Title: Delivering Nature Positive outcomes through landscape conservation: credible actions and shared responsibility in the mining sector

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Abstract: The mining sector is increasingly expected to align their corporate nature commitments with global biodiversity goals. Emerging Nature Positive frameworks require companies not only to mitigate impacts of direct operations, but also to contribute to biodiversity recovery at the landscape scale, where impacts, dependencies and conservation priorities intersect. Yet expectations for credible landscape action remain under-specified, leaving substantial scope for inconsistent practice and potential greenwash. Here, we clarify the role of landscape conservation in Nature Positive mining commitments and propose a practical framework to guide credible, outcome-oriented investments. We define what constitutes a landscape conservation action in this context and distinguish it from obligations under the mitigation hierarchy, including actions related to offsetting, rehabilitation and mine closure. We outline how landscape boundaries and conservation targets can be defined to align with global biodiversity goals, and how responsibility and delivery roles can be shared among multiple actors. Key challenges include attributing outcomes to individual companies in complex socio-ecological systems, addressing data and monitoring limitations, navigating evolving guidance on corporate claims, and designing durable collective governance and implementation arrangements. We conclude with near-term methodological priorities and a piloting agenda for implementation across contrasting mining landscapes. Clearer sector guidance and broader societal consensus on landscape-level action are essential if mining contributions to Nature Positive goals are to be meaningful and credible.

Keywords: biodiversity; credible claims; minerals; metals; Nature Positive; no net loss; net gain; net positive impact; responsible mining

Introduction

Biodiversity is in steep decline (Díaz *et al.* 2019; IPBES 2022), creating material risks for society and business (IPBES 2022; WEF 2024). The mining sector is exposed to these risks but can also shape ecological outcomes where their extraction, infrastructure and associated land-use change are concentrated (Sonter *et al.* 2018). The Kunming–Montreal Global Biodiversity Framework (CBD 2022) commits governments and other actors to halt and begin to reverse biodiversity loss by 2030, and to support recovery by 2050—an ambition often referred to as "Nature Positive" (Locke *et al.* 2021). Nature Positive is gaining traction among the private sector (TNFD 2023), yet delivering "more biodiversity in 2030 than existed in 2020" will require systematic change in how companies operate (Booth *et al.* 2024). Business-as-usual impact

mitigation will not be enough; companies are increasingly expected to contribute beyond their operational footprints (Booth *et al.* 2024; Bang *et al.* 2025). This shift creates an urgent need for practical approaches to setting targets and prioritising actions that collectively 'add up' to achieve global biodiversity goals (Milner-Gulland 2022; Maron et al. 2024).

This challenge is particularly acute for the mining and metals sector. Increased production of many mined materials is essential for the energy transition (Aska et al. 2025) and to meet other sustainable development goals (Hertwich et al. 2015; Franks et al. 2023). However, at the same time, mine expansion, mineral processing and waste storage can drive biodiversity loss in areas of conservation significance (Luckeneder et al. 2021). While the sector has a long history of making ambitious biodiversity commitments and engaging with best-practice bodies and standards (BBOP 2012; Rainey et al. 2015)—often motivated by regulation, social licence and finance considerations (Boiral & Heras-Saizarbitoria 2017)—the ambition, terminology and implied actions associated with Nature Positive commitments vary widely, creating uncertainty about what credible action entails and how claims should be assessed.

Recently, sector initiatives have committed to action across mining's four "spheres of influence" (ICMM 2024) – Direct Operations, Value Chains, Landscapes and Business Systems – and Victurine et al. (2024) describe how actions across these spheres must be integrated and scaled to meet conservation needs (Fig. 1). Practical guidance among these spheres, however, varies in completeness. For "Direct Operations" (i.e. the operational/financial boundary used in fiscal reporting, such as a mine site or processing plant), minimum expectations are relatively well specified, including rigorous application of the mitigation hierarchy and alignment with standards such as the International Finance Corporation (IFC) Performance Standard 6 (IFC 2012; CSBI 2015; ICMM 2024). Expectations for the "Landscape" sphere—where mining operations and conservation priorities often intersect most directly—remain under-specified, leaving uncertainty about what constitutes credible landscape action and how contributions to Nature Positive should be designed, implemented and governed in multi-actor landscape settings.

In this Perspective, we develop a mining-focused approach to align landscape actions with Nature Positive outcomes. We define what counts as a landscape conservation action (and what does not) and propose a typology to select appropriate actions in mining landscapes. We synthesise approaches to define landscape boundaries, priorities and targets, and clarify how responsibility and accountability can be shared among contributors, convenors and implementers. Finally, we identify methodological priorities and a piloting agenda needed to make monitoring, claims and governance workable at the landscape scale.

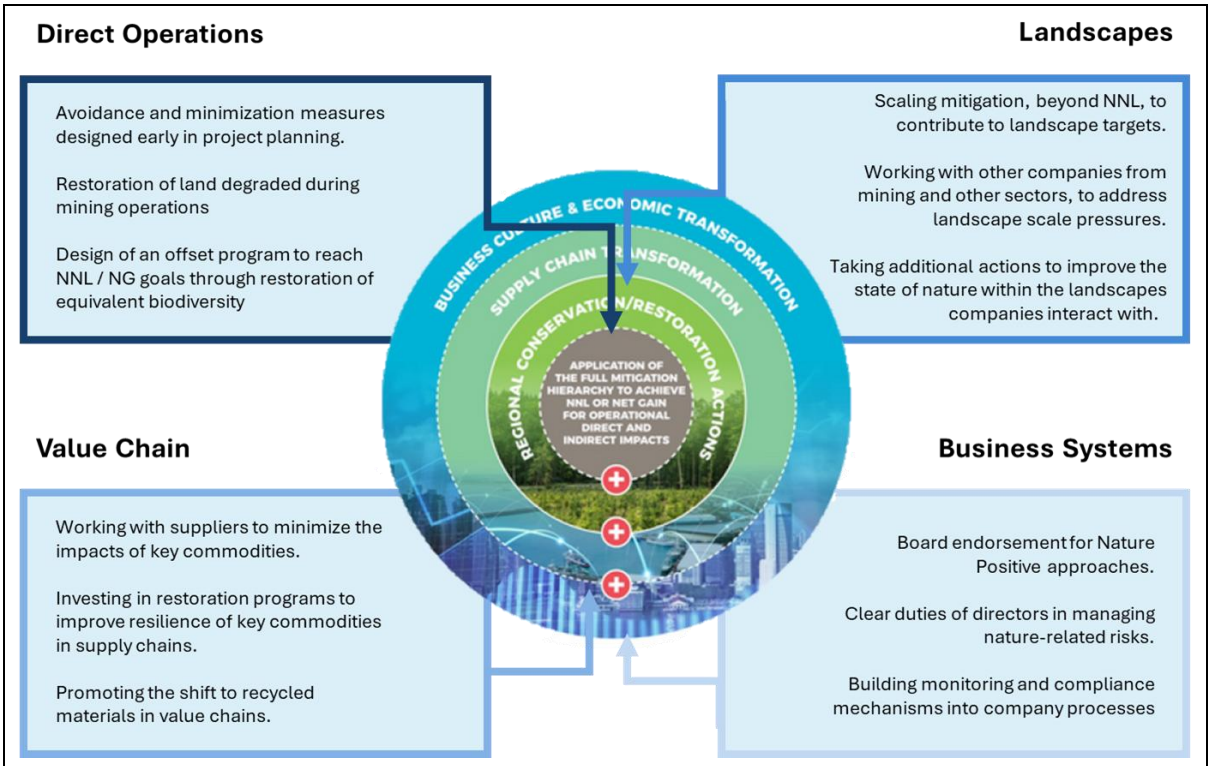

Figure 1: The mining sector's four spheres of influence over biodiversity and example actions that can contribute towards Nature Positive outcomes (adapted from Victurine *et al.* 2024). Actions are required across all spheres of influence, and actions within one sphere may depend on and drive progress in others.

Landscape conservation actions: why, what and how

Why mining sector engagement in landscapes matters

Mining companies are well positioned to drive landscape scale outcomes for biodiversity. Their tenure overlaps a substantial share of Key Biodiversity Areas (Simkins et al. 2023), and this overlap is likely to increase as demand for energy-transition minerals grows and ore grades decline, expanding exploration, production and waste storage into ecologically important regions (Sonter et al. 2020, 2023). However, because mining concentrates disturbance and infrastructure in specific places, opportunities for the sector to invest in conservation tend to be clustered within landscapes (Sonter et al. 2014). With multi-decade operational horizons, companies also often become influential landscape actors, shaping land-use decisions, infrastructure trajectories and ecological outcomes over long timeframes, which are needed to implement effective conservation programmes (Boldy et al. 2021; Giljum et al. 2025).

Landscape action can provide significant benefits to mining companies, reducing their operational, social and long-horizon risk of nature loss. Mining operations often depend on landscape-scale ecological conditions, including stable hydrological regimes (Northey *et al.* 2017) and seed supply for mine site rehabilitation (Turner *et al.* 2022). Achieving no net loss at the operation level is also increasingly treated as a necessary foundation for corporate commitments, but often insufficient to meet societal expectations implied by Nature Positive (Booth *et al.* 2024; Maron *et al.* 2024). In many regions, legitimacy and regional support for mining therefore hinge on whether companies contribute to enhancing multiple values of

biodiversity, including those important to Indigenous Peoples (Boldy *et al.* 2023), beyond their direct operations.

What counts as landscape conservation action (and what does not)

Landscape conservation actions sit beyond existing requirements to manage nature-related impacts from direct operations and value chains, including rigorous application of the mitigation hierarchy (Milner-Gulland 2022; Maron et al. 2024; Thomas et al. 2024). They are not a rebrand of measures such as offsets to compensate for the residual impacts of mining, or to undertake mine-site rehabilitation to reverse impacts, or to implement other mine closure commitments. Instead, they deliver additional outcomes for biodiversity (Maron *et al.* 2024), consistent with the Nature Positive ambition to halt and reverse biodiversity loss (Milner-Gulland 2022; Thomas *et al.* 2024). They may involve taking new activities, or extending and amplifying existing measures across space and time to generate additional outcomes.

Four features can be used to define which actions credibly "count" at the landscape scale. They are additional to required mitigation and do not shift costs across spheres of influence (Maron *et al.* 2024); aligned with landscape objectives and targets (and, where feasible, global goals; Simmonds *et al.* 2020); measurable in implementation and outcomes (Bang *et al.* 2025); and grounded in evidence, with a clear theory of change linking action to biodiversity outcomes(Milner-Gulland 2022; White *et al.* 2024). These guardrails to actions do not eliminate their uncertainty but do reduce scope for misinterpretation and help distinguish credible landscape actions from business-as-usual biodiversity impact mitigation and investment.

A typology of landscape conservation actions for mining

Three types of landscape conservation action exist for mining (Fig. 2), each differing in their relationship to addressing residual impacts of direct operations, their conservation logic, governance needs and feasibility of measurement and attribution (Table 1). First, substantially scaling up compensation actions beyond what is required (once uncertainties have been considered) to balance project impacts, helping to align offsetting practices to the level of contribution needed achieve landscape-level conservation targets (Simmonds et al. 2020, 2022). Second, addressing landscape-level pressures driving biodiversity decline, helping to secure the durability and longevity of already required actions, such as offsets or rehabilitation (Glen et al. 2013). Third, opportunity-driven landscape investments, improving the state of biodiversity for priority values not directly linked to mining impacts, although through improving the aspects of nature valued by rights-holders and stakeholders they can help to de-risk mining operations (Northey *et al.* 2017; Turner *et al.* 2022).

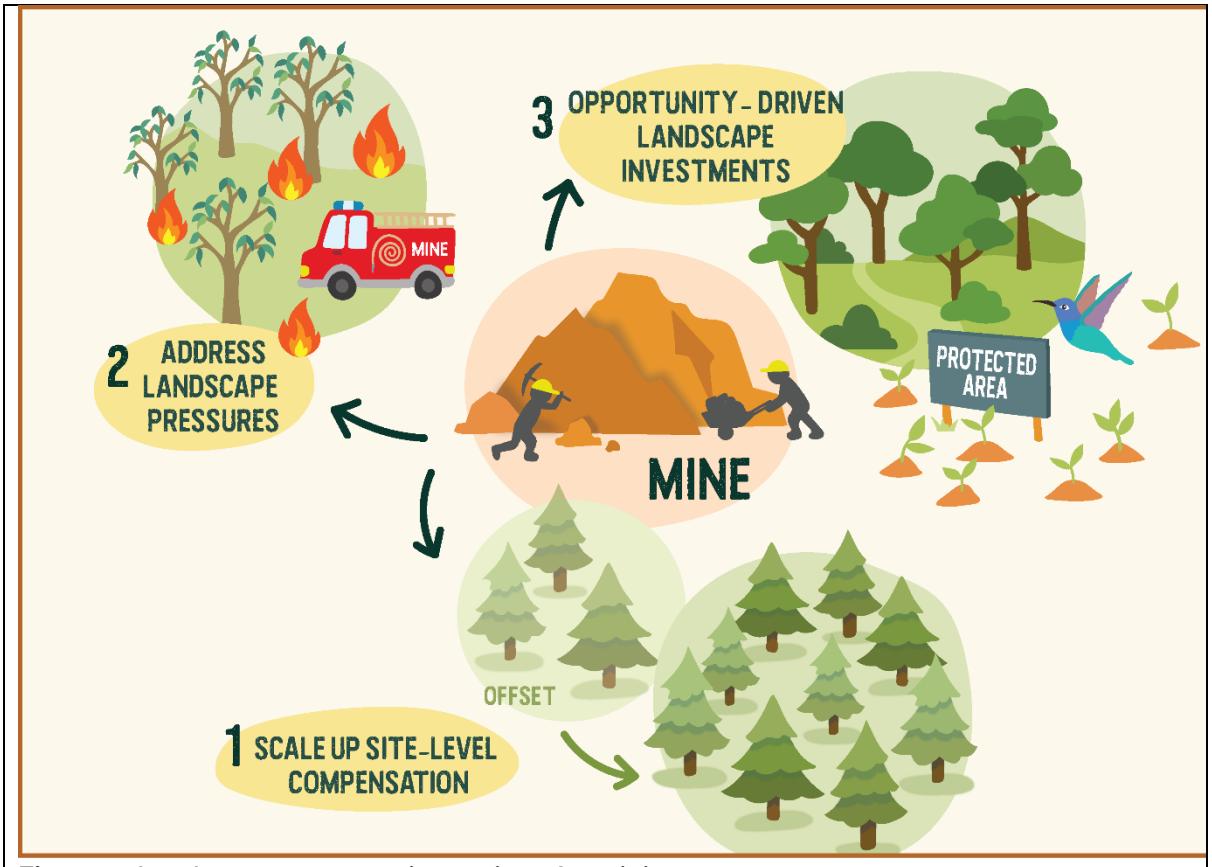

Figure 2: Landscape conservation actions for mining

Table 1: Types of landscape conservation actions for mining companies (summary)

Dimension	**Type 1: Scaling compensation beyond site-level impacts**	**Type 2: Addressing broader landscape pressures**	**Type 3: Opportunity-driven landscape investments**
Primary rationale	Extend mitigation/compensation to deliver gains beyond required project-level no net loss or net gain	Secure site-level gains and sustain broader outcomes by reducing external pressures	Improve the state of biodiversity for priority values within the landscape
Link to residual impacts	Directly linked: scales up mitigation/compensation to generate additional gains	Indirectly linked: reduces threats that undermine mitigation/rehabilitation/offset outcomes	Not linked to residual impacts
Core conservation logic	"More-than-offset" scaled to landscape targets	Threat reduction to maintain/enhance outcomes	Contribution to recovery/natural capital assets
Typical actions	Increase scale, duration or ambition of offsets/compensation beyond regulatory requirements	Manage invasive species, land-use change, pollution or overexploitation across the landscape	Protect/restore priority ecosystems, species or functions not connected to impacts
Theoretical example	Expand offset restoration to contribute to regional biodiversity recovery targets	Catchment-wide invasive control to secure offset outcomes and broader values	Voluntary creation of a new protected area to secure shared water/biodiversity values
Governance implications	Often anchored in approvals; may extend into landscape partnerships	Requires coordination with multiple land managers and stakeholders	Typically relies on collaborative or collective landscape governance
Measurement & attribution	Comparatively well-defined metrics; scaling adds complexity	Moderate complexity (indirect links; shared outcomes)	Highest complexity (diffuse benefits; shared responsibility)
Contribution logic to Nature Positive	Generates additional gains beyond balancing impacts	Safeguards/amplifies gains across the landscape	Improves overall state of biodiversity within the landscape

From actions to outcomes: landscapes, targets and shared responsibility

Credibility depends on whether actions translate into measurable biodiversity outcomes at the landscape scale. What this looks like will vary with a landscape's baseline condition, distribution of pressures, and governance capacity. For example, in heavily degraded landscapes where mining has been a major driver of impacts, targets may need to be more ambitious and mining's share of contribution correspondingly larger; comparatively, where pressures are distributed and collective institutions are strong, responsibilities may be more widely shared. Across contexts, three linked design elements recur: the landscape boundary used for target-setting, the priorities and targets defined within it, and the allocation of responsibility for contribution and accountability for convening and delivery among actors who influence outcomes.

The landscape boundary sets the scale at which priorities and targets are framed, actions planned and responsibility shared (Fig. 3). Landscape frameworks have converged on boundaries that enable management while aligning with the scales of key ecological processes and pressures (ISEAL 2024). While mining companies often delineate such areas for impact assessment purposes (Glasson & Therivel 2013), best-practice approaches broaden these areas to include the ecological patterns, processes and functions needed to sustain priority biodiversity values (Juffe-Bignoli *et al.* 2021), consistent with IFC's "ecologically appropriate area of analysis" (IFC 2019). Boundary-setting is also increasingly complemented by dependency- and influence-based perspectives (Carvalho *et al.* 2023; TNFD 2023) and by a socio-ecological systems framing that foregrounds other critical considerations for effective landscape conservation: governance and investment in livelihoods (Morrison 2016; SBTN 2024; AFI 2025).

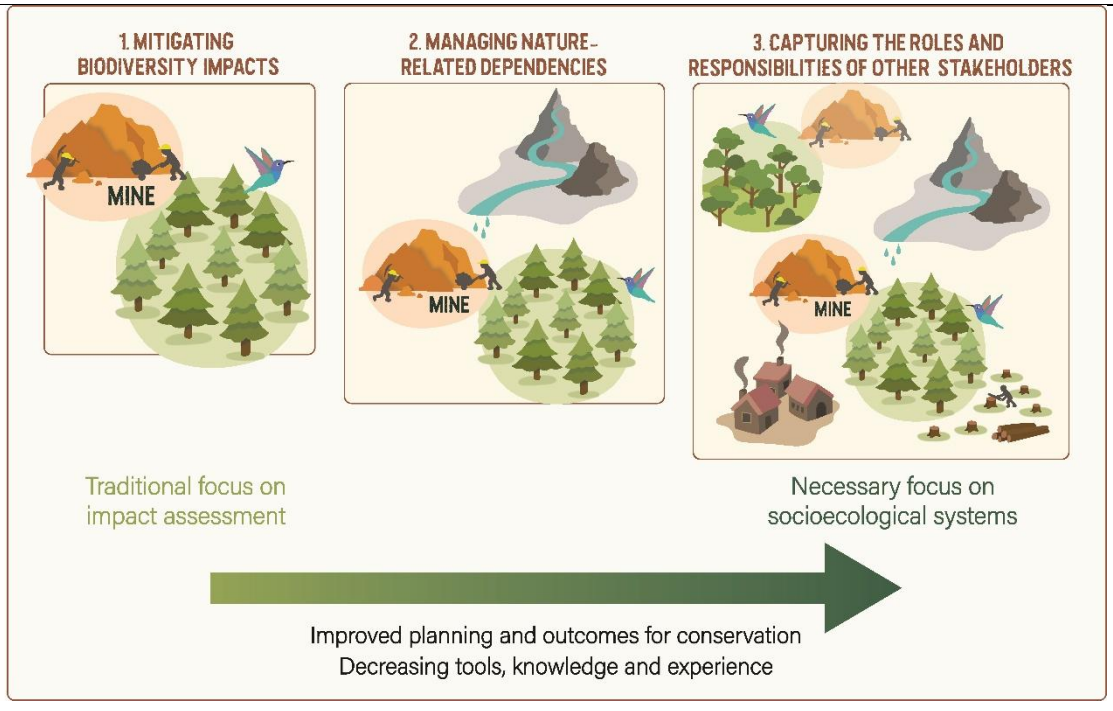

Figure 3: Defining landscape boundaries for target setting.

The literature on Systematic Conservation Planning provides a well-established basis for identifying landscape conservation priorities, quantitative targets and portfolios of possible actions. In some landscapes, such plans may already exist—prepared by governments, natural

resource management groups or conservation organisations, including those linked to National Biodiversity Strategies and Action Plans. Where robust plans are absent, global goals can sometimes be translated ("downscaled") to landscape targets (Bai *et al.* (2024), either using uniform targets (e.g. GBF Target 2 would translate to effectively restoring 30% of a landscapes degraded ecosystems by 2030) or contextual approaches which distribute global targets among landscapes based on biodiversity importance and degradation (Simmonds *et al.* 2020; Maron *et al.* 2024). In many cases, downscaling remains difficult because global targets are not directly measurable at landscape or finer scales (Butchart *et al.* 2016). A complementary pathway is to set targets through bottom-up processes that engage landscape actors (Indigenous Peoples and local communities, businesses, governments and civil society) to align priorities, feasibility and monitoring, and to strengthen durability through shared governance (Estrada-Carmona *et al.* 2024; ISEAL 2024).

In mining landscapes, the stakeholders that can contribute towards achieving set targets typically include mining companies, public actors (governments and rights-holders), land managers and civil society, and value-chain actors such as financiers and downstream purchasers. A challenge is that contribution, convening and delivery roles in mining landscapes are often conflated across these actors, or change over time. Contributors may provide resources or operational change, whereas convening, governance and implementation often sit with institutions able to coordinate across land tenures and persist beyond individual project lifecycles. Allocating responsibility among actors can also draw on multiple factors, including the extent of each actor's activity, historical impacts, capacity to act, and opportunity and equity (Piñero *et al.* 2019; Hickel *et al.* 2022; Sun *et al.* 2022; Bai *et al.* 2024; Booth *et al.* 2024; Gupta *et al.* 2024). Current guidance treats activity in the landscape as a transparent baseline for allocation, which can be adjusted for feasibility and fairness (ISEAL 2022, 2023a, 2023b). Pooled mechanisms, such as trust funds and collective programmes, can reduce transaction costs and sustain delivery across mine life and post-closure, but also heighten the need for clarity about shared responsibility and credible claims when outcomes depend on multiple actors (Gupta *et al.* 2024; Kılkış *et al.* 2024).

Methodological priorities and a piloting agenda

Substantial innovation is needed if mining companies are to effectively and credibly contribute to Nature Positive outcomes through landscape scale actions. A core need is to translate global biodiversity goals into landscape-level targets that reflect ecological conditions, multiple pressures and data constraints (Bai et al. 2024; Maron et al. 2024). A priority is clarifying when companies are expected to take landscape action across the full set of places where they impact and depend on nature (TNFD 2023), and how ambition should vary with degradation, feasibility and equity (Gupta et al. 2024). National Biodiversity Strategies and Action Plans (NBSAPs) can provide an intermediate reference point to align landscape targets with national priorities, but their spatial specificity and implementation status vary. Without clearer ways to translate and compare contributions across actors and sectors, there is a limit to how far corporate landscape action can be aggregated as a meaningful contribution towards the Global Biodiversity Framework.

Guidance is converging on principles for credible claims about landscape outcomes, including distinguishing participation, action and outcome claims; avoiding implied sole attribution; and being transparent about scope, evidence and assumptions (ISEAL 2023a). In the absence of fully developed attribution methods, these principles provide an immediately usable basis for responsible reporting. However, a central unresolved question is what level of outcome claim is appropriate given the landscape context and a company's impacts, capacity and role in

collective delivery. Advancing methods to link observed landscape change to specific actions and actors remains a priority, alongside clearer guidance on how claims should vary across contexts while acknowledging the inherent limits of attribution in complex systems (Bai *et al.* 2024; Gupta *et al.* 2024).

Demonstrating Nature Positive outcomes at the landscape scale requires monitoring systems that are sensitive to change, fit for context, and supported by governance arrangements for data sharing (Sayer *et al.* 2013; ISEAL 2024). Many tools exist, but there is limited consensus on which indicators and institutional arrangements are most appropriate for tracking landscape-level change (Victurine *et al.* 2024; White *et al.* 2024). Earth Observation can monitor land-use change, habitat extent and fragmentation at scale, and proxy some aspects of condition through change detection and machine-learning approaches (LEON 2025), but direct measurement of many biodiversity components remains limited. Progress will therefore depend on integrating Earth Observation with field-based monitoring, Indigenous and local knowledge, and complementary approaches such as Natural Capital Accounting (Parkhurst *et al.* 2025), coupled with improved data governance, interoperability and collaborative monitoring that can evolve as standards develop.

Many pressures relevant to mining landscapes, such as invasive species, altered fire regimes and catchment-scale processes, cannot be managed effectively by individual actors. Pressures are dynamic and may intensify due to population growth, in-migration and new development, underscoring the need for durable governance arrangements (Sayer *et al.* 2013). Research and practice are needed to identify which governance models (e.g. pooled funds, coordinated spatial action plans, jurisdictional initiatives, public–private partnerships or delegated management arrangements) most effectively support long-term delivery and how companies can invest credibly in lands and seascapes they do not control. Responsibility sharing raises parallel questions about how actors at varying distances from the landscape, including financiers and downstream purchasers, should contribute (Piñero *et al.* 2019; Sun *et al.* 2022; Gupta *et al.* 2024). It also raises challenges for corporate claims when other actors fail to deliver; existing guidance points to protecting credibility by distinguishing participation, action and outcome claims, being explicit about boundaries and assumptions, and avoiding any implication of sole attribution (ISEAL 2022b), though best practice is still emerging.

Across these priorities, piloting of coordinated conservation programmes will be essential. Carefully designed pilots across contrasting mining landscapes—varying in ecological condition, governance systems, data availability and stakeholder composition—offer an efficient way to test and refine the framework in decision-relevant settings. Pilots can operationalise the action typology proposed in this paper and apply the guardrails in real portfolio choices, while explicitly testing the limits of attribution and monitoring under changing future pressure scenarios. Comparative learning across pilots can show how boundaries are negotiated, how targets are interpreted, how responsibility sharing functions, and which combinations of actions are feasible and effective. Done well, pilots will generate transferable lessons while providing mining companies and other actors with a clearer pathway for credible contributions to Nature Positive outcomes at landscape scales.

The principal constraints on scaling mining-sector landscape conservation contributions to global biodiversity goals are increasingly methodological rather than conceptual. Without improved approaches to monitoring landscape change and situating individual and sectoral contributions within shared outcomes, landscape actions will remain difficult to compare, aggregate or rely upon as contributions to the Global Biodiversity Framework. Advances in Earth Observation, data integration and collective monitoring offer a plausible pathway, but only if

coupled with transparent attribution frameworks and governance arrangements that explicitly recognise uncertainty and shared responsibility. Addressing these challenges is therefore critical not only for credible Nature Positive claims, but for enabling landscape conservation to contribute meaningfully to halting and reversing biodiversity loss at scale.

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