature finance. One example is the Tropical Forest Investment Fund, recently launched at COP 30 alongside the Tropical Forests Forever Facility, to fund annual payments to countries for conserving and restoring tropical and subtropical moist broadleaf forests[116]. 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[117,118]. This combined pool will be invested in a diversified portfolio of public and corporate bonds, with stated intentions to exclude investments that cause substantial 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[117]. The fund's ultimate value will depend on retained earnings available once invested capital is returned and on the ecological integrity of investments chosen to deliver genuine long-term net benefits for nature.

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[49].

Integrity issues can lead to serious devaluations in credit prices, threatening businesses reliant on those revenues[106] 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)[18].

Conservation outcomes are inevitably uncertain[1], 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[86]. Similar concerns have been raised over nature-based carbon offsets in Australia[119], species conservation banks in California[120], and biodiversity offsets in Victoria and New South Wales[65,66]. However, impact risks are not confined to crediting schemes: the use-of-proceeds Tropical Landscapes Finance Facility corporate sustainability bond has been criticized for its association with deforestation of Indonesian forests[121], despite the project's zero-deforestation policy[122]. 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[121]. 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 effects 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[48]. This counterfactual is, by definition, unobservable[123] and difficult to estimate owing to the limited spatial and temporal resolution of most biodiversity datasets[124], 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)[125]. 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 could somewhat bias the assessment of project-level impacts[126]. The challenge of robust impact evaluation leads projects to rely on weak output indicators that can result in misleading claims of success[18].

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'[18]. Premature metrics focus on project outputs, such as tree planting as used in the Tropical Landscapes Finance Facility[127,128], rather than outcomes such as long-term tree survival rates and changes in biodiversity or forest carbon stocks. Simple metrics rely on broad measures such as 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[56]. 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[18].

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[48], and focus on issues such as permanence (whether gains persist over time) and leakage (whether harm is displaced elsewhere) is increasing[49,129,130]. Technological innovation can also help to plan, implement and monitor conservation and restoration interventions[131,132]. Qualitative methods such as process tracing offer pragmatic alternatives for assessing performance, either in addition to quantitative evaluation methods or when the implementation of quantitative methods is not possible[133–135]. 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.

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[136]. 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[137], failure to address social risks can generate substantial commercial risks for investors by undermining long-term ecological outcome[77,138,139].

A key social risk is the potential for biodiversity finance models to sideline IPLCs, undermining principles of justice and equity[102–104,140]. Conservation interventions designed to maximize biodiversity gains can affect local livelihoods; for example, by restricting local hunting or agricultural expansion[141,142], or by increasing populations of potentially dangerous wildlife that can intensify conflict[143]. IPLCs frequently bear these costs locally, whereas financial benefits are often disproportionately distributed outside of project landscapes, reflecting underlying asymmetries in actor, institutional and structural power[144]. For example, the Kariba Forest Carbon Project generated a revenue of up to 100 million euros 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[145]. Such inequities, long recognized in conservation practice, fuel local resentment towards developers[146], and undermine trust[147] and project effectiveness[148]. The Kariba project was ultimately ended amid reputational fallout that also affected buyers[149].

Although in theory clear land rights and local mandates are pre-conditions for attracting biodiversity finance[94], in practice, land tenure is often complex, and projects can drive displacement and exacerbate conflict[150]. Complexity often stems from mismatches between legal (that is, de jure) land ownership and customary (that is, de facto) rights, especially when projects recognize the former and overlook the latter[151]. For example, independent reports from carbon projects in Uganda and Kenya describe IPLCs being violently displaced to clear land for project development[152–154]. Economic displacement, in which rising land values or living costs associated with biodiversity finance have priced local people out of landscapes, has been observed in both high-income[155] and low and middle-income countries[121]. Although displacement and conflict are not unique to conservation funded through private investment, having characterized fortress conservation approaches for decades[156], the large-scale acquisition of land rights under biodiversity finance risks amplifying these inequities[157]. 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[158,159].

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[94], but interpreting land rights in the context of local socio-economic and political system is equally important[151]. For example, in many high-biodiversity areas, land ownership might not include ownership of the wildlife[160,161], creating additional complexity and contestation over financial rewards tied to wildlife presence[50]. Free, prior and informed consent (FPIC) is a legal requirement for project actions that might affect Indigenous people or certain other groups[137], yet only around half of voluntary biodiversity credit providers have established comprehensive FPIC protocols[57]. Direct involvement of IPLCs in project design and management has resulted in interventions that are more likely to be locally appropriate and adopted[162,163]. When interventions deliver genuine value over time, co-designed approaches can also strengthen the permanence of outcomes and reduce leakage[164–166]. 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.

Summary and future directions

Understanding return-seeking biodiversity finance mechanisms will enable stakeholders (governments, regulators, conservation practitioners, academics, investors, public actors and IPLCs, among 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)[106,158]. Return-seeking biodiversity finance that generates commercial returns without delivering ecological outcomes is unsustainable[18], 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[93]. 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[167]. 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.

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H.C. and S.O.S.E.z.E. researched data for the article. H.C., B.S.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
S.S. holds a role on the investment team at Just Climate LLP, but this article does not represent the views of the organization or have any impact on Just Climate's activities.

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