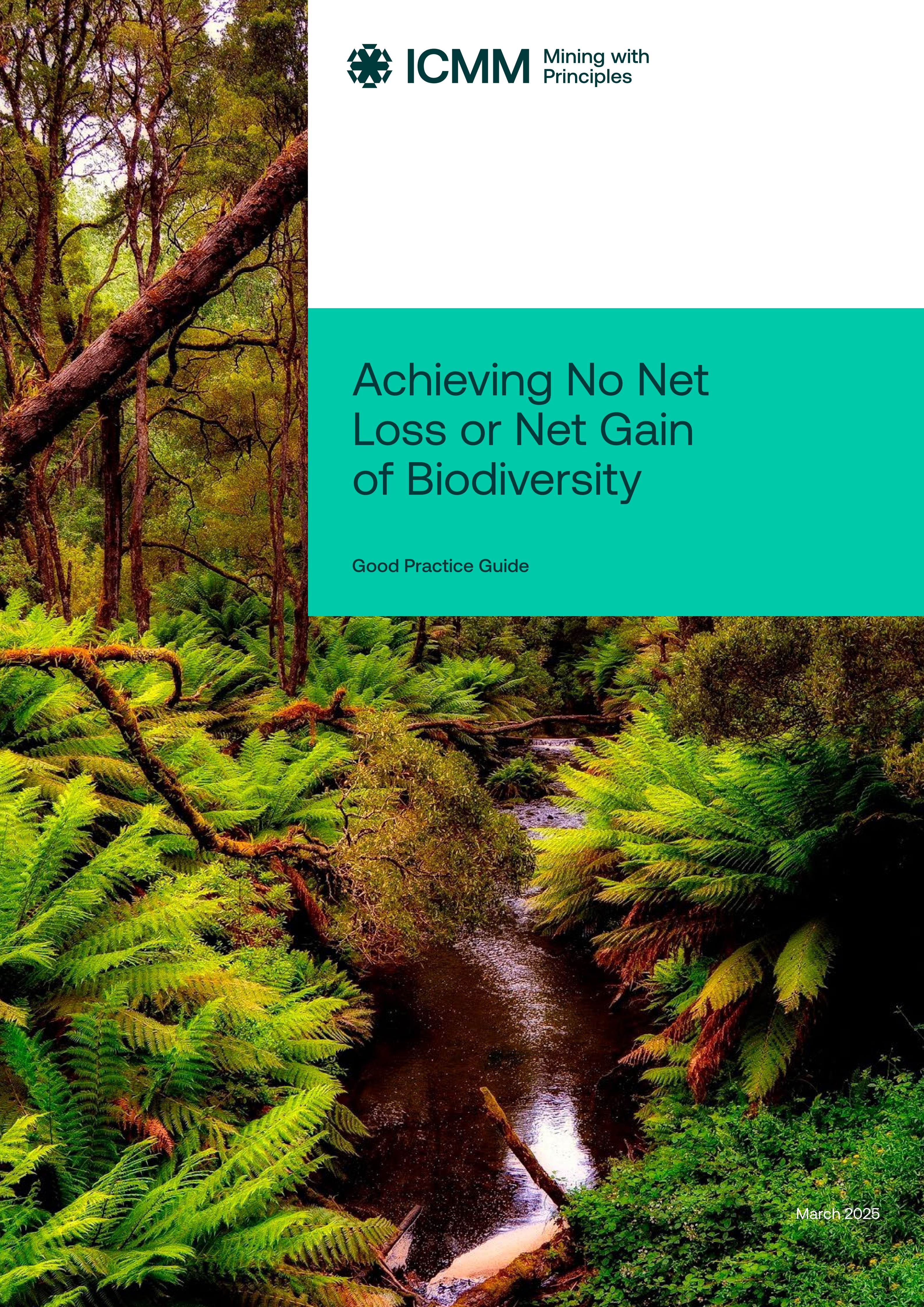
ICMM Mining with Principles

Achieving No Net Loss or Net Gain of Biodiversity

Good Practice Guide



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Foreword

Nature is the lifeblood of our planet, sustaining the ecosystems, communities, and economies that form the foundation of our collective well-being. For the mining and metals industry, whose operations often intersect with areas of high biodiversity value, the imperative to protect and conserve nature is not just a responsibility – it is a call to leadership.

I am proud of the commitments that ICMM members have made to contribute to a nature positive future. These commitments are rooted in an acknowledgment of our industry's impact on nature and dependence on the essential services healthy ecosystems provide – such as reliable access to clean water, erosion prevention and flood control. We are committed to not only mitigating harm but also fostering restoration and regeneration. At the heart of these efforts lies our goal to achieve no net loss or net gain of biodiversity across our operations by mine closure – a principle enshrined in ICMM's Nature Position Statement and guided by the Kunming-Montreal Global Biodiversity Framework.

This *Good Practice Guide for Achieving No Net Loss or Net Gain of Biodiversity* embodies our collective ambition to deliver tangible, science-based outcomes for nature. The guide is both a technical resource and a testament to our shared commitment to a sustainable future. It provides practical steps for every stage of the mining lifecycle – from baseline assessments to applying the mitigation hierarchy and transparent disclosure of progress – and reflects the evolving standards of best practice for our sector.

But guidance alone cannot achieve change. Action requires collaboration, innovation, and accountability. It calls on us to listen to those most deeply connected to the land, to partner across value chains, and to invest in systems transformation that addresses the root causes of nature loss. Achieving no net loss or net gain is not the endpoint; it is a milestone on the path to a regenerative relationship with nature.

I encourage all ICMM members and the wider mining and metals industry to embrace this guidance as a tool to deepen their commitments to nature. Together, let us demonstrate that responsible mining is not just possible but essential for achieving a resilient and equitable future for all.

Rohitesh Dhawan
President and CEO, ICMM

How to Use this Guidance

This guide is structured in the following sections:

01	**Introduction:** Introduction and overview of no net loss of biodiversity in a mining and metals context as well as commitments for ICMM members
02	**The key elements for achieving no net loss or net gain:** Overview of the seven stages in the process of achieving no net loss (NNL) or net gain (NG) of biodiversity
03	**Establish a biodiversity Area of Analysis:** Guidance on how to establish a comprehensive biodiversity Area of Analysis (AoA), which is foundational to establishing an effective baseline
04	**Establish a baseline: the foundation for impact assessment and mitigation:** Overview of the importance of robust baselines and guidance for the process of conducting new or retrospective baselines
05	**Select site-level biodiversity indicators and metrics:** Outline of ways companies can measure progress towards NNLs or NG of biodiversity using biodiversity indicators within a Pressure-State-Response framework
06	**Assess impacts and apply the mitigation hierarchy:** Overview of the iterative nature of assessing impacts and effectively applying the mitigation hierarchy to support the achievement of NNL or NG of biodiversity
07	**Offset residual impacts on biodiversity:** Guidance on how to undertake quantitative residual impact assessments and outline of good practice offsetting principles to achieve NNL or NG of biodiversity outcomes
08	**Monitor and apply adaptive management:** Explains the rationale for monitoring progress towards the achievement of NNL or NG of biodiversity and the value of applying an adaptive management approach given inherent uncertainties
09	**Transparently disclose:** Identifies disclosures relating to NNL and NG required of ICMM members, as well as some other regulatory or voluntary NNL or NG commitments and how these might be achieved

Introduction

01

Key objective: To introduce why no net loss and net gain of biodiversity are so important for the mining and metals industry, ICMM's related commitments, and provide an overview of the purpose of this guidance.

Box 1.1: Definition of no net loss and net gain of biodiversity[1]

No net loss (NNL) is the point at which losses in biodiversity are balanced by proportional gains, relative to a defined baseline state. Net gain (NG) is achieved when biodiversity gains exceed biodiversity losses, measured in the same way as losses, using a credible metric. The amount of NG may be framed to deliver a safety margin or to meet a regulatory or other target (e.g. 10% above NNL[2]).

1.1 Context

In December 2022, the need for urgent action to halt and reverse biodiversity loss by 2030 was codified in the Kunming-Montreal Global Biodiversity Framework (GBF). The global societal goal for nature positive (a term established by the Nature Positive Initiative) is to halt and reverse nature loss by 2030, relative to a 2020 baseline, and achieve full recovery by 2050 to support the implementation of the GBF.

The mining and metals industry has a high level of interaction with and dependency on nature. As such, the industry bears a responsibility to understand and actively mitigate nature-related impacts and seek opportunities to contribute to the conservation and restoration of nature. Responsibly produced minerals and metals play a critical role in meeting global sustainable development goals, and demand for energy transition metals and mined materials is increasing as the world transitions to a low carbon economy. Supplying these materials while also halting and reversing nature loss is crucial to a nature positive future.

ICMM's Nature Position Statement draws on global goals and was shaped by experts and leaders from across industry, civil society, Indigenous Peoples' groups, academia and finance. It signifies a collective commitment to contribute to a nature positive future. The Position Statement includes commitments across mining and metals companies' four spheres of influence: direct operations, value chains, landscapes and systems transformation, all supported by transparency. Achievement of no net loss (NNL) or net gain (NG) of biodiversity (see Box 1.1) for all members' direct operations is a core foundation of the contribution to a nature positive future.

1. Net Gain (NG) may be used synonymously with Net Positive Impact.
2. As in England's Biodiversity net gain policy, [Online]. Available at https://www.gov.uk/guidance/biodiversity-net-gain

1.2 Why no net loss or net gain of biodiversity is important for the mining and metals sector

Mined materials are spread across many of Earth's terrestrial biomes and the impact of mining on biodiversity differs significantly between regions and locations. Some of the minerals needed for clean energy technologies, such as nickel and cobalt, are largely found in tropical forested areas of biodiversity importance. For example, Indonesia accounts for over 54%[3] of the world's nickel production and the expansion of nickel mining, particularly on the islands of Sulawesi and Halmahera, has contributed significantly to deforestation. In Latin America, the 'Lithium Triangle' is concentrated in Argentina, Chile and Bolivia in salt pans, some of which support unique biodiversity of significance to conservation. Copper porphyry occurs in a wide range of environments, including the North American Cordillera, the Andes, the Philippines, Indonesia and Papua New Guinea, whereas sediment-hosted deposits support different habitats in the Central African Copperbelt. Iron ore is mined in around 50 countries, with Australia and Brazil dominating exports, while bauxite is found in biodiversity-rich tropical areas of Guinea and Brazil and in the Jarrah Forest in temperate Southwestern Australia.

Using data from S&P Global (2023), the Worldwide Fund for Nature – Norway (WWF-Norway) in collaboration with the Rainforest Foundation Norway[4], completed a global geospatial assessment of extractive datasets against forest-related variables. Globally, 4.6% of active mining projects have some form of direct spatial relationship with Intact Forest Landscapes[5]. An estimated 7.5% of active mines had some form of direct spatial interaction with protected areas, and around 6.2% are associated with Key Biodiversity Areas (i.e. sites of global significance for biodiversity conservation). These figures would be much higher if this spatial analysis included active mining concessions (acknowledging that many concessions never progress to active mining).
Given the high level of interaction that mining and metals operations have with nature, and in many cases with areas of high biodiversity importance, achievement of NNL or NG of biodiversity at direct operations would represent a significant and tangible contribution towards a nature positive future.

1.3 ICMM nature commitment to no net loss or net gain of biodiversity

This guidance document relates to direct operations and addresses ICMM's Nature Position Statement Commitment 1.3. This commitment (see Box 1.2) is to assess and address material risks and impacts to biodiversity and ecosystem services by implementing the mitigation hierarchy actions to avoid and minimise impacts, to restore affected areas and, finally, to offset the residual impacts to achieve a minimum of NNL/NG of biodiversity by completion of closure. The mitigation hierarchy is regarded as the best practice approach for managing biodiversity risk in development projects.

Box 1.2: ICMM's Nature Position Statement – wording of Commitment 1.3

Assess and address material risks and impacts to biodiversity and ecosystem services by implementing the mitigation hierarchy actions to achieve a minimum of NNL or NG of biodiversity by completion of closure. This includes through:

- Applying the mitigation hierarchy with an avoidance-first focus from the earliest feasible stage of exploration and continuing throughout project lifecycles, and
- Pursuing progressive restoration, rehabilitation and/or reclamation where feasible and commencing with offsets for residual adverse impacts as early as possible, and
- Transparently disclosing the relevant methodology used to calculate NNL or NG, objectives, and site-level performance in 2030, 2040 and 2050, or more frequently.

For all new operations and significant expansions, no net loss or net gain should be measured against a pre-operation or pre-expansion baseline respectively. For existing operations, this should be measured against a 2020 or earlier baseline. For future acquisitions, the baseline should be the date of takeover or earlier.

Where NNL is not feasible at existing operations, disclose how the mitigation hierarchy and additional conservation actions are applied to appropriately address negative impacts on biodiversity.

3. S&P Global Research (2024), Indonesia – *Mining by the numbers,* 20204. [Online]. Available at https://www.spglobal.com/marketintelligence/en/news-insights/research/indonesia-mining-by-the-numbers-2024
4. Patterson, D.J., Trebbi, E., Naime, J., Izquierdo, P., Tibaldeschi, P. and McQueen, S. (2024). *Forest-Risk Extractives: A Geospatial Analysis.* World Wide Fund for Nature Norway (WWF-Norway) and Rainforest Foundation Norway. [PDF]. Available at https://dv719tqmsuwvb.cloudfront.net/documents/High_risk_extractive_assets_forests_final_compressed-1.pdf
5. Potapov, P., Hansen, M.C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S., and Esipova, E. (2017). 'The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013', *Science Advances*, volume (1). Available at https://www.science.org/doi/10.1126/sciadv.1600821

1.4 Purpose, contents and scope of this guidance

The purpose of this guidance is to support practitioners to meet their NNL or NG of biodiversity commitments, such as ICMM's Nature Position Statement Commitment 1.3. This document is designed to take practitioners on a comprehensive journey through the critical steps needed to develop accurate loss-gain calculations. The guidance situates NNL accounting within the broader process of biodiversity assessment, rather than limiting loss-gain calculations to a standalone chapter. This is intentional, as the accuracy of these calculations is critically dependent on the robustness of all stages in the assessment process. For example, errors in establishing baselines, selecting indicators and metrics, or applying the mitigation hierarchy can lead to inaccuracies in the final residual loss calculations.

The document outlines key steps to achieving NNL and/or NG, including determining a company's areas of influence, undertaking baseline surveys, selecting indicators and metrics, assessing impacts, applying the mitigation hierarchy, monitoring and disclosing the outcomes. Many of these concepts are not new to the mining sector – indeed some companies have had NNL or NG targets for years – however, the purpose of bringing them together here in a single guidance document is to support sector-wide progress on nature commitments and to further support in monitoring outcomes, improving current practice and preparing for disclosure.

The guidance is primarily focused on land and freshwater realms of nature, although many of the principles will also extend to oceans and the atmosphere. Mitigation of the impact to ecosystem services is beyond the scope of this guidance and is covered elsewhere[6]. The guidance represents current good practice and provides practical steps for companies delivering NNL or NG of biodiversity commitments. However, achieving NNL/NG of biodiversity is only one part of a nature positive commitment. As biodiversity is complex and dynamic, approaches towards nature-positive outcomes will continue to improve and, as such, readers are encouraged to continue to review and revise actions as new approaches and practices emerge.

Some components of ICMM's NNL or NG of biodiversity Commitment 1.3 (see Box 1.2) are clearly specified. For new operations (from 1 January 2024 onwards), NNL or NG should be measured against a pre-operational or pre-expansion baseline respectively. For existing operations, this should be measured against a 2020 or earlier baseline and for future acquisitions, the baseline should be the date of takeover or earlier. Lastly, the target date for achievement of NNL outcomes is by the completion of the site's closure.

Closure is the act of stabilising and restoring environments that have been affected by operational activities. This can start when or before operations have ceased and ends when all decommissioning, demolition and restoration activities have been completed. Some monitoring, management and ongoing mitigation measures for specific aspects (e.g. water treatment) may still occur after this point (i.e. during post-closure)[7].

Other areas are left open for interpretation, such as which components of biodiversity are within scope (e.g. ecosystems, species, processes), whether biodiversity losses caused by indirect and cumulative impacts of project operations should also be mitigated, and the amount of gain required to constitute a NG outcome. The document does, however, signpost the specific requirements of accepted good international industry practice on these issues, particularly International Finance Corporation Performance Standard 6 (IFC PS6), where they are more prescriptive.

To improve the value of the guidance to practitioners, case studies and examples are used throughout to highlight challenges, illustrate practical solutions and demonstrate where successful outcomes have been achieved.

Additional detail on the scope and structure of the guidance is provided in Section 2.

A glossary of terms and their definitions is provided in Annexe 1.

6. Bull, J.W. 1, Baker, J. 2, Griffiths, V.F 3, Jones, J.P.G. 4 and Milner-Gulland, E.J. 5 (2018). *Ensuring No Net Loss for people as well as biodiversity: good practice principles.* [Online]. Oxford, UK. Available at DOI: 10.31235/osf.io/4ygh7
7. Adapted from: ICMM (2019), *Integrated Mine Closure: Good Practice Guidance, 3rd ed*. [PDF].

The Key Elements for Achieving No Net Loss or Net Gain

02

Key objective: To provide an overview of the key elements for achieving NNL and NG of biodiversity and how these are addressed in later sections of this guidance.

Area of Analysis (AoA): The study area for the assessment of biodiversity-related risks, impacts, opportunities and dependencies, which includes the project's AoI, as well as an understanding of the presence and distribution of habitats, species and key underlying ecological processes and the likely intersection between those. The AoA may extend across jurisdictional boundaries, incorporate multiple discontinuous areas, and change over the lifetime of a project as indirect effects of the project are realised.

2.1 Key elements of achieving no net loss and net gain

Achieving NNL or NG of biodiversity requires tailored, context-specific strategies due to variations in ecological settings, operational scales and types of mineral extraction. However, certain fundamental components underpin effective practices in this area.

a. **Establish a biodiversity Area of Analysis (AoA)**: Define an AoA that supports a landscape-scale ecological perspective (see Section 3.2 for approaches to defining the AoA). It should over time encompass the full extent of potential direct, indirect and cumulative impacts of the project on priority biodiversity values, considering both the physical footprint of mining and metals infrastructure and operations and its broader effects on biodiversity and nature. This area might span multiple jurisdictions and change over time.

b. **Establish a biodiversity baseline:** Establish a baseline to assess impacts, plan mitigation strategies and evaluate NNL or NG outcomes. For new operations, this involves understanding the initial conditions of biodiversity within the AoA. For existing operations or major acquisitions, this section also includes guidance on how to establish a retrospective baseline for the year 2020 or earlier.

c. **Select site-level biodiversity indicators and metrics:** Select indicators and metrics to standardise the measurement of key biodiversity values which is essential for monitoring and demonstrating progress toward NNL or NG.

d. **Assess risks and impacts and apply the mitigation hierarchy:** Assess risks and impacts on biodiversity and apply the mitigation hierarchy throughout the project lifecycle. Prioritise avoidance of negative impacts, followed by mitigation measures, restoration and the assessment of residual impacts for which offsetting would be required to achieve the NNL or NG targets.

e. **Quantify and offset residual impacts on biodiversity:** Undertake quantitative residual impact assessments and, design and implement steps to establish offsets to achieve NNL or NG and sustain these outcomes in the long term.

f. **Monitor and apply adaptive management:** Continuously monitor outcomes and adjust actions to ensure that assumptions and strategies remain valid throughout the project's duration.

g. **Transparently disclose:** Clearly disclose methods and performance based on reliable evidence to maintain credibility and accountability.

Each of these elements is addressed in turn below, see Figure 2.1, which also indicates where these elements are covered within subsequent sections of the guidance.

2.2 No net loss accounting

NNL accounting enhances the traditional elements associated with biodiversity assessment mentioned above, by introducing a more quantitative approach to assessing losses and gains. While biodiversity assessments or Environment and Social Impact Assessments (ESIAs) provide a foundation for identifying and mitigating impacts, NNL accounting ensures these efforts are measurable, comparable and verifiable, driving more a rigorous approach to account for and address biodiversity losses and gains. Figure 2.1 indicates which of the elements described in Section 2.1 connect to NNL accounting. This differentiates between those that are foundational to assessing NNL, linked to quantifying losses or gains, or that enable monitoring losses and gains.

2.2.1 Biodiversity baseline: the foundations for accounting

Preparing the foundations for 'loss' accounting that occurs at the impact stage, requires selecting the most appropriate metrics and obtaining the requisite quantitative data in addition to qualitative data. This is because, where possible, losses should be expressed numerically, using the correct metrics (e.g. hectares of vegetation type lost or changes to species abundance).

Your accounting may also include other elements such as habitat condition/quality which may include qualitative and quantitative aspects. This might mean undertaking population surveys for selected species, assessing the current number and size of patches of a particular habitat or establishing criteria for assessing habitat condition. See Sections 3, 4 and 5.

2.2.2 Impact assessment: quantify the 'loss'

Having mapped the project footprint (area of direct and indirect impacts) and identified the biodiversity components affected (i.e. species, habitats and ecosystems), the next stage is to quantify the loss directly and indirectly impacted. This may include areas impacted by different vegetation types, changes to species abundance or changes to ecosystem functionality (e.g. patch size or water abstraction). Depending on the circumstances, you may also need to quantify cumulative effects at a landscape level. See Section 6.

2.2.3 Apply the mitigation hierarchy: adjust the 'loss'

There is greater scrutiny around the application of the mitigation hierarchy, so where possible it is useful to be able to quantify those reductions in losses through avoidance, the application of impact mitigants or restoration. See Section 6.

2.2.4 Quantify residual loss and assess gain required for offset

Calculate the final losses remaining after avoidance, minimisation and restoration (where appropriate) associated with a project or activity and quantify the gains required to balance/offset the loss. The offset requirement may be larger than the residual loss if multipliers are used to account for uncertainty, time lags and ecological risk. See Section 7.

2.2.5 Offset selection and design

There may need to be further adjustments to the gains required, depending on the conditions at the offset site such as habitat quality. See Section 7.

In addition to the further resources listed at the end of Sections 3–9, there are several online resources that have potential value to many of the sections in this report. Rather than include them in several places, these are summarised in Annexe 2. The potential applicability of these resources to the various sections is indicated in the table.

Figure 2.1: Stages in the process to achieve NNL or NG and links to NNL/NG accounting

The process stages with this icon are closely linked to NNL/NG accounting (foundational to assessing, linked to quantifying or monitoring losses and gains)

Establish a Biodiversity Area of Analysis

03

Key objective: This section provides guidance on how to establish a comprehensive biodiversity AoA, which is foundational to establishing an effective baseline.

Area of Analysis (AoA): The study area for the assessment of biodiversity-related risks, impacts, opportunities and dependencies, which includes the project's AoI, as well as an understanding of the presence and distribution of habitats, species and key underlying ecological processes and the likely intersection between those. The AoA may extend across jurisdictional boundaries, incorporate multiple discontinuous areas, and change over the lifetime of a project as indirect effects of the project are realised.

3.1 Conduct a desktop-based assessment

The first step is to undertake a desktop-based review around the project site or operation to screen biodiversity features that may be within proximity to the project and to obtain important landscape context to ultimately inform the AoA delineation. The area for desktop assessment should be larger than the area likely impacted directly and indirectly by the project. Previous studies suggest that these indirect impacts can extend up to 70km from mining lease boundaries (Sonter et al. 2017[8]). Screening for biodiversity features at this distance, or further, from individual projects could provide valuable information on the existence of protected areas, internationally designated sites of conservation value and the presence and extent of ecosystems and species ranges, as well as other nature-related risks and opportunities for even relatively small mining projects.

In addition to a literature review (peer-reviewed papers and grey literature) and consultation (see Section 3.1.1 below), the following global data sources are likely to provide valuable insights.

The Integrated Biodiversity Assessment Tool (IBAT) is a global database which includes three core datasets and two derived datasets from the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™. It provides data, tools and guidance that help organisations understand biodiversity-related risks and opportunities, including the following (several of which can also be accessed directly):

— The World Database on Protected Areas identifies all legally protected areas (i.e. UNESCO World Heritage Sites, UNESCO Man and the Biosphere Reserves and IUCN I-VI).

— The World Database of Key Biodiversity Areas, Wetlands designated under the Ramsar Convention and Alliance for Zero Extinction websites provide details on these Internationally Recognised Areas.

— The IUCN Red List of Threatened Species™ (also known as the IUCN Red List) provides information about species' range, population size, habitat and ecology.

— The Species Threat Abatement and Restoration (STAR) metric allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk across the world.

8. Sonter, L.J., Herrera, D., Barrett, D.J. et al. (2017), 'Mining drives extensive deforestation in the Brazilian Amazon', Nat Commun 8, 1013. https://doi.org/10.1038/s41467-017-00557-w

— The Rarity Weighted Richness[9] map is a layer showing the relative importance of each ~1km grid cell in terms of its aggregate contribution to the global distribution of several taxonomic groups. Currently included in the data on IBAT are mammals, birds, amphibians, crabs, crayfishes and shrimps.

Other important sources include:

— Government or other national databases on biodiversity, e.g. the Canadian Species at risk public registry (under the Species at Risk Act 2022), the Colombian National Red List, Australia's Matters of National Environmental Significance (under the Environment Protection and Biodiversity Conservation Act 1999) and the Threatened Species Action Plan, and in the USA the 2024 Vulnerable Species Action Plan and recovery plans developed under the Endangered Species Act.

— Regional databases such as Matters of state environmental significance in Queensland, NatureServe for North American assessments, and MapBIomas in Brazil. The IUCN Red List of Ecosystems is a global standard for assessing risks to ecosystems. Its database includes the Red List of Ecosystems assessments that have been undertaken to date.

— Intact Forest Landscapes, which provides information on landscapes that have high conservation value and are critical for stabilising carbon storage, harbouring biodiversity, regulating hydrological regimes and providing other ecosystem functions.

— Available remote sensing data, such as satellite imagery (e.g. Google Earth or data from the Sentinel and Landsat missions) or aerial imagery (e.g. unmanned aerial vehicle imagery, videos, spectral data or digital terrain models) or publicly available datasets.

— Migratory flyways from Birdlife International, which provides details on transnational bird migrations.

— The Global Biodiversity Information Facility open access data showing the locations of species from different kinds of sources (e.g. museum specimens, peer-reviewed publications and other reports).

While every effort is made to ensure that IUCN Red List information and other data on protected areas is up to date, listings may be out of date or based on limited information. In addition, many species (flora in particular) have not yet been evaluated by the IUCN or national authorities. It is always worth checking data with the relevant authorities and experts on additional local protection requirements.

Caution should be used when using global datasets such as these. While they may be useful for initial desktop-based screening for potential impacts and delineating the AoA, they should not be relied upon alone for biodiversity impact assessments, target setting for NNL or NG achievement and decision-making. Limitations for these purposes include their resolution being too coarse – spatially and temporally – for the purposes of assessing and attributing the impacts of an individual project on biodiversity. For example, a global dataset with a maximum spatial resolution of 10km2 is unable to detect species with small habitat ranges, which may be particularly vulnerable to proposed mining projects. Section 5 of this guidance provides more information on appropriate metrics and data for use in baselining and impact assessment.

3.1.1 Consultation

Early consultation with stakeholders such as relevant authorities, communities, Indigenous Peoples, non-governmental organisations (NGOs), species experts (including individuals from IUCN Species Survival Commission Specialist Groups), and academic, research or other scientific institutions is likely to provide valuable insights. Where applicable, Traditional Knowledge should be integrated into the data collection process. Engagement with regional and local knowledge holders needs to be conducted in an appropriate manner and with the utmost respect. Additional resources from ICMM on stakeholder engagement are included at the end of this section.

9. High values show that a cell holds a large number of species and/or that the average ranges of the species present in the cell are small, so that the cell represents a relatively high proportion of their range.

3.2 Define the biodiversity Area of Analysis

The AoA for the assessment of biodiversity-related risks and impacts must use, as its starting point, the project's Area of Influence (AoI). The project's AoI is larger than the physical footprint of the mine operations and includes the area within which a project may potentially directly, indirectly and cumulatively cause impacts or have dependencies on nature. It is important to consider both the presence and distribution of habitats, species and key underlying ecological processes, alongside the spatial layout of all the facilities and the likely extent of emissions, abstractions and discharges, and the likely intersection between those. Figure 3.1 shows how the biodiversity AoA is defined and refined, according to the:

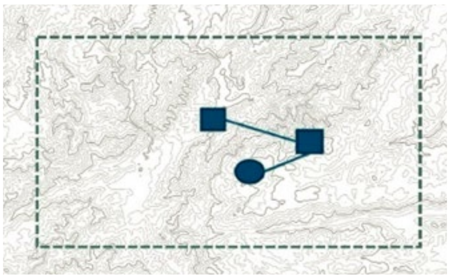
— geographic extent of project facilities and their potential indirect effects, i.e. the AoI (see Section 3.2.1)

— extent of biodiversity features intersecting the AoI (see Section 3.2.2)

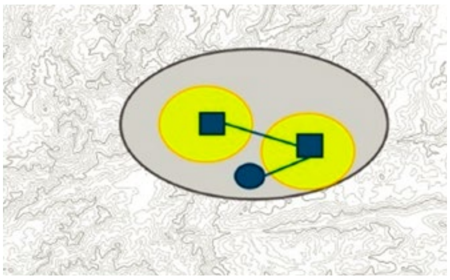
— protected areas and other internationally designated sites (see Section 3.2.3)

— landscape context (see Section 3.2.3).

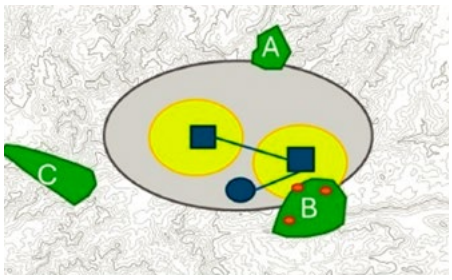
Figure 3.1. Defining and refining an appropriate study area/AoA



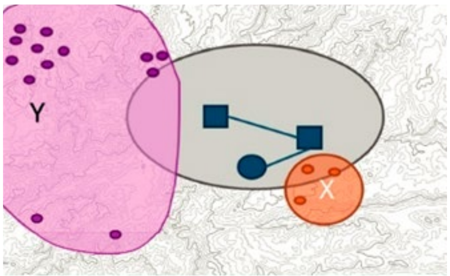
I . Project footprint including temporary and associated facilities (blue) used to select a broad landscape search area (dotted line) e.g. to obtain satellite/aerial imagery for habitat mapping or risk screening.



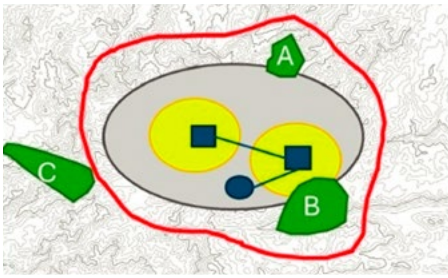
2. Area of Influence (AoI) includes project footprint, areas affected by direct (yellow) and indirect (grey) impacts. Practitioners to refine AoI as designs and layouts are finalised.



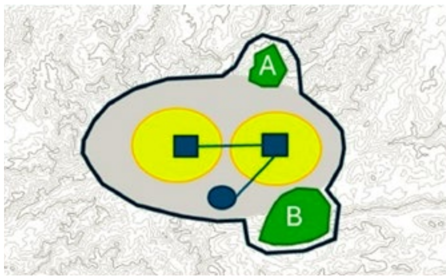
3. Develop landscape ecological context to screen risks and opportunities for ecosystems and protected areas. Map protected areas and internationally recognised areas of importance for biodiversity (e.g. KBAs) (A, B and C). Map presence of species of concern if known (orange dots).



4 . Map potential occurrence of species of concern, e.g. use IUCN species range data for threatened species where habitat overlaps with AoA for narrow distribution species (see orange X) and wide-ranging species (see purple Y). Dots indicate location of species records.



5. Establish study area (Area of Analysis) (red outline) for baseline and impact assessment. This encompasses AoI, protected areas A and B, the whole range of threatened species X and affected population only of wide-ranging species Y.



6. Amended AoI and revised project design that includes avoidance and minimisation of impacts.

Source: Produced by Treweek Environmental Consultants

3.2.1 Identify the geographic extent of facilities and their potential extent of impacts

The geographical extent of a site's facilities and their potential impacts on biodiversity should consider the following elements:

— The site's facilities that are directly owned, operated or managed (including by contractors acting on the operator's behalf) by the company. These may include power supply and transmission corridors, pipelines, infrastructure (such as rail, access roads and ports), resettlement sites, permanent accommodation, recreational areas, offices, temporary construction camps, quarry sites and borrow and disposal areas. It should also include non-operational land holdings, exploration or prospective mining sites, and sites currently in care and maintenance.

— The spatial extent of the impacts from the site's footprint, for example including land clearing, air, noise, blast and light emissions (and where relevant their intensity), effluent discharges and potential changes from ground or surface water abstraction associated with the site's activities.

— Associated facilities not necessarily funded nor operated by the site, but whose viability and existence depend (almost) exclusively on the site and without which the site's operations would not be viable.

— Potential for indirect impacts of the project operations, such as project-induced migration, spread of invasive species, increased viability of other economic activities and improved access to biodiversity[10].

— The potential extent of the risk of unplanned incidents, such as tailing failures.

— Cumulative effects. Consideration should be given to how other current and reasonably foreseeable future projects or activities, by the operation and those by other owners within the AoA, could materially affect outcomes (both negative and positive) for biodiversity and compromise an operator's ability to achieve NNL. This may include cumulative pressures on water quality that result in individual impacts becoming material and thus requiring mitigation or a reduction in regional land available to implement planned offsetting activities.

3.2.2 Account for the presence of ecosystems, species and processes

The desktop-based assessment will have identified species (and associated habitats) whose ranges might overlap with the initial AoI. The AoA should reflect the spatial requirements of those habitats and species alongside key processes on which they may depend. In addition to specific regulatory requirements, particular attention should be paid to:

— **Highly threatened, range restricted species and single site endemics:** These are likely to be more vulnerable to impacts.

— **Species with large home ranges:** For example, medium-sized and large mammals with extensive ranges[11] may be significantly affected even if they are not close to project facilities.

— **Migratory species:** Species that migrate for resources or breeding may only be present in the AoA periodically. For example, the barren-ground caribou (*Rangifer tarandus*) is known to migrate over large distances to access seasonal resources and to calve. There are over 1,000 species of freshwater fish that migrate to spawn and access food sources. This total increases significantly when including those that migrate between marine and freshwater environments. An estimated 4,000 bird species are migratory. See Box 3.1 for thresholds for determining significant impacts to migratory species.

— **Congregatory species:** Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis. They are uniquely vulnerable as disturbance or habitat loss can disproportionately affect an entire population. For example, the lesser flamingo (*Phoeniconaias minor*) relies heavily on specific saline lakes, particularly in East Africa. Other examples include sea turtles nesting or bats roosting in large colonies. See Box 3.1 for further information on thresholds for determining significant impact to congregatory species for projects where the IFC Performance Standards are applicable.

— **Keystone or umbrella species:** A species that has a disproportionately large impact on its ecosystem relative to its abundance. These species play a critical role in maintaining the structure, stability and diversity of their environment. This includes the African savanna elephant (*Loxodonta africana*), the

10. Indirect effects are hard to predict and some practitioners include a precautionary buffer to capture the indirect effects.
11. The home range of a species is the area individuals use to rear their young, find resources and secure mates. Home range size varies depending on many factors (such as energy requirements, habitat productivity, population density, predation rate), and provides ecological information on the use of space and resources by animals.

forest elephant (*Loxodonta cyclotis*), Gray wolves (*Canis lupus*), e.g. in the Greater Yellowstone Ecosystem, and several insect species, including bees and butterflies.

— **Highly threatened or unique ecosystems:** Examples include the following endangered ecosystems; the Grey box-grey gum wet forest of subtropical eastern Australia, the Southern Rakhine evergreen rainforest in Myanmar, the Brazilian Atlantic Montane Humid Forest and the Espinal Deciduous Forest and Woodland of Argentina, Brazil and Uruguay (see Box 3.1) as an example for projects where the IFC Performance Standards are applicable.

— **Key ecological or evolutionary processes:** Understand essential processes, such as hydrological cycles, which support habitats and species. Water withdrawal might affect groundwater-dependent ecosystems far beyond the project's physical footprint, such as a reduction in water levels at ephemeral springs and seeps, which are critical drinking sources for wildlife in the dry season and in arid climates. Some sites refer to evolutionary processes and these locations play a significant role in driving and maintaining the mechanisms of evolution such as natural selection, genetic diversity and adaptation over time. This may include sites with physical barriers between populations of species resulting in isolation and speciation, or areas with diverse microclimates, environmental gradients and a wide variety of ecological niches promoting evolutionary divergence.

— **Species of stakeholder concern:** These include species of cultural significance and/or charismatic megafauna. Examples include the white pine (*Pinus strobus*), Western red cedar (*Thuja plicata*), desert tortoise (*Gopherus agassizii*), caribou, jaguars and tigers.

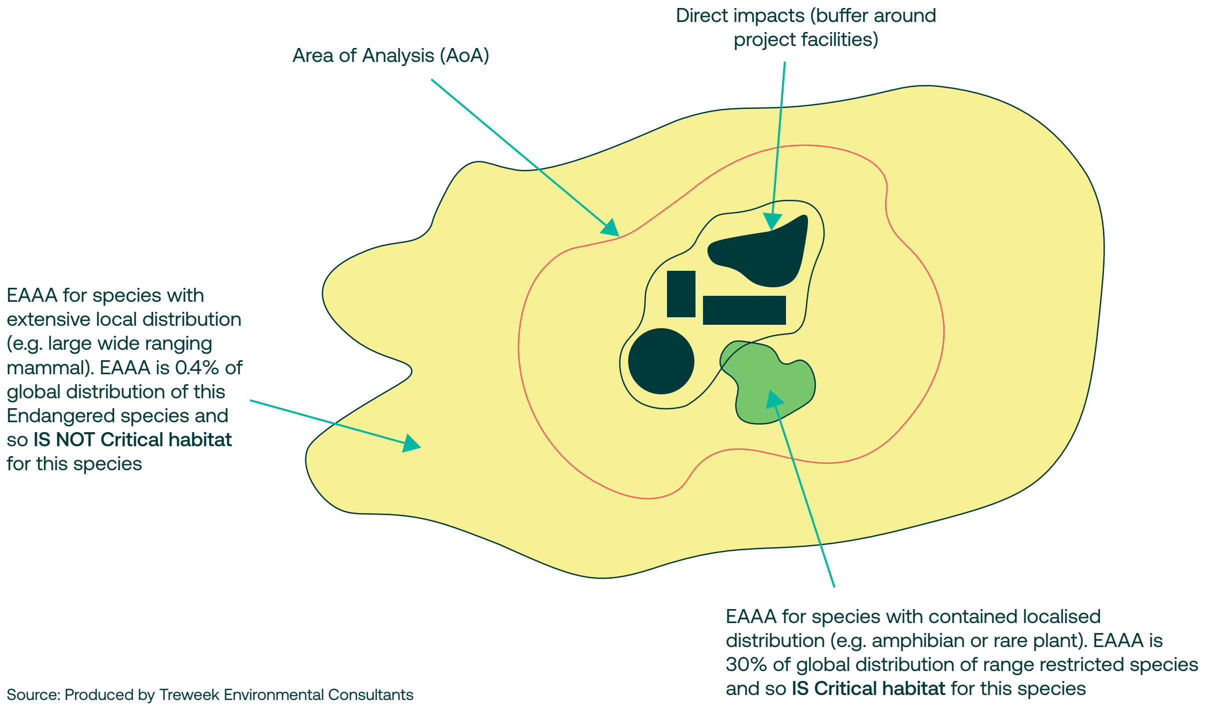
Box 3.1: Using ecological thresholds to inform the AoA
The IFC categorises areas into natural, critical and modified habitats. Critical habitats are areas of high biodiversity value that include at least one or more criteria:

- **Criterion 1:** Critically endangered (CR)/Endangered (EN) species
- **Criterion 2:** Endemic/range-restricted[12] species
- **Criterion 3:** Migratory/congregatory species
- **Criterion 4:** Threatened and unique ecosystems
- **Criterion 5:** Key evolutionary processes

Four of these criteria (Criterion 1–4 as listed above) have numerical thresholds. To apply these numerical thresholds, (for projects where the IFC Performance Standards are applicable), the project needs to identify an Ecologically Appropriate Area of Analysis (EAAA) to determine the presence of critical habitat for each species with regular occurrence in the project's AoI. The EAAA of each species takes account of the distribution of that species (within and sometimes extending beyond the project's AoI) and the ecological patterns, processes, features and functions that are necessary for maintaining them. To apply the numerical threshold, the process involves overlaying the extent of occurrence of species with the EAAA or assessing what proportion of the population overlaps with your EAAA, as demonstrated in Figure 3.2.

- Thresholds for Criterion 1 are the following: An EAAA that supports global concentrations of an IUCN red-listed EN or CR species (≥ 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species) would trigger critical habitat.
- The threshold for Criterion 2 is areas that regularly hold ≥ 10% of the global population size AND ≥ 10 reproductive units of a species.
- Thresholds for Criterion 3 are the following: (a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1% of the global population of a migratory/congregatory species at any point of the species' lifecycle; (b) areas that predictably support ≥ 10% of the global population of a species during periods of environmental stress.
- The thresholds for Criterion 4 are the following: a) Areas representing ≥ 5% of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or ER; b) other areas not yet assessed by IUCN but determined to be of high priority for conservation by regional or national systematic conservation planning.

Figure 3.2 Example of an Ecologically Appropriate Area of Analysis



Source: Produced by Treweek Environmental Consultants

12. For terrestrial vertebrates and plants, restricted-range species are species that have an extent of occurrence less than 50,000km². For riverine, and other aquatic species, restricted range is defined as having a global range of less than or equal to 500km linear geographic span (i.e. the distance between occupied locations furthest apart).

3.2.3 Identify legally protected areas and internationally designated sites

It is important to identify all national and state/province-level protected areas, including World Heritage Sites (see Box 3.2), Biosphere Reserves and IUCN I-VI, as well as internationally designated sites of conservation value (i.e. Key Biodiversity Areas, Alliance for Zero Extinction Sites and Ramsar Sites) even those that are close to but beyond the physical footprint of the mine. In most countries, there is specific legislation pertaining to protected areas that need to be considered alongside ICMM's Nature Position Statement and lender requirements (e.g. IFC or Equator Principle Financial Institutions where they are applicable), to ensure that the proposed development is legally permitted and doesn't undermine the values for which it was designated and is in accordance with the site's management plans. In addition, it is important to consider discharges into or abstraction from rivers that flow into protected areas or internationally designated sites, that may appear unconnected to operations yet be critically dependent on the maintenance of water quality or quantity.

Box 3.2 Impacting the Outstanding Universal Value of World Heritage Sites

Three components must be in place for a property to meet the requirements for inscription on the World Heritage List: the values that meet the criteria for Outstanding Universal Value, the site's integrity, and its protection and management. Outstanding Universal Value means '*cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity*'. Projects located outside of World Heritage Sites still have the potential to impact Outstanding Universal Value because of direct impacts from water withdrawal, effluent discharges, noise, light and vibration, or indirect effects such as increasing access to remote areas, induced migration or by interfering with migration patterns.

3.2.4 Applying a landscape lens

While not all elements of the landscape will fall within the designated biodiversity AoA, it is crucial to understand the broader landscape. The wider context presents both challenges and opportunities to enhance conservation and maintain connectivity. These contextual factors have a bearing on the ability of projects to manage biodiversity risks over the medium to long term. It may be worth referring to National Biodiversity Strategies and Action Plans for an overview of strategies, plans or programmes for the conservation and sustainable use of biodiversity in a given country. Doing so may also identify opportunities for proponents to contribute to their host nation's commitments to meeting GBF targets.

Understanding these broader risk factors, especially the complex socio-ecological environment, helps operations to more accurately assess biodiversity impacts (particularly induced and cumulative effects) and plan to mitigate them in an integrated manner, where the operation has influence. Partnering with other stakeholders within the AoA, where relevant, can leverage better outcomes for nature at the landscape level.

Further resources

European Bank for Reconstruction and Development (2018), *Guidance Note for Standard 3 on Biodiversity and Ecosystems*. [PDF].

ICMM (2015), *Stakeholder Research Toolkit*. [PDF].

IFC (2007), *Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*. [PDF].

IFC (2019), *Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. (Note that Guidance Note 6 corresponds to Performance Standard 6.) [PDF].

Watson, E. (2020), *Guidance for identifying and prioritising action for HCVs in jurisdictional and landscape settings*, ed. HCV Network. [PDF].

Establish a Baseline: The Foundation for Impact Assessment and Mitigation

Key objective: To outline the importance of robust baselines and guide companies through the process of conducting baselines, either prior to a project proceeding or retrospectively.

Baselines are used to measure changes in biodiversity between two specified times (current vs future, pre- vs post-project), whereas the related concept of 'reference conditions' enables comparisons between biodiversity at one site against those at others under different levels of human disturbance.

4.1 The purpose of baselines

Baselines serve as the reference state against which changes, whether from past to present, or pre- to post-planned interventions can be measured. Establishing robust baselines is essential for understanding and evaluating a project's impacts and risks, effectively applying the mitigation hierarchy, and designing a comprehensive biodiversity monitoring program aimed at ensuring NNL or NG if required. Sub-sections 4.2–4.3 deal with establishing baselines for new operations and expansions and Sub-section 4.4 elaborates on the additional step required for companies with existing operations to develop a retrospective baseline so as to quantify any other residual historic impacts that have occurred between the current year and the baseline year.

> "A biodiversity baseline is not just a measure of what is; it is a warning of what could be lost, and a challenge for us to act before we lose more."
> **Thomas Lovejoy**

4.2 Survey principles

Baseline surveys should be planned and conducted early in the planning and design stages to facilitate the most effective application of the mitigation hierarchy. For sites in areas of high conservation value, establishing credible baselines may require extended lead times and substantial resources. Where insufficient baseline data on a high-value biodiversity feature (e.g. a threatened species) is not available, application of the precautionary principle may be necessary. However, it is imperative to have sufficient confidence in baseline data prior to causing impacts that may cause irreversible damage to significant features before initiating substantial land disturbance.

If a new biodiversity feature of concern is discovered after a project commences, the baseline should be updated, mitigation measures applied, and the residual impact assessment should also include this feature.

The following guidelines outline good practices for establishing a baseline, which are further illustrated with examples in Boxes 4.1 and 4.2.

— **Be clear about survey objectives:** Tailor data collection to the biodiversity feature in focus, ensuring it supports impact assessment, change monitoring and progress toward NNL or NG outcomes. For example, for some species, collecting data on presence/absence, extent and condition of the habitat type may be sufficient but for other species, total abundance or density/ha may be required (see Box 4.1).

- **Develop an evidence-based rationale for selecting which biodiversity features to include or exclude from baseline surveys:** This selection should be based on factors such as the likelihood of occurrence (including species range overlaps and previous records), their intersection with the project, their threat status, whether they are range-restricted and migratory/congregatory, are of particular importance to stakeholders, or need to be considered under a regulatory requirement.
- **Ideally surveys should be performed over multiple seasons and at a time and frequency of relevance to the feature:** This is because of variation in species distribution due to: seasonal changes (e.g. temperature or precipitation); reproduction cycle of the species of interest; migration periods for birds and other animals; and growth and flowering periods of plants. Indeed, some biodiversity features may require re-assessment over longer periods of time to tease out declining trends due to other pressures, such as climate change.
- **Provide sufficient resources:** While there are often time and budgetary constraints, it is counterproductive conducting cost-effective surveys or limiting their scope if a project cannot effectively evaluate risk or meet survey objectives.
- **Consider survey effort:** Survey effort directly affects the reliability and accuracy of the data collected. Use standardised and replicable methods (e.g. point counts and transect walks) and ensure adequate spatial coverage and survey during optimal times.
- **Engage experts where appropriate:** Engage with experts and seek Indigenous and local knowledge where this is warranted. The IUCN Species Survival Commission Specialist Groups are a useful starting point for species-specific expertise (see Box 4.2). However, this can be difficult for the emergence of new species and will likely require novel research and engagement with academic institutions.
- **Employ competent personnel:** Employ specialists who apply best practice methods for surveying, use appropriate statistical methods to analyse survey data and have knowledge of the area.
- **Employ diverse techniques:** Standard survey methods can be supplemented using high-resolution remote sensing, thermal Imaging, Global Positioning System (GPS) or satellite transmitters, drones, camera traps and environmental DNA (eDNA) analysis for a range of species and bioacoustics to detect the presence of bats, birds, insects and amphibians, and the use of artificial intelligence (AI) and machine learning to analyse images captured by remote sensing technologies.
- **Consider ethical and safety aspects:** Conduct surveys in a way that minimises disturbance to species and follow established safety protocols for fieldwork, especially when working in remote areas.
- **Undertake comprehensive reporting:** Document survey methods, findings with GPS locations, limitations and any challenges encountered. Provide detailed reports that include data analysis and recommendations for further actions.

Box 4.1: Conducting Caribou baselines exemplifies some of the key points concerning survey design

Sufficient coverage: Caribou[13] use wide areas such as nursery areas, winter use areas and travel corridors.

Timing: Conduct surveys at different times of the year, including caribou migration periods, to capture their movement patterns, herd dynamics, calving rates and herd composition.

Survey techniques: These can include aerial surveys, ground surveys (systematic walking or vehicle-based transects), camera traps and GPS for movement data, and satellite imagery to assess habitat condition and caribou distribution over large areas.

Engage Local Knowledge: Surveys should involve Indigenous communities who have Traditional Knowledge of caribou populations and migration routes. Their insights can enhance survey design and interpretation.

13. Different sub-species have different behaviours.

Box 4.2: Engage experts where necessary
All great ape populations are either endangered or critically endangered. They show high variability in space and time in their movement patterns and require long-term data sets to acquire information on distribution and abundance, number of groups and, where needed, genetics. Conducting systematic surveys throughout the AoA requires significant financial and human resources so it is important to consult experts on the survey methodology to ensure high-quality data and advice on the most effective forms of mitigation. Where great apes are present within your AoI, engage experts from the IUCN Species Survival Commission Primate Specialist Group Section on Great Apes.

Guidance Note 73: *Special consideration should be given to great apes (gorillas, orangutans, chimpanzees and bonobos) due to their anthropological significance. Where great apes may potentially occur, the IUCN/Species Survival Commission Primate Specialist Group Section on Great Apes, must be consulted as early as possible to assist in the determination of the occurrence of great apes in the project's area of influence. Any area where there are great apes is likely to be treated as critical habitat. Projects in such areas will be acceptable only in exceptional circumstances, and individuals from the IUCN Species Survival Commission Primate Specialist Group Section on Great Apes must be involved in the development of any mitigation strategy.*

4.3 Biodiversity features to identify and map

4.3.1 Ecosystems

One of the most important things to do to inform biodiversity baseline data collection, and subsequent impact assessment, mitigation planning and monitoring progress (see Sections 6 and 7) is to prepare a vegetation/ecosystem map delineating different vegetation types, ecological communities and watercourses. This will help guide surveys for the various biodiversity values and can then be refined following detailed surveys. In particular, the map should detail:

— **Ecosystems/vegetation types:** Many jurisdictions will already have ecosystem and vegetation maps available. However, if no national or regional vegetation classification exists, classify ecosystems/vegetation types to enable you to quantify losses and gains using biodiversity metrics. Even if ecosystems are not threatened, natural or semi-natural habitat is valuable for a wide range of species and services. The IUCN Ecosystem Typology/Classification can serve as a starting point.

— **Threatened or unique ecosystems:** Identify and map highly threatened or unique ecosystems using national and regional assessments and, if available, any IUCN Red List Ecosystem Assessments that have been completed (see Box 4.3). The IUCN Red List of Ecosystems is an emerging global standard to document the relative risk status of ecosystem types. Some countries have completed a Red List Ecosystem Assessment of all their ecosystems such as Colombia, Myanmar, Italy and Abu Dhabi and numerous other sub-regional or ecosystem-specific assessments have been completed including an assessment of the temperate and tropical forests of the Americas. In Guinea, Kew has identified the Tropical Important Plant Areas which include threatened habitats. Australia has national-level assessments of 'threatened ecological communities'. In the absence of the IUCN Red List, some projects have asked internationally accredited botanical organisations to undertake an assessment of the ecosystems threat and range.

— **Key evolutionary processes:** Map areas supporting key evolutionary processes[14] (if relevant), including physical or spatial features that give rise to genetically unique populations. Examples include landscapes with very high spatial heterogeneity, environmental gradients and/or isolation (many mountains are evolutionary arenas). Some lake

14. The key evolutionary processes, or 'forces of evolution' that lead to changes in the DNA in a population are: natural selection, genetic drift, gene flow and mutation.

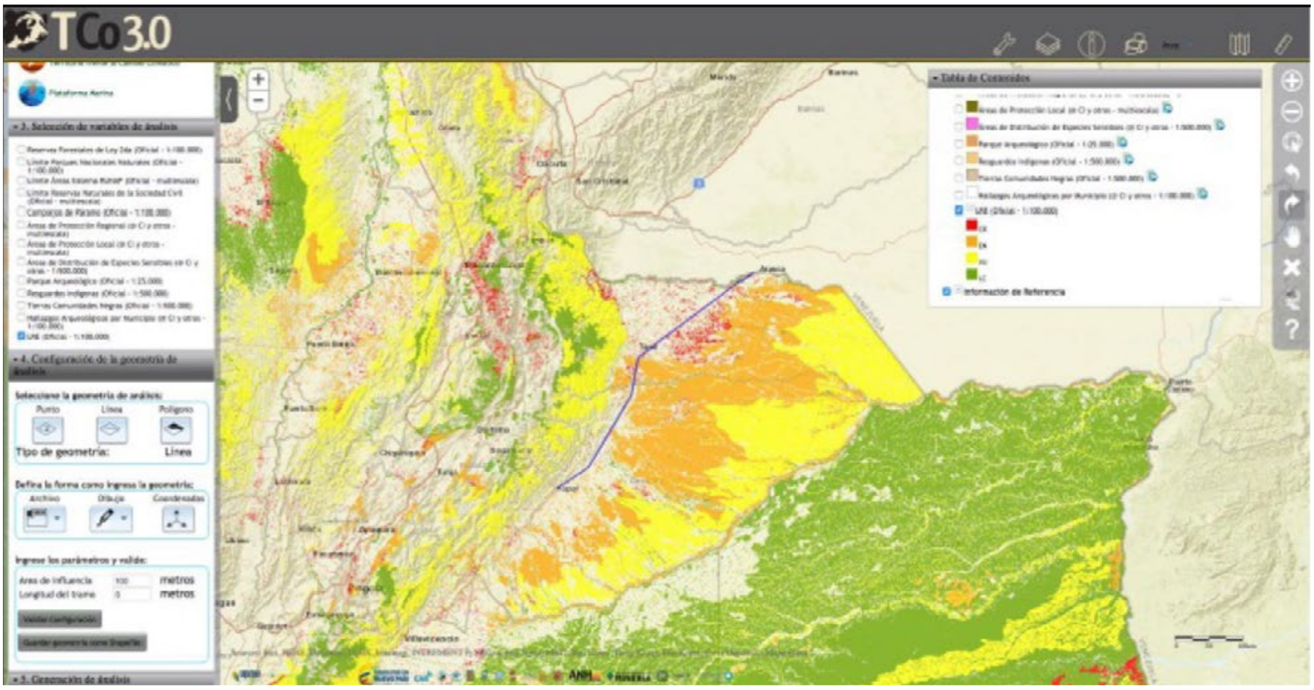
systems, particularly those that are isolated or have unique physical and chemical properties, often become areas of evolutionary divergence. Some short coastal rivers represent areas of evolutionary divisions, due to their isolation and steep salinity gradients. Karst systems (e.g. limestone caves with subterranean rivers or pools) and Isolated aquifers can promote speciation.

— **Area with very high ecosystem integrity[15], including intact forest landscapes:** Intact forest landscapes are important ecosystems which exhibit no (or very low) remotely detected signs of human activity or habitat fragmentation, and which are large enough to maintain all native biodiversity, including viable populations of wide range of species.

The mapping of ecosystem features and attributes outlined above, coupled with subsequent surveys where required, provides a solid understanding of ecosystem types and condition – typically assessed based on composition, structure and function – which is foundational to indicator selection (see Section 5) and impact assessment (see Section 6).

Box 4.3: A Red-List Ecosystem Assessment from Colombia

A Red List Ecosystem Assessment was carried out on all ecosystems in Colombia which has proven to be an incredibly useful risk assessment tool (v2.0 2017). Tremarctos Colombia 3.0 is a free online system where project footprints can be screened against the IUCN Red List of Ecosystems mapping.



Visualisation of the affectation of endangered ecosystems identified in the RLE, by the 4G road infrastructure project Arauca-Tame-Yopal (ANI 2017).

15. Areas with good structure, function and composition and low anthropogenic stress.

4.3.2 Ecological connectivity/habitat fragmentation

Are species able to engage in natural movement patterns? There are some circumstances where understanding ecological connectivity in the landscape is very important. This may include the presence of forest-dependent birds that rely on continuous forest habitats or migratory fish and species such as moose, bear and elephants. Assessing habitat fragmentation involves evaluating the degree to which a continuous habitat has been divided into smaller, isolated patches due to human activities or natural processes. This can be done using satellite imagery, fieldwork or connectivity models to measure key landscape metrics, such as patch size (relative to the original extent), mosaic (i.e. the arrangement of different habitat types) and distribution (including the connectivity of patches to enable long-term persistence of species).

4.3.3 Species

While it is not always necessary to do a complete inventory of species present, the following are important to identify:

— **Threatened species:** Map the distributions and ranges of globally or nationally threatened species within the AoA and relate these to their broader distributions. This includes species categorised as Vulnerable and above on the IUCN Red List, as well as species that may not meet global criteria but are national or sub-national priorities.

— **Range-restricted species:** Restricted range refers to a limited extent of occurrence[16]. Identify the presence and distributions of range-restricted species and the supporting habitat required to sustain their populations.

— **Important populations:** Document globally or IBAT regionally significant populations of migratory/ congregatory species and their critical supporting habitats.

— **Protected species:** Include data on species that are legally protected.

— **Species important to stakeholders:** Species important to stakeholders are often recognised by their prevalence in language, cultural practices (e.g. ceremonies), traditions, diet, medicines, material items and histories of a community. For example, the Eastern White Pine (*Pinus strobus*) holds significant cultural importance for several Indigenous groups. These groups of species may be distinct from species that are threatened or protected by legislation and would typically not be identified through a traditional biodiversity-focused baseline. Alternative approaches that focus on ecosystem services would need to be used to identify these species and those are beyond the scope of this guidance although the reader could be directed to existing guidance[17].

— **Range-weighted rarity:** It might also be useful to look at IBAT's Range-weighted rarity metric. It measures the presence of species in a given area (e.g. a project site or region) by taking into account how restricted or widespread each species is globally. Species with smaller global ranges (i.e. those found in fewer locations) are considered rarer, and thus more important for conservation. If a project site is home to a bird species that exists only in a few specific regions globally, that species would have a high range-weighted rarity score.

4.3.4 Legally protected areas and internationally recognised sites

These areas are especially important for biodiversity and therefore important to identify and map:

— **Legally protected areas:** Areas protected by law, specifying the geographic scale (e.g. national, regional or local).

— **Internationally recognised sites:** Sites of importance for biodiversity that may not be protected at the national level, such as Alliance for Zero Extinction sites, Ramsar sites and Key Biodiversity Areas.

4.3.5 Other areas of importance

Beyond legally protected areas and internationally recognised sites, you should also identify and map:

— **Priority Conservation Areas:** Areas identified as high priority for conservation by regional or national systematic conservation planning, such as Critical Biodiversity Areas and Ecological Support Areas, as seen in South Africa (see Box 4.4) and The Map of Biodiversity Importance in the US, which illustrates the distribution of imperilled unprotected species.

— **Cultural and sacred sites:** Culturally significant or sacred sites (e.g. forests, groves, water bodies and ancestral lands) and other community conservation areas, whether or not they are formally recognised or delineated.

16. For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an extent of occurrence less than 50,000km². IFC GN6. Key Biodiversity Area Criterion B2 define it as species with a global range size less than or equal to 10,000km².
17. C Hanson (2012), *The Corporate Ecosystem Services Review*, World Resources Institute. Available at: https://www.wri.org/research/corporate-ecosystem-services-review

Box 4.4: Systematic conservation planning in South Africa

The South African National Biodiversity Institute periodically evaluates and maps the threat and protection status of biodiversity in a scientifically robust manner through a national biodiversity assessment. Systematic conservation planning processes are applied to establish Critical Biodiversity Areas which represent the most efficient configuration in the landscape to meet biodiversity targets for ecosystems, species and ecological processes. Ecological Support Areas, which are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services, are also identified.

Most provinces have developed, or are in the process of developing, maps of Critical Biodiversity Areas and Ecological Support Areas in the form of provincial spatial biodiversity plans. The purpose of these plans is to inform biodiversity-inclusive land use planning, improve decision-making and support expansion of the protected areas network. They identify conservation priorities and indicate receiving areas for offsets and have been found to be an effective complementary strategy for reducing biodiversity loss alongside protected areas in some provinces, such as Mpumalanga Province.

The most recent National Biodiversity Assessment was completed in 2018 and can be read via the South African National Biodiversity Institute.

4.3.6 Conservation context

The broader landscape context in which a project or operation is situated presents both opportunities and challenges for biodiversity management. While there may be potential opportunities to enhance conservation efforts and maintain ecological connectivity, social factors and natural resource governance challenges significantly influence the project's ability to manage biodiversity risks over the medium to long term. Beyond establishing an adequate biodiversity baseline, it is important to understand these broader dynamics, particularly the complex socio-ecological systems at play. Important factors to identify include the presence of:

- High dependence of local communities on ecosystem services.
- Low levels of human capital and widespread gender gaps.
- Very low agricultural productivity and food insecurity.
- Governance challenges and poor capacity within government to effectively manage natural resources and provide oversight over in-migration and associated developments.
- Climate change vulnerability, overexploitation and conflicts over shared water resources. This can be particularly prevalent in water-scarce areas where wetland ecosystems and/or rare species may exist and rely on the limited water sources in the area.

In some jurisdictions, there is greater pressure to convert offset areas for productive use, such as agriculture or development, due to economic needs and greater protections may be required.

This might include gathering information on external drivers of biodiversity loss not directly related to the project, such as deforestation rates, habitat degradation, frequency of fires, hunting practices (including bushmeat consumption), exploitation of non-timber forest products and water resource use within the catchment area. While much of this data may be collected as part of the biodiversity baseline, in some cases, specific studies – like regional assessments of bushmeat markets – may be necessary to fully grasp the broader context. Additionally, socio-economic data from the social team can provide valuable insights, enriching the understanding of the local context and enhancing biodiversity risk management.

4.3.7 Currency of data

The average permitting time for a mine varies significantly depending on the country, the complexity of the project and the regulatory framework. However, delays to permitting are common for a range of reasons. Biodiversity baseline data should be regularly reviewed and updated to ensure it accurately reflects the baseline state of ecosystems and project risks. Using outdated data can lead to significant gaps in understanding the current biodiversity conditions due to natural changes, human activities and environmental factors. Some jurisdictions have specific requirements for reassessing and updating baseline studies. When no specific timeline is required, three to five years is a common benchmark for data currency in Environmental and Social Impact Assessments, however, the exact timeframe depends on site-specific contexts. For example, species distributions may change frequently as a result of ongoing changes to habitat extent or condition and migratory patterns may necessitate annual updates for certain taxa.

4.4 Establishing a retrospective baseline

ICMM's Nature Position Statement Commitment 1.3 states that: "*For existing operations, this [NNL or NG] target should be measured against a 2020 or earlier baseline.*"

Ideally, comprehensive baselines are established before the mine is established and impacts on biodiversity occur. For existing sites where this has been done, using a pre-operational baseline may be a viable option. However, for existing operations that lack this information or prefer to measure NNL relative to an earlier baseline year (e.g. 2020), a retrospective biodiversity baseline needs to be established. A range of methods are available to establish baselines for a historical point in time. Once developed, these can be used to approximate residual impacts that have occurred between then, now and mine closure.

Retrospective baselines allow operations to:

— Establish and measure gains towards target NNL and/or NG outcomes so they can be monitored and accounted for against a historic date (e.g. ICMM's commitment of 2020 or earlier baseline).

— Determine trends in biodiversity and help distinguish project-related risks and impacts from other external background threats.

— Model trajectories of change towards future states of biodiversity to determine whether end-targets are achievable and establish interim milestones.

— Report on performance in relation to corporate, national or global targets (e.g. ICMM's commitment of 2020 or earlier baseline in line with the 2020 baseline for GBF targets).

4.5 Methods for setting retrospective baselines

Once the objectives, spatial scope and timeline of the retrospective baseline assessment are established, an initial gap analysis of available information should be undertaken to inform the most suitable approach and methods, taking account of any reliable data on non-project related drivers of biodiversity loss or change that may have occurred over time, including those resulting from other developments within the wider study area or AoA. Potential methods for developing a retrospective baseline assessment include some combination of the following:

— Analysis of existing project data, literature and historical data

— Consultation with experts and other stakeholders

— Satellite and aerial imagery analysis for vegetation mapping and assessing changes over time

— Field surveys of adjacent or similar vegetation and habitat types, including reference sites representing 2020 baseline conditions

— Scientific modelling.

Further details regarding each method are provided below. More than one method may be needed for each biodiversity feature being assessed.

4.5.1 Analysis of existing project data, literature and historical data

Where existing project biodiversity data are available, this can be a cost-effective and efficient method for setting the retrospective baseline[18]. The following types of information that may either be held by operations or available from external sources may be suitable for establishing retrospective baselines:

— Original project Environmental and Social Impact Assessments and other biodiversity/ ecosystem service-related reports (e.g. monitoring reports, as well as management plans and monitoring reports with elements relating to biodiversity (such as

18. This data would have been collected for different purposes and is unlikely to overlap with the exact retrospective data (e.g. 2020), spatial scope and/or align with the NNL or NG commitments. Further extrapolation is likely to be required

biodiversity or environmental management plans, rehabilitation/revegetation plans)).

- Historical project mapping and photographs.
- Environmental and Social Impact Assessments, biodiversity- and ecosystem-service-related documents from nearby projects, particularly if they are located in similar ecosystems.
- Information from nearby protected areas or internationally recognised areas (i.e. Key Biodiversity Areas).
- Analysis of other external data sources, such as scientific literature from peer-reviewed journals, relevant grey literature, including other reports by reputable experts, student theses, NGO studies, etc.
- Species records, including IUCN or state and national species records of government agencies, other non-government natural heritage programs, museum collections, herbarium collections and, where verified, records from citizen science data repositories, such as iNaturalist.

Where relevant information is already being measured, reference conditions from existing project data (e.g. from monitoring plans) may be adequate for establishing retrospective baseline values for assessing NNL or NG targets (see Box 4.5). This may inform a NNL or NG target relative to a retrospective baseline earlier than 2020 for some biodiversity features on a site and not others. In these cases, transparently disclosing the methodology to measure progress towards the targets would include noting the relevant baseline year for each feature on the site.

Box 4.5: Using results from an ongoing threatened species monitoring program to set a retrospective baseline

An operational mine site is situated within the known distribution of a threatened mammal species. This species was confirmed present during fieldwork completed for the original project Environmental and Social Impact Assessment. A bi-annual monitoring program was initiated in 2013 as part of the conditions of project approval and has been ongoing since that time. Monitoring is undertaken to provide an understanding of local populations of the threatened species, track effectiveness of habitat rehabilitation throughout the life of the project and to measure changes in the population over time.

Monitoring data collected includes information on population numbers, population distribution, behavioural patterns and impacts from pests and predators. As data collection has been consistent across all monitoring events to date, and monitoring data is compatible with selected NNL or NG indicators for this species, the project has chosen to set the retrospective baseline date as 2013, in line with the commencement of the monitoring program. Population data collected during the first 2013 monitoring event is then set as the retrospective baseline value against which NNL or NG outcomes for this species are measured.

4.5.2 Satellite and aerial imagery analysis for vegetation mapping

Spatial data extracted from satellite and/or aerial imagery is a powerful tool for assessing baseline vegetation at a pre-defined date (e.g. 2020) and changes over time. This data can provide insights into vegetation extent, landscape connectivity and, when combined with ground-truthing, ecosystem condition. The process typically involves these steps:

1. **Desktop review of spatial data:** This starts with an analysis of the company's Geographic Information System (GIS) data, publicly available external sources and sensitive data requests from agencies. Archived satellite imagery is procured, taking into account factors such as the area of coverage, image date, seasonality, quality, spatial resolution and spectral requirements.
2. **Multi-temporal and multi-resolution datasets:** Using imagery from different dates and resolutions improves the accuracy of interpretation. Aerial or drone imagery can further validate satellite findings.
3. **Pre-processing and enhanced image processing:** Techniques like orthorectification (i.e. removing image distortions or displacements caused by sensor tilt and topographic relief) help align the imagery with project datasets. Image processing (e.g. using the Normalized Difference Vegetation Index for vegetation analysis) enhances the detection of key features.
4. **Supervised classification and ground-truthing:** Supervised classification uses known vegetation types and field data to map land cover accurately. GIS and remote sensing experts play a critical role in refining this process.
5. **Validation and final mapping:** The classified data is validated against reference datasets (e.g. field GPS points) and further field surveys might be required. This final step includes revising maps and extracting quantitative data for baseline reporting.

4.5.3 Field surveys of adjacent or similar habitat types, including reference sites representing 2020 baseline conditions

Field surveys in adjacent or similar vegetation and/or habitat types may be considered when a high level of accuracy is required, and/or where other sources of historical information are inadequate or lacking, especially for ecosystem condition and species presence. Similar vegetation types should, where possible, be ecologically connected with land previously disturbed to limit the effects of biogeographic factors such as dispersal barriers, evolutionary processes or biophysical factors that might influence species distributions and community compositions.

The type and amount of information gaps determined from other methods should inform the scope of any field surveys required. See Box 4.6 for a hypothetical example of the application of this method.

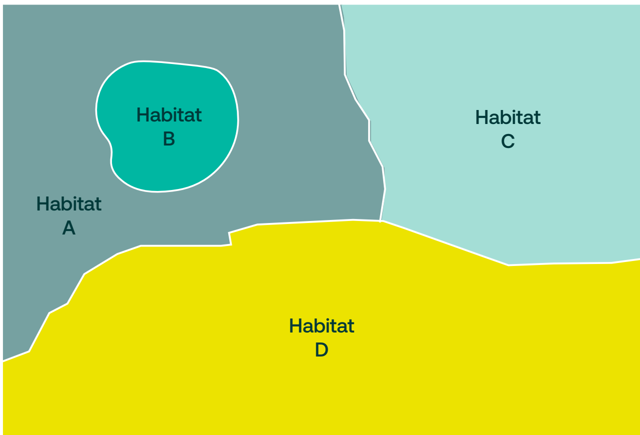
Biodiversity metrics associated with measuring ecosystem structure/condition, species richness, abundance and/or distribution are the same as those presented in Section 3 on selecting indicators/metrics. Appropriately qualified personnel and relevant specialists should be engaged to design, implement and analyse field surveys. Where required, expert opinion should be consulted to understand how ecosystem condition has changed between current field surveys and the pre-defined baseline year.

Box 4.6: Undertaking field surveys in adjacent similar habitat types – a hypothetical example

Assessing changes to habitat condition from a 2020 baseline was chosen as a suitable objective for measuring NNL and NG outcomes for a hypothetical project. Retrospective baseline values representing the condition of habitats within the project AoA for the year 2020 need to be determined. A review of existing project data and literature (from the project's existing Environmental and Social Impact Assessment) identified that four habitat types were mapped within the project footprint prior to construction of the project (see image 1 below). However, habitat condition assessments were not completed as a component of the existing Environmental and Social Impact Assessment.

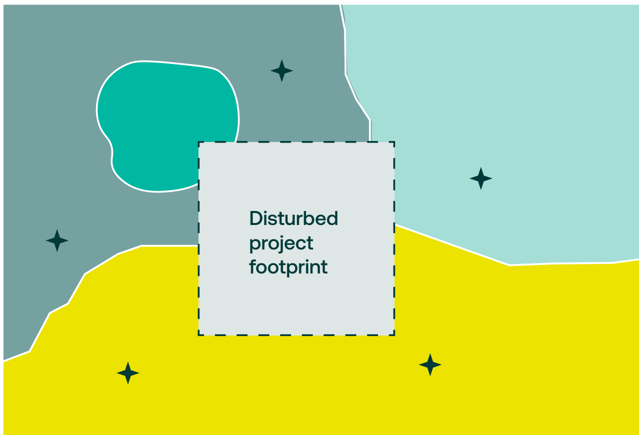
As areas of each habitat type outside of the disturbed project footprint were unaffected by the project, the present condition of each habitat type is likely to be representative of the baseline condition from the 2020 retrospective baseline year.

Reference sites within each habitat type were selected as locations to undertake habitat condition field surveys in the current year (see image 2 below). Field surveys were then planned and undertaken to determine the baseline habitat conditions in 2020 for each habitat type.



1. Habitat map from the project's Environmental and Social Impact Assessment showing mosaic of habitats

Source: Produced by Treweek Environmental Consultants



2. Reference sites chosen to inform habitat condition for the 2020 baseline

✦ Reference sites

4.5.4 Scientific modelling to estimate retrospective baseline conditions

Animals select habitats based on a complex interaction of factors, including the availability and distribution of food resources, predators, competitors, and a range of abiotic factors. Species distribution modelling is a scientific method used to predict the geographical distribution of species based on environmental conditions and known occurrences. It combines ecological and environmental data with mathematical models to estimate where species are likely to occur. The process typically involves the following steps:

1. Input data to the model:

a. Species occurrence data: Records of where the species have been observed, often gathered through field surveys, remote sensing or databases.

b. Environmental data: This includes climate variables (e.g., temperature and precipitation), land cover, topography and other environmental or anthropogenic factors that influence species' habitats and distribution.

2. Apply modelling algorithms: Species distribution models use various algorithms to relate species occurrences to environmental variables:

a. Presence-only models: Methods like maximum entropy use only data on where a species has been observed, predicting areas with suitable conditions.

b. Presence-absence models: These models use both observed presences and absences (or pseudo-absences) of species, applying techniques like generalised linear models or random forests.

c. Machine learning: Newer approaches use machine learning techniques (e.g. random forest or gradient boosting) for more complex and accurate predictions.

3. Undertake model calibration:
Models are trained using known species occurrence data and environmental predictors. Calibration ensures that the model accurately reflects the species' ecological preferences.

Some examples of species distribution modelling are provided in Box 4.7.

Box 4.7: Examples of the application of species distribution modelling
In Colombia, the Jaguar Corridor Initiative used species distribution models to model ecological corridors for the jaguar. This was then validated using a rapid assessment. The models have been used in various Environmental and Social Impact Assessments and helped design wildlife corridors to maintain habitat connectivity.

Species distribution modelling has been undertaken for various sub-species of chimpanzees due to the large number of records in the Ape, Populations, Environments, and Surveys database of the IUCN Species Survival Commission, and the Pan African Programme database. Studies showed a range of variables associated with habitat suitability including the presence of forest, elevation, specific tree species and distance to rivers and presence was negatively correlated to roads and settlements.

Species distribution modelling has proven to be effective for the conservation of the red panda in Nepal to estimate habitat suitability across different elevations and forest types. Factors like bamboo availability, which is the panda's primary food source, as well as canopy cover and human disturbance, are key variables in these models. These models have also been instrumental in planning wildlife corridors to ensure habitat connectivity, crucial for red panda populations that are spread across fragmented landscapes.

Depending on their application, species distribution models are generally developed by qualified personnel as a stand-alone product for a biodiversity feature for a site. They are more prevalent for species with NNL and/or NG targets when the extent/condition of suitable habitat is not a suitable proxy for their distributions and abundance. The usefulness of species distribution models depends on data availability and model accuracy (i.e. how well a model is able to make predictions). Data limitations reduce model accuracy and predicting species distributions in new areas or under future climate scenarios can be difficult as environmental factors may vary significantly.

Spatio-temporal modelling can play a crucial role in establishing **retrospective baselines** by reconstructing past ecosystem conditions and biodiversity patterns. This approach combines spatial and temporal data to analyse historical trends, filling gaps in direct observations and enabling the estimation of baseline conditions before significant anthropogenic impacts. Spatio-temporal models use historical data (e.g. land-use maps and climate records) and statistical techniques to infer past ecosystem states and biodiversity distributions.

Digital twin includes spatio-temporal components alongside other types of modelling and real-time data integration. It can aid in establishing retrospective baselines by using their ability to integrate historical data, simulate past conditions and predict changes in ecosystems or systems over time. These virtual replicas provide a dynamic platform for reconstructing and analysing historical baselines even when direct observational data are incomplete or unavailable.

4.5.5 Summary on setting retrospective baselines
A summary of the methods for setting retrospective baselines is provided in Table 4.1 along with an indication of the potential accuracy/confidence level of the methods when used in isolation (noting that higher accuracy levels should be expected when methods are combined). The accuracy levels associated with each method will also vary depending on the biodiversity feature being retrospectively assessed and the quality of the data associated with the method.

Table 4.1: Summary of methods, potential accuracy levels and limitations

Method	Potential accuracy/ confidence level[19]	Limitations
Analysis of existing project data and literature	Low – High	— Data may not cover the selected retrospective baseline timeframe or provide only partial coverage of the spatial scope. — Data collected using methods that are not directly comparable makes conclusions about the distributions or abundance of species populations or the condition of ecosystems challenging without the need for further assessment or field survey.
Consultation with experts and other stakeholders	Moderate – Very High	— Some opinions on species' presence are anecdotal, not based on empirical data and can be subjective. — Experts may or may not have quantifiable metrics to standardise and compare results from different time periods. — Data sharing may be limited, particularly if expert knowledge is the accumulation of experience working with other clients or a regulator and their non-public data.
Historical records analysis/desktop assessment	Moderate	— The type and amount of data available for historical records analysis depends on a project's location, scope and objectives and may be limited. — Existing datasets and literature may lack specific details on methodologies, survey effort and timeframes of data collection, which makes it difficult to assess accuracy, coverage and relevance. — Significant data gaps in some geographic regions and less developed countries can result in underrepresentation in historical records. The absence of data should not necessarily be confused with an absence of the relevant biodiversity. — Access to databases and information may be restricted by barriers or safeguards put in place to protect sensitive information, such as the locations of threatened species or sensitive sites. — Specific information, such as population density or migratory information, may be either unavailable or incomplete in historical data records.
Satellite and aerial imagery analysis, for vegetation mapping	Moderate – Very High	— Access to suitable satellite imagery from archives may be constrained (e.g. cloud cover in optical imagery, particularly in equatorial areas). — While freely available medium-resolution imagery is useful to map larger AoAs/ landscapes, it may not be sufficient for detailed baseline assessments or impact calculations. — It is unlikely that this method alone will provide accurate information for assessing ecosystem condition or establishing the suitability of habitats for target species.
Field surveys of adjacent or similar vegetation and habitat types, including reference sites	Moderate – Very High	— Data collected at nearby representative sites may not provide a completely accurate representation of the historical biodiversity values that have already been affected. — Similar ecosystems may still vary in species composition and ecological dynamics. The reference sites used for field assessment might be subject to other historical impacts not connected with project operations (e.g. the spread of invasive species, hunting pressures and private landowner changes such as water diversion).
Scientific modelling	Moderate	— Historical data may be sparse or inconsistent, affecting model accuracy. — Models are influenced by the number of records used to support predictions, so their use is limited to species with a sufficient number of occurrence records. — Developing and maintaining digital twins for large-scale ecosystems can be resource intensive. — Combining diverse datasets and models requires advanced technical expertise.

19. Estimated accuracy/confidence levels have been categorised as low, moderate, high and very high in line with definitions of 'Accuracy Levels' defined in Accounting for Nature (2023), *Method Rules: Rules for the development and accreditation of environmental condition monitoring methods.* Accounting for Nature Ltd. [PDF]. Available at https://static1.squarespace.com/static/6422478a7c84f76efc2ca36a/t/657a92786cf87f76c33f9876/1702531788251/Methods+Rules++v1_December+2023.pdf

Further resources

Accounting for Nature (2023), *Method Rules: Rules for the development and accreditation of environmental condition monitoring methods*. Version 1.0, Accounting for Nature Ltd. [PDF]. Available at https://static1.squarespace.com/static/6422478a7c84f76efc2ca36a/t/657a92786cf87f76c33f9876/1702531788251/Methods+Rules++v1_December+2023.pdf

Equator Principles (2022), *Best-practice note on biodiversity baseline surveys*. Equator Principles Association. [PDF].

Gullison, R.E., J. Hardner, S. Anstee and M. Meyer (2015), *Good practices for the collection of biodiversity baseline data*. Prepared for the Multilateral Financing Institutions Biodiversity Working Group and Cross-Sector Biodiversity Initiative.

The Biodiversity Consultancy (2018), *How to make biodiversity surveys relevant to your project*. Industry Briefing Note. [PDF].

Select Site-Level Biodiversity Indicators and Metrics

05

Key objective: To explore ways in which companies can measure progress towards NNL and NG using biodiversity indicators within a Pressure-State-Response framework.

5.1 Introduction

Albert Einstein's observation, "*Not everything that can be counted counts, and not everything that counts can be counted*", aptly captures the complexity of biodiversity. It is intricate, ever-changing and uniquely tied to specific environments, defying a simple, universal metric for assessing its fluctuations over time. Conversely, Peter Drucker's insight that "*you can't manage what you can't measure*", remains equally valid. While biodiversity may resist easy quantification, finding meaningful ways to measure it is essential for its effective management and stewardship.

This section explores ways in which companies can measure progress toward NNL and NG using biodiversity indicators and metrics within a Pressure-State-Response framework. By utilising biodiversity indicators in this context, we can better understand and quantify the relationships between the current state of biodiversity within a project's AoI (derived from the biodiversity baseline within the AoA, see Section 3), the human-induced pressures affecting these biodiversity values, and the effectiveness of the responses implemented to mitigate those impacts.

The terms 'metrics' and 'indicators' are often used interchangeably. In literature, the distinction between terms like 'metrics', 'indicators' and 'indexes' is not always precise and often reflects differences in language usage, context and purpose rather than strict definitions. For this document, the definitions are presented below. An example is as follows: If the indicator is population trends, a suitable metric might be species density per hectare (ha).

- **Biodiversity indicators:** An indicator is a measure or proxy used to assess, track or communicate a broader condition or trend, and extent of ecosystems. These indicators provide raw or processed data that represent distinct attributes of biodiversity.
- **Biodiversity metrics:** A metric is a specific, quantitative measure used to describe a particular characteristic or variable. Metrics ensure standardised and specific measurements and are the building blocks of data analysis, providing the raw numbers that are often used to inform or construct indicators. Examples include species density/ha (number of individuals of a species per ha) or % canopy cover (the percentage of ground covered by tree canopy in a forest).
- **Biodiversity index:** An index is a type of indicator specifically designed to aggregate data from multiple sources or metrics. The Living Planet Index tracks trends in the abundance of vertebrate species globally. The Biodiversity Intactness Index combines species abundance and richness data relative to a baseline.

5.2 Why use indicators?

Biodiversity indicators and metrics are essential tools to demonstrate progress toward NNL and are often required to meet regulatory conditions, responsible mining standards, reporting frameworks/standards, lender standards and internal corporate commitments to supporting global biodiversity targets. They can also be a very effective communication tool for stakeholders. Some examples of the use of indicators include:

- **Meeting regulatory requirements:** Many regulatory requirements specify indicators, for example, the EU Corporate Sustainability Reporting Directive (CSRD). Companies subject to the CSRD must report according to the European Sustainability Reporting Standards (ESRS), including disclosure of impact metrics related to biodiversity and ecosystem change (E4-5).
- **Implementing responsible mining standards:** Indicators are required to demonstrate progress toward commitments in responsible mining standards, such as NNL or NG (ICMM's Nature Position Statement Commitment 1.3).
- **Assessing the efficacy of project interventions:** Indicators are key to assessing whether project mitigations are working or need adjustment.
- **Meeting reporting commitments:** Almost all sustainability reporting frameworks such as the Global Reporting Initiative (GRI) and the Taskforce on Nature-related Financial Disclosures (TNFD) recommendations require disclosure of material impacts and dependencies using selected biodiversity indicators/metrics.
- **Meeting lender requirements:** All multilateral and Equator Principle Financial Institution lenders require companies to demonstrate NNL or NG although they don't specify which indicators to use (e.g. IFC, Multilateral Investment Guarantee Agency, European Bank for Reconstruction and Development, African Development Bank and all 131 Equator Principle Financial Institutions such as ABN AMRO, ANZ, Banco do Brasil, Ex-Im Bank, Nedbank, Shinhan Bank and Westpac).
- **Assessing progress towards global targets:** Tracking progress towards internal corporate targets on biodiversity or the contribution the company makes to global targets.

Many global and sector-wide initiatives are currently reviewing and consensus-building on a universal set of metrics and guidance, on which a draft consultation update was produced in January 2025.

5.3 Indicators and the Pressure-State-Response framework

Site-based biodiversity indicators often require fieldwork and are at a scale that can support site-based decision-making. By their nature, individual indicators can never provide an overall picture of the state of biodiversity but used in combination with other indicators (or suites of indicators) can be used to assess and infer information about the following:

— **State of biodiversity:** These indicators describe the current condition of biodiversity within a specified area over time (e.g. extent, species richness, ecosystem condition and genetic diversity).

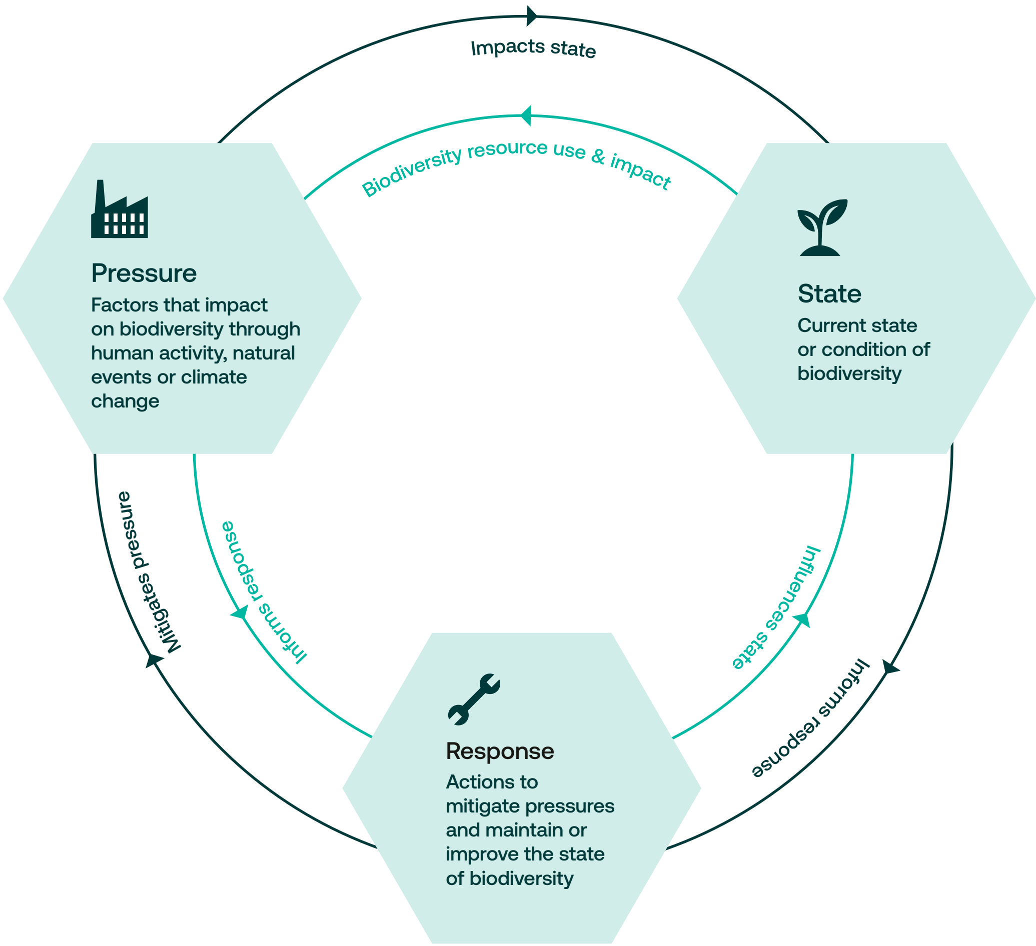
— **Pressures (drivers) on biodiversity:** These indicators could be used to assess adverse effects on biodiversity (e.g. habitat loss, habitat degradation, pollution and hunting pressures).

— **Response to pressures:** These indicators can help monitor the implementation of mitigation measures to improve the state (e.g. increasing the number of rangers, restoration, wildlife crossings). While they can act as proxy indicators to some extent, they cannot be used to evaluate mitigation effectiveness as that will only be reflected in a revised state of biodiversity.

Changes in state indicators can be influenced by the actions of the company as well as external factors beyond the company's control, which highlights the need for long-term monitoring programs and the integrated use of state, pressure and response indicators to support data interpretation and assess the efficacy of mitigation efforts (see Figure 5.1[20]).

Other frameworks for organising metrics and measurement approaches are provided by other accounting frameworks and further guidance is available on how to implement these[21,22,23,24].

Figure 5.1: Pressure-State-Response Framework



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21. United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), Capitals Coalition, Arcadis and International Climate Finance (ICF) (2023), *Aligning Accounting Approaches for Nature: Measuring and valuing biodiversity at site level.* [PDF].
22. United Nations et al. (2021), *System of Environmental-Economic Accounting—Ecosystem Accounting* (SEEA EA). Available at https://seea.un.org/ecosystem-accounting
23. Partnership for Biodiversity Accounting Financials (PBAF) (2022), *Taking biodiversity into account*, PBAF Standard v2022, Biodiversity impact assessment – Overview of approaches. [PDF].
24. Endangered Wildlife Trust (2020). The Biological Diversity Protocol (BD Protocol) (2020). National Biodiversity and Business Network – South Africa, 123p.

5.4 Selecting suitable indicators and associated metrics

The selection of indicators to measure progress towards NNL and/or NG outcomes are site-specific and will be based on the types of biodiversity values being affected as well as their conservation value or their value to stakeholders. Ideally, indicators should be based on the three main components of biodiversity: ecosystems, species and, if required, genetics. Thus, it should be a process informed by the best available scientific knowledge, which may require inputs from species experts and other stakeholders. Ideally, indicators and metrics should:

— Focus on those priority biodiversity values that will be affected.

— Incorporate ecosystems, species and, where relevant, processes on which ecosystems or species depend.

— Be sensitive to changes in the intensity of pressures and the efficacy of responses.

— Be feasible to apply (i.e. the company will be able to collect the required data).

— Be understandable such that everyone who is concerned by the results can interpret what they mean.

Some of the considerations that inform the choice of indicators for priority biodiversity values are outlined in Figure 5.2. These could equally apply to natural habitat or other non-priority biodiversity values.

Figure 5.2: Indicator and metrics selection for monitoring priority biodiversity values

A. Threatened ecosystem or habitat that supports threatened species

- **Extent:** used to monitor loss or gain in area
- **Condition:** used to monitor changes in habitat quality, e.g. degradation
- **Fragmentation:** used to monitor how intact or connected areas of habitat may be
- **Processes:** used to monitor processes on which an ecosystem may depend such as groundwater recharge

B. Threatened, range rest migratory or congregator species

- **Population size/abundance:** used to monitor site endemics, some great apes, and selected migratory or congregatory species
- **Density (per unit of area):** used to monitor medium to large mammals (e.g. great apes, primates, bears, elephants)
- **Species assemblages:** used to demonstrate importance of an area (e.g. birds, amphibians)
- **No. of breeding pairs:** used to monitor certain bird species
- **Habitat proxies:** used for other threatened species where monitoring abundance is challenging, e.g. frogs

C. Protected areas and sites designated as internationally important

- **Designation dependent:** choice of indicators should account for:
  - the basis of the protected area designation; and
  - the nature of the potential impacts, to provide confidence to the responsible authorities that adverse impacts are not occurring

Note: For either A, B or C, regulatory requirements may also prescribe specific monitoring requirements

5.5 State indicators

State indicators are foundational to understanding the **state** or condition of biodiversity at a given point in time. They are also essential to understanding changes in biodiversity that may arise due to shifts in the **pressures** that impact and drive changes in biodiversity. Similarly, they are essential to understand changes in biodiversity that may result from **responses** to mitigate impacts on biodiversity. While **state** indicators can sometimes be used on their own, **pressure** and **response** indicators should always be used in combination with state indicators.

State indicators for projects and operations should encompass a selection of metrics that cover species, ecosystems and, where relevant, processes and protected areas. The indicators and metrics presented in Table 5.1 are simply illustrative to provide ideas about the types of metrics that are in use. Many of the indicators and associated metrics suggested apply at the operational level and may not be able to be aggregated across projects.

Table 5.1: Examples of state, pressure and response indicators and metrics

State	State indicators measure the status and/or condition of biodiversity values of interest in monitoring progress towards NNL and/or NG targets				
Indicator	**Description of indicator (and, if available, Indexes)**	**Example metrics[25]**	**Advantages**	**Disadvantages**	**Standards examples**
Terrestrial and aquatic ecosystems	**Spatial extent** Measuring area is conceptually simple and relatable	Area in ha^2 or km^2	— Key for assessing habitat loss or restoration — Applicable at site — Sensitive to short-term and long-term change — Data readily available through satellite imagery and global datasets — Easy to communicate	— Significant limitations if used in isolation — Provides no information on the conservation value or condition of habitat or species present — Challenging to differentiate some ecosystems without ground-truthing (e.g. natural grasslands from pasture, natural forests from plantations or tree crops)	— Part of most reporting standards (e.g. GRI, ESRS, TNFD) and lender requirements
	Condition or quality This is often habitat-specific and can include variables relating to structure, function and composition and overall intactness or integrity. Ecosystem condition can sometimes be assessed using high-quality remote sensing. For example, the Forest Structural Condition Index (SCI) uses the best existing global forest data sets to represent a gradient from low to high forest structure development. The inputs of the index comprise remotely sensed estimates of canopy height, tree cover and time since disturbance. Other condition or quality indicators include: — Riparian Quality indices — Habitat Quality Index	Structural metrics: — Vegetation height — % canopy cover — Number of canopy stories — Variety of aquatic substrates — Biomass (tons/ha) — Compositional metrics: — Presence of indicator or keystone species — Flora species richness (number of species present) — Species evenness (balance in species abundances) — Functional metrics — Carbon Sequestration Value — Normalized Difference Vegetation Index	— Key for assessing degradation or changes to structure or composition — Applicable at site — Functional indicators like Carbon Sequestration Value help measure co-benefits (carbon/biodiversity) — Normalized Difference Vegetation Index gives a measure of vegetation health and density using satellite near-infrared and red-light reflectance, so can be monitored remotely — Index of Biological Integrity assesses the condition of ecosystems by measuring indicators (e.g. species composition), relative to an un-impacted condition, and can be very efficient	— Requires site-based fieldwork — Also requires an understanding of the characteristics of that vegetation type or ecosystem — Functional indicators can either involve significant time to estimate or be costly to apply — Some functional indicators such as the Index of Biological Integrity rely on a detailed understanding of species of concern, which is not always known	— ESRS, E4-5, 41(b), Material impacts on ecosystems – one or more indicators that measures the quality of ecosystems relative to a pre-determined reference state — GRI 101-7, Changes to the State of biodiversity, (ecosystem type, size, condition) — TNFD, A5.0, State of Nature, Ecosystem condition — Science Based Targets Network (SBTN), State of Nature, Ecosystem extent, connectivity and integrity

25. Some indexes are composite metrics

State	State indicators measure the status and/or condition of biodiversity values of interest in monitoring progress towards NNL and/or NG targets				
Indicator	**Description of indicator (and, if available, Indexes)**	**Example metrics**	**Advantages**	**Disadvantages**	**Standards examples**
Terrestrial and aquatic ecosystems	— EPT Index: Proportion of *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies) and *Trichoptera* (caddisflies) which are sensitive to pollution. — Index of Biological Integrity combines multiple metrics (species richness, trophic composition, etc.) to assess fish community health.				
	Connectivity/fragmentation Connectivity measures the relative ease of species movement between patches of habitat Poor connectivity inhibits the dispersal of species across landscapes – essential for population persistence, range shifts under climate change, and maintaining genetic diversity River Connectivity Index: Measures longitudinal connectivity of river systems **Ecosystem integrity** The state of an ecosystem where its structure, composition and functions are intact and capable of supporting biodiversity and ecosystem services over time. For example: — Forest Landscape Integrity Index — Local Biodiversity Intactness Indexes	— Number of patches — Patch area — Mean patch area — Edge to core ratio (measures the amount of core habitat relative to edge habitat) — Percentage of natural habitat remaining (the proportion of an area that retains its original vegetation or land cover)	— Data is often readily and freely available through satellite imagery and global datasets — May integrate information on extent, integrity and connectivity (e.g. Forest Landscape Integrity Index) in a way that integrates human pressures	— May require a high level of expertise to apply and/or to interpret, e.g. the same overall area made up of numerous small patch sizes (as opposed to a few large patch sizes) may have higher species richness	— ESRS, E4-5, 38(d)(e), direct contribution to impact drivers, changes in ecosystem structural connectivity, and functional connectivity — GRI 101-5-b (ii) and (iii), report when in or near ecologically sensitive areas, of high ecosystem integrity, or rapid decline in ecosystem integrity

State	State indicators measure the status and/or condition of biodiversity values of interest in monitoring progress towards NNL and/or NG targets				
Indicator	**Description of indicator (and, if available, Indexes)**	**Example metrics**	**Advantages**	**Disadvantages**	**Standards examples**
Processes	**Ecological processes** Ecosystems are sustained by a number of processes, such as primary production and nutrient and hydrologic cycles, yet these are rarely factored into monitoring. Where there is a clear connection between processes and ecosystem condition, monitoring may provide important insights	— Hydrologic function where the interplay between surface and groundwater has an important bearing on species, e.g. in Salars — Monitoring ecological processes in riparian habitats where flow regimes may profoundly impact some species — Gene flow-genetic indicators	— Provides a more holistic understanding of the interplay between biotic and abiotic factors — Can provide an early warning of potentially significant impacts on species of habitats — Can show changes to the genetic health of a population	— Although there is a relatively good understanding of how abiotic processes have the potential to impact on biodiversity monitoring, such processes can be complex	— N/A
Protected areas	**Proximity or extent of impact** Mining activities adjacent to protected areas may cause impacts either directly or indirectly, e.g. by depleting water resources the protected area depends upon	— Distance to protected areas — Extent of habitat loss within or adjacent to protected areas or Key Biodiversity Areas — Potential indirect impacts related to water abstraction, noise and vibration, etc.	— Data on distance and extent of habitat loss readily available — Obtained through satellite imagery and global datasets on protected areas	— The dependence of protected areas or species/habitats that form the basis of the designation on abiotic factors such as groundwater flows may be poorly understood — Sensitivity of some species to noise and vibration may also be poorly understood	— ESRS, E4-1, 19, whether activities may cause deterioration of natural habitats and disturbance of species for which a protected area has been designated — GRI 101-5-a (i) the distance to ecologically sensitive areas of biodiversity importance
Species	**Abundance and population size** This indicator informs an assessment of a species' status, population viability and trends	— Species population size — Species abundance — Species richness — Population growth rate — Number of breeding pairs — Genetic variation — Species threat, abatement and restoration (STAR) — Red List Index	— Provide direct measures of changes in species over time — Offer insight into rates of population growth and decline, and in some instances (e.g. breeding pairs) insights into habitat quality	— Requires fieldwork to establish most indicators — Population size and abundance requires very good sets of data — IUCN's STAR focuses on threatened species of very high conservation priority, but other biodiversity values may not be covered	— ESRS, E4-5, 40(b)(c), consider population size, range within specific ecosystems as well as extinction risk, and disclose metrics that measure changes in the number of individuals of a species in an area — TNFD A5.4, species population size

Pressure	Measures the pressures affecting the state of an indicator arising from operational and/or non-operational activities. They are used to monitor changes in the direct, indirect and cumulative impacts of operations on biodiversity.				
Indicator	**Description of indicator (and, if available, Indexes)**	**Example metrics**	**Advantages**	**Disadvantages**	**Standards examples**
Resource conversion or natural disasters	**Exploitation and disasters** Pressures that often manifest themselves at scale and can have indiscriminate effects	— Number of wildfires — Presence of invasive species — Rate of deforestation — Flood impacts on riparian and coastal habitats	— Can help to differentiate between man-induced and natural disaster impacts on biodiversity	— May be weakly connected to impacts on faunal species, e.g. long-lived species might initially survive but exhibit reduced reproduction or recruitment and later decline	— ESRS, E4-5, 38(a), conversion over time (e.g. 1 or 5 years) of land cover (e.g. deforestation or mining)
Species-targeting or unintentional impacts	**Hunting and collisions** Pressures that result from specific targeting of species or causal factors that impact certain types of species, e.g. on rural roads	— Hunting pressure (number of cartridges, traps, number of bushmeat snares recorded) — Number of collisions between motor vehicles and land-based species	— Can be integrated into the work of security patrols within protected areas — Relatively easy to count fatal interactions between vehicles and animals	— Requires special surveys where no security patrols are present	— GRI 101-6-b (i), where activities could lead to exploitation of natural resources report quantity, type and extinction risk of species harvested
Pollutant releases	**Releases to air, soil or water** May cause impacts on biodiversity directly or by affecting food sources of species of concern	— Pollution of streams affects food sources of aquatic wildlife and people — Noise or vibration impacts sensitive receptors	— Relationship between many aquatic species and pollutants well understood	— Relationship between sensitive receptors and noise, vibration or light is generally not well understood	— GRI 101-6-c, where activities could lead to pollution report quantity and type of each pollutant
Social	**Migration and settlement** Social factors that can in turn have adverse impacts on biodiversity Human Footprint Index: Combines data on infrastructure, agriculture, settlements, and other human activities to measure the cumulative impact on ecosystems	— Number of in-migrants to the AOI — Number of ad hoc settlements without social services	— Builds out understanding of associated pressures such as fuelwood collection, hunting or pollution	— Connection between indicators and impacts on biodiversity are indirect so need to be combined	— N/A

Response	Response indicators measure the status of implementation – and the effectiveness – of measures implemented to respond to threats and to achieve NNL and/or NG outcomes.				
Indicator	Description of indicator (and, if available, Indexes)	Examples of metrics	Advantages	Disadvantages	Standards examples
Actions taken to mitigate impacts	**Mitigation progress** Process-oriented indicators seek to demonstrate progress in implementing an operation's mitigation measures and are under the direct control of the site Biodiversity Manager. The outcome of responses will connect back to – and must be used in conjunction with – state indicators to assess the efficacy of responses and inform adaptive management	— Provisions of wildlife crossings — Signage and speed limits — Demarcation of sensitive areas on the ground — Number of rangers in protected areas — Number and frequency of patrols, removal of traps and snares — Capacity and training of wildlife managers — Availability of monitoring and other equipment — Changes to lighting — Implementation of fire control plans — Removal of invasive species — Number of education programs at schools — Progress with seed collection and success rate of seed germination for restoration — Size of areas under restoration or rehabilitation	— Usually relatively easy to measure and low cost to implement — Monitoring response indicators helps reinforce the implementation of actions within management plans (e.g. Biodiversity Action Plan or Biodiversity Management Plan) — Can also provide some indication of the success of mitigation efforts, e.g. removal or traps and snares	— Attributing causality between implementation of actions to mitigate impacts on biodiversity and observed changes in the state of biodiversity can be difficult — One factor that makes this challenging is the lag time between implementing actions to mitigate impacts and observed improvements in biodiversity	— N/A

5.5.1 Species indicators

Although habitat extent and quality are often used as proxies for monitoring fauna species, there are certain situations where species monitoring is required. The choice of indicator is dependent on the priority species that have been selected for monitoring. Priority species may include highly threatened or range-restricted species, globally significant concentrations of migratory and/or congregatory species, keystone species or species of particular importance to stakeholders (see Figure 5.2).

Species metrics can include simple presence/absence, species assemblages in a specified area, abundance in a specified area or density per unit area. There are certain situations where a total population count is required, such as where you have site endemics on your concession and there is a high risk of extinction. However, it is often impossible to count every individual and estimating density in smaller sample areas and extrapolating these results to larger regions provides a more feasible method of assessing populations.

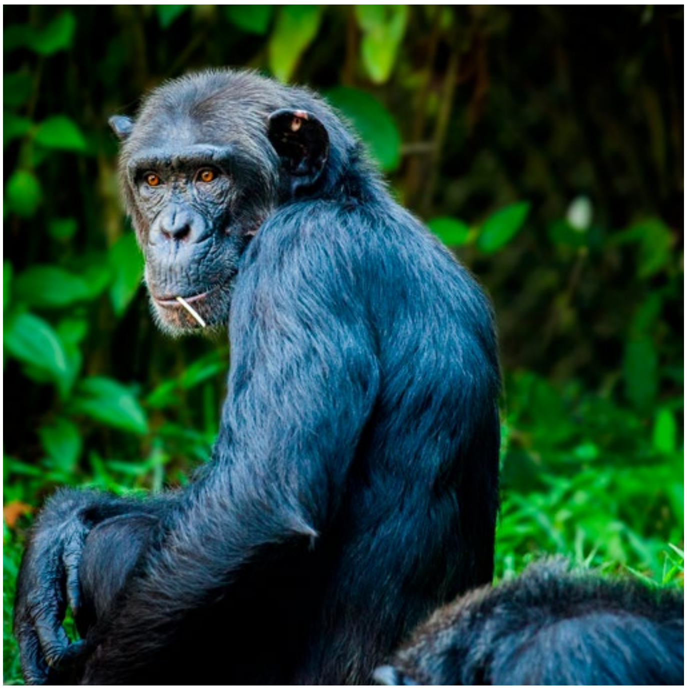
It is important to engage species experts on the best way to monitor a particular species, which metric provides the most useful information and which is feasible. For example, some bat species populations gather in large colonies to raise young in summer or to hibernate in winter, and roost counts or carefully counting bats as they leave their roosts to feed can provide reliable population estimates. However, many solitary bats are cryptic (i.e. they occupy distinct ecological niches and their conservation status may be uncertain) and difficult to locate, and some bat species are highly susceptible to disturbance in roosting situations and may abandon these sites in response.

Some amphibians can be effectively monitored using counts or abundance data from the same site(s) over multiple years. Monitoring riparian assemblages along the same transects over many years can also be very effective as, in general, forest amphibians and riparian amphibians are often more sensitive than savannah species to habitat changes.

Monitoring mammal populations can be challenging, especially those that live in dense habitats, making them difficult to observe directly, or because they occur at low densities or are dispersed widely over large home ranges. Without physical observation of mammals, their signs such as tracks, sounds, droppings, feeding signs, walking trails, skeletal parts and faecal pellets/scat can be recorded along the transects. The large-scale movements of migratory species mean that monitoring and management at the landscape scale might be necessary. Lastly, some taxa have long lifecycles and low reproductive rates (e.g. great apes and elephants). As a result, changes in their populations can take years to become apparent, requiring long-term monitoring to capture trends as well as the use of proxy indicators.

Densities of mammals can be assessed using line transect sampling and capture-mark-recapture (CMR) models can be used to derive density estimates from cameras for species like elephants and chimpanzees that can be identified based on their morphological features (e.g. face, ear lobe shape, tusk orientation and tail length).

For the critically endangered Western chimpanzee (*Pan troglodytes verus*) carefully designed camera trapping for capture-recapture analysis is often used in combination with genetic sampling. Genetic non-invasive sampling was used at Mount Nimba World Heritage Site in Guinea[26] to estimate population size, sex ratio, community composition, gene health, and flow and range boundaries. The study showed that genetic sampling provides essential data both for impact assessments and for long-term population monitoring.



26. Koops, K., Humle, T., Frandsen, P., Fitzgerald, M., D'Auvergne, L., Jackson, M., Børsting, C., Siegismund, A., Soumah, A.G. and Hvilsom, C. (2023), 'Genetics as a novel tool in mining impact assessment and biomonitoring of critically endangered western chimpanzees in the Nimba Mountains, Guinea', *Conservation Science and Practice*, volume 5(4). Available at https://doi.org/10.1111/csp2.12898

Genetic non-invasive sampling has also been used to monitor population sizes of black bear and grizzly bear using hair, and faecal samples. This has also been successfully used to monitor coyotes and wolves. However, genetic non-invasive sampling has some limitations as it is difficult to know what proportion of a population has been sampled and infants and juveniles are less likely to be sampled because their faeces are typically smaller and harder to find.

eDNA is a powerful tool for use in biodiversity baselines, especially in areas with hard-to-access species. It is non-invasive, has high sensitivity and works well across various habitats, including aquatic, terrestrial and soil ecosystems. While it complements traditional methods, its limitations necessitate combining eDNA with other survey techniques to ensure comprehensive and accurate assessments. eDNA indicates presence but doesn't reliably measure population size or density.

An example of a suitable species metric could be the density of critically endangered individuals or number of breeding pairs. For the cotton-top tamarin (*Saguinus oedipus*) at a site in north-east Colombia this might be density per km^2 of humid tropical forests. For the endangered Sierra Leone Prinia (*Schistolais leontica*) in Guinea this might be the number of breeding pairs in thickets bordering montane savanna (see Figure 5.3).

Plant species can be assessed based on presence/absence, or by measuring plant densities based on temporary or permanent sampling plots. For site endemics, you might need a complete population census. However, the reproductive phases of many plants are mobile and annual. Ephemeral or geophytic species may only be present episodically as standing populations, and their distributions can vary greatly depending on climate conditions (temperature and rainfall), soil conditions or disturbance events such as fires.

Monitoring of breeding pairs of birds is often used as an indicator of the health of a bird population, and over time can help identify the impact of various pressures on the population. This can also be important to estimate rates of population growth and decline, and to assess the effectiveness of (or need for) conservation actions. As birds are also sensitive to environmental conditions, monitoring breeding pairs can give a good indication of ecosystem health.

Figure 5.3 Species indicators could involve density of individuals or number of breeding pairs

For example, density of critically endangered cotton-top tamarin (*Saguinus oedipus*), left, per km^2 of humid tropical forests in Columbia or number of breeding pairs or the endangered Sierra Leone Prinia (*Schistolais leontica*), right, in thickets in Guinea.

5.5.2 Proxy indicators

Metrics typically provide a direct measure of some aspect of biodiversity (e.g. number of breeding pairs of a particular bird species). In some situations, directly monitoring the numbers or abundance of threatened species may be very challenging and resource intensive, either because the species of interest are highly elusive, occur in low densities over large and sometimes impenetrable habitat, or are highly susceptible to disturbances (including from biodiversity survey work). In such situations, proxy indicators can be considered (see Figure 5.2).

Proxy indicators measure changes in a factor known to be linked to an aspect of biodiversity to infer a correlation. If the proxy indicator changes, the assumption is that the related aspect of biodiversity changes. Often habitat level indicators are used to infer information on species. If the quality of a particular habitat has improved, the assumption is that the number of breeding pairs of birds will increase. It is important to recognise that proxies are imperfect measures and if used, it is important that they are based on a clear understanding of their relationship with the aspect of biodiversity they relate to.

5.5.3 Ecosystem indicators

The concept of integrity is often used to describe a measure of the completeness or intactness of an ecosystem's key attributes. For example, is it of an adequate size to ensure the complete representation of the features and processes normally associated with the ecosystem? An ecosystem supporting wide-ranging species should be large enough to include the most critical habitats essential to ensuring the survival of viable populations of those species. For an area containing migratory species, areas for seasonal breeding and nesting sites, or migratory routes, may be critical for their survival. Habitat degradation can lead to the loss of species, impaired ecosystem structure, function and diminished resilience.

While it is recognised that 'extent' of habitat alone will not adequately reflect changes that are likely to occur from project- or operational-related impacts, it is unrealistic to measure all the components that make up a healthy ecosystem. Some ecosystem indicators can be measured separately, and some are combined. Suitable ecosystem indicators are presented below with possible metrics (see Figure 5.2):

— **Extent:** The metric is area (km^2 or ha^2). It can be measured over time and the changes estimated retrospectively using time-sequenced aerial photographs or satellite images.

— **Structure:** Metrics include: % canopy cover, number of storeys, extent of fragmentation (patch size, distance to core area).

— **Composition:** The metric might be the presence of a flora species that are characteristics of that particular vegetation type or a fauna species that is dependent on that habitat type. For example, the Greater Sage-Grouse (*Centrocercus urophasianus*), which is protected under the Endangered Species Act in the USA, as an indicator of sagebrush habitats in the Western United States.

— **Processes:** These refer to the physical, chemical and biological activities that occur within ecosystems (water cycle, nutrient cycling). While is challenging to measure ecological processes, it is sometimes vital to monitor water quality and hydrology, and fire regimes where they underpin a particular ecosystem. Evolutionary processes (gene flow) can be particularly important on some sites and understanding dispersal and genetic affinity between communities and overall genetic health can help to monitor and ensure gene flow between the different communities.

— **Condition:** Condition tends to be a composite indicator encompassing a range of the metrics mentioned above. For example, the 'Quality Hectares' aims to combine extent and quality/condition. It measures the 'quality' of a vegetation type based on comparisons between existing vegetation features and those of 'benchmarks' representing the characteristics of 'natural' stands of native vegetation of the same community type. The attributes of quality will vary according to the vegetation type and context (e.g. presence of invasive species, patch size, tree canopy). See Box 5.1 for an example.

— **Keystone or umbrella species:** As defined in Section 3.2.2. Metrics might be presence/absence, abundance or density per hectare.

Box 5.1: Example of creating a Biodiversity Forest Quality Index for a West African mine

A Biodiversity Forest Condition Index was developed based on Worldview and other imagery with additional ground truthing. Individual distinctive species were picked out by eye. Then selected ground truthing of the list of tree species which could be identified to species level in the imagery was undertaken. An AI image recognition algorithm capable of recognising texture as well as spectral properties and informed by terrain and other environmental data was used to enhance identification.

This allowed discrete classes of vegetation and their condition to be mapped as polygons in spatial imagery. The next stage was to correlate this map with known critical habitat qualifying species[27] that were ground truthed in subsamples of these polygons separately.

The Biodiversity Forest Quality Index reflected the percentage of canopy closure, with adjustments made for steep slopes and causal factors (shallow soil vs regular fire). Ground truthing was important as some patches identified by the algorithm as 'poor condition' were actually edaphic savanna or a reflection of past disturbances, especially fire, that had led to local tree loss and soil erosion, preventing rapid secondary succession. The Biodiversity Forest Quality Index classes were descriptive, such as:

— **Good moist gallery forest:** Many *Lophira/Hertiera* species and typical 25–40% gaps (where the water runs).

— **Good dry semi-deciduous forest:** The dry semi-deciduous indicator set at <10% gaps or pioneer thickets.

— **Poor condition dry semi-deciduous forest on the lowlands and moderate to low slope:** Abundant *Elaeis guineensis* and Pioneer thickets >25% cover. Gaps >10%.

Although this condition metric was primarily a structural one, known critical habitat qualifying species would be included in the next stage to highlight where gains could be made with restoration or enrichment and by preventing fires.

5.5.4 Protected area indicators

Mining activities adjacent to protected areas may cause impacts either directly or indirectly, e.g. by depleting water resources the protected area depends on. The choice of indicators for monitoring potential impacts on protected areas should always take account of:

— The basis of the protected area designation and specifically which species or habitats are referenced within the designation.

— The nature of the potential impacts and how these might manifest themselves, including how they influence the areas surrounding and connecting to the protected area.

This should provide confidence to the responsible authorities that adverse impacts are not occurring – or where they are, that adaptive management measures are being applied to mitigate adverse impacts (see Figure 5.2).

5.5.5 Global metrics

There are numerous ecosystem and species indexes that aggregate and interpret large data sets to assess the state of different aspects of biodiversity. They often combine satellite imagery, global data sets and modelling. These types of indexes can be particularly useful for comparative purposes across portfolios (or value chains), but some have limited value for monitoring site-based NNL or NG and so are not covered extensively in this section. A few relevant examples are presented in Table 5.1. They include:

— The Forest Landscape Integrity Index which integrates data on observed and inferred forest pressures.

— The Species Threat Abatement and Restoration (STAR) metric which combines data on species, the threats they face and their risk of extinction, to produce two complementary global data layers for threat abatement ($STAR_T$) and restoration ($STAR_R$).

27. Critical habitat is a concept that has been adopted by the IFC in Performance Standard 6 and is used by regulators (such as the US Fish and Wildlife Service and Australian Department of Climate Change, Energy, the Environment and Water). In both instances, it refers to areas within the geographical area occupied by the species at the time of listing that contain physical or biological features essential to conservation of the species and that may require special management considerations or protection.

— The Biodiversity Habitat Index which uses biologically-scaled environmental mapping and modelling to estimate the impacts of habitat loss, degradation and fragmentation on the retention of terrestrial biodiversity globally, from remotely sensed forest change and land-cover change datasets. The approach uses data covering the entire terrestrial area of all countries of the world, at 1km grid resolution.

— The Local Biodiversity Intactness Index which is based on a purpose-built global database of local biodiversity surveys combined with high-resolution global land-use data.

5.6 Pressure and response indicators

The relationship between pressure, state and response is illustrated in Figure 5.1 which helps explain the description of and relationships between the indicators below.

Pressure indicators measure the various **pressures** affecting the state of biodiversity originating from operational and/or non-operational activities that may convert habitats, directly use natural resources, or in other ways impact the **state** of biodiversity. They are used to monitor c**hanges in the drivers** of direct, indirect and cumulative impacts of operations on biodiversity. Pressure indicators should always be used in conjunction with **state** indicators.

The drivers of change leading to **pressures** on biodiversity should inform the **response** to mitigate these pressures. Response indicators measure the status of implementation and the effectiveness of measures designed to mitigate pressures or threats to biodiversity values to help achieve NNL or NG outcomes. The outcomes of those responses in turn influence the **state** of biodiversity, as measured by the **state** indicators which should always be coupled with the use of response indicators. Monitoring indicators of the state of the biodiversity in turn informs the response; where actions to mitigate pressures seem to be ineffective in improving the state indicators, the response needs to adapt accordingly.

As ecological responses to impacts and mitigation measures are complex and not necessarily linear, it is important to select several different metrics. For example, for species with slow life histories (such as elephants and great apes) who invest more energy and time in growth and development, the response to impacts or mitigation measures may take a long time to become measurable. Their populations may initially survive but exhibit reduced reproduction or recruitment over the longer term. So, in addition to measuring changes in species abundance, pressure and response metrics are also important to paint a complete picture.

For detailed illustrative examples of pressure and response indicators, see Table 5.1

5.7 Challenges

Many challenges exist to selecting appropriate metrics and indicators, as has already been discussed throughout Section 5. For example, biodiversity metrics may not adequately represent variations in species abundance or diversity across different spatial and temporal scales. Gaining sufficient and reliable data on species, ecosystems and ecological processes can be challenging, particularly in remote or understudied regions. Biodiversity indicators often focus on charismatic or well-studied species, neglecting less visible or understudied organisms. The choice of different biodiversity indicators can be subjective and influenced by human values and priorities. Further, it is often difficult to distil the complex interactions between components of biodiversity into a single metric and the best combination of metrics (species and ecosystems) often differs among places.

Further resources

Finance for Biodiversity (2024), *Biodiversity measurement approaches: A practitioner's guide for financial institutions*, 4th ed. [PDF].

IUCN (2020), *Guidelines for planning and monitoring corporate biodiversity performance*. Draft version for public comment. International Union for Conservation of Nature.

Kühl, H, F. Maisels, M. Ancrenaz and E.A. Williamson (2008), *Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations*, IUCN SSC Primate Specialist Group (PSG). p.32 [PDF].

TNFD (2023), *Guidance on the identification and assessment of nature-related Issues: the LEAP approach*. version 1.0. Annex 2: Guidance on how to measure changes in the state of nature. [PDF].

United Nations Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC), Conservation International and Fauna & Flora International (2020), *Biodiversity Indicators for Site-Based Impacts*. Cambridge, UK. [PDF].

UNEP-WCMC (2017), *Biodiversity Indicators for Extractive Companies: An Assessment of Needs*, Current Practices and Potential Indicator Models. UNEP-WCMC: Cambridge, UK. [PDF].

Assess Impacts and Apply the Mitigation Hierarchy

06

Key objective: To understand the iterative nature of assessing impacts and effectively applying the mitigation hierarchy to support the achievement of NNL or NG of biodiversity.

6.1 Introduction

This section emphasises the importance of the mitigation hierarchy in achieving NNL or NG of biodiversity. The mitigation hierarchy consists of sequential steps: avoidance, minimisation, restoration/rehabilitation and offsetting. Applying this hierarchy is crucial because it prioritises actions that prevent biodiversity loss (i.e. through avoidance and minimisation) before considering more high-risk actions that compensate for it once lost (i.e. through mine site restoration and offsetting).

While biodiversity impact assessment is a detailed topic with extensive coverage in other resources, it is briefly discussed here to highlight its role in identifying and quantifying the impacts of mining at each stage of the mitigation hierarchy, including an estimation of their significance and ultimately the residual impact requiring compensation to achieve NNL or NG.

Additionally, this section examines the role of mine site rehabilitation and restoration within the mitigation hierarchy, specifically addressing if and how restoration can contribute to achieving NNL. Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed and returning it to its original state or a condition that supports biodiversity. Rehabilitation also improves the condition of impacted areas towards an agreed post-mining state; however, this is not necessarily its original condition. See ICMM's *Integrated Mine Closure: Good Practice Guide* for further clarification on the differences between restoration and rehabilitation.

Mine site rehabilitation can play an important role in addressing impacts on site that cannot be entirely avoided or minimised, thus contributing to the overall goal of NNL or NG. However, the ultimate contribution of rehabilitation towards NNL or NG depends on various factors, including the biodiversity values impacted by mining, the degree of degradation that occurs, the effort and resources put into rehabilitation and the end state of biodiversity achieved once rehabilitation is complete.

The topic of biodiversity offsetting is addressed separately in Section 7.

6.2 Types of biodiversity impacts

Mining can have significant and wide-ranging impacts on biodiversity. The impacts vary depending on the location, type of mining, extent of associated infrastructure, the effectiveness of the application of the mitigation hierarchy, the dependence of local communities on natural resources, and the capacity of regulatory authorities. For existing projects, retrospective baselines provide an estimate of past impacts on biodiversity (see Section 4) and the residual impact that has occurred between the historic baseline year and the current state. For new projects and significant changes to existing projects, the Environmental and Social Impact Assessment should assess direct, indirect and cumulative impacts on the species, ecosystems and (where relevant) processes identified in the baseline studies. Assessments should consider project-related impacts across the affected landscape especially those on habitat connectivity and/or on downstream catchment areas outside the boundaries of the project area.

— **Direct impacts:** These are immediate effects caused by project activities, such as habitat loss, fragmentation or species displacement.

— **Indirect impacts:** Indirect impacts result in effects with a delayed spatial or temporal extent, and are often described as secondary or as being mediated through intermediate changes in land use, resource availability or social dynamics. In some jurisdictions, this can arise from in-migration and settlement, increased access to new infrastructure and improved viability of other economic activities.

— **Cumulative impacts:** The combined effects of the project along with other nearby projects or land uses, or reasonably foreseeable projects. Modern GIS tools can assess cumulative impacts by integrating data from multiple projects and land-use changes within a region. Indirect impacts are inherently difficult to predict with precision before a project begins. While the available literature on the exact spatial extent of these impacts is limited, there is evidence that indirect effects can be extensive and are underestimated[28].

Companies should, however, adopt a precautionary approach and estimate the potential range of indirect impacts. These estimates can be incorporated into offset calculations and refined as new information becomes available. Approaches include:

— Adding a spatial buffer around the project area to account for predicted indirect impacts, such as habitat fragmentation, pollution or loss of habitat (e.g. 10–20% additional area).

— Applying buffer zones around influx hotspots to mitigate localised pressures.

— Using a multiplier for offset requirements to account for unmeasured or uncertain indirect impacts (e.g. increasing the offset area by 1.2–1.5 times the directly impacted area).

For cumulative impacts, in some circumstances, there is a risk that piecemeal solutions fail to address the broader biodiversity challenges caused by multiple developments in the same landscape. To tackle this, a collaborative approach is necessary to maintain and enhance ecosystem functionality at a landscape scale. This may involve coordinating with other stakeholders to identify collective initiatives and creating a fund, supported by contributions from all project developers, to finance these initiatives across the landscape.

By adopting these measures, companies can proactively address both indirect and cumulative impacts, contributing to more effective biodiversity conservation at both the project and landscape levels.

6.3 Effects of mining on biodiversity

Mining activities cause both direct, indirect and cumulative impacts on terrestrial and aquatic ecosystems. Direct impacts include habitat loss from land clearing and water diversion, leading to species displacement and loss. Additionally, habitat degradation occurs due to noise, dust, pollution (e.g. SO_2 and NO_x), light, vibrations, blasting and the spread of invasive species. Mining infrastructure (such as roads, rail, transmission lines and pipelines) fragment habitats, limiting species' movement, access to resources, and mating opportunities, which can lead to population declines and reduced genetic diversity. Infrastructure also increases the risk of wildlife collisions with vehicles.

28. Sonter, L.J., Herrera, D., Barrett, D.J. et al. (2017), 'Mining drives extensive deforestation in the Brazilian Amazon', *Nature Communications* 8, 1013. [PDF]. Available at https://doi.org/10.1038/s41467-017-00557-w

In some regions, indirect impacts, such as induced human migration, can result in increased settlements, further land conversion, unsustainable use of natural resources, increased hunting pressure, and access to areas that were previously inaccessible. Multiple projects in a single area are likely to result in cumulative effects on biodiversity values, as seen with the greater sage-grouse, whose habitat has been heavily fragmented, leading to population declines. Similarly, multiple mining operations can deplete water resources, harming aquatic ecosystems.

6.3.1 Assessing the significance of impacts

Assessing impacts on biodiversity involves determining the significance of those impacts and whether they are substantial enough to require mitigation and justify a NNL or NG target. It is therefore essential that any NNL commitment be clear on which biodiversity features and/or what levels of impact constitute a 'significant impact' and thus fall within the scope of the mitigation hierarchy.

Significance in biodiversity impact assessment is determined by evaluating two key factors: the magnitude of change, and the sensitivity or conservation value of the biodiversity feature. Some methodologies include the likelihood of the impacts occurring. This process is systematic and relies heavily on expert judgment, supported by legal requirements.

Achieving NNL or NG for features of high conservation value or sensitivity is likely to involve a range of indicators (ecosystems and species), whereas addressing NNL for significant residual impacts on natural habitat[29] tends to be habitat rather than species-focused. Excluding less significant features from loss or gain calculations risks underestimating broader ecological impacts. Even if individual features are not deemed significant, their combined role in landscape connectivity and ecosystem functionality can be critical.

Most lender requirements mandate NNL for residual impacts on natural habitats where feasible and NG for residual impacts on critical habitats, reinforcing the importance of considering all biodiversity components in impact assessments. Additionally, some government policies set thresholds and provide guidance for determining the significance of impacts and the NNL or NG requirements for these.

While various methodologies exist, they often distil down to the same principle:

Significance = Conservation status and sensitivity x Magnitude of impact

Conservation value and sensitivity

Biodiversity features of global, national or regional importance, or species of concern to stakeholders – such as threatened species, critical habitats, sites within or near protected and internationally designated areas, or species that have cultural value – are more likely to experience significant impacts. Beyond conservation value, practitioners also consider the sensitivity of biodiversity features. Even widespread species or ecosystems may be highly sensitive to disturbances and have limited resilience to recover. For example, ecosystems with low biological productivity, like deserts or alpine zones, are particularly vulnerable due to their harsh environmental conditions and once degraded, restoration is exceedingly difficult. Similarly, some wetlands, are dependent on specific conditions, such as stable water levels, and are highly sensitive to external disruptions, as are peatlands. The significance of impacts on biodiversity can also be guided by local, national or international regulations.

Magnitude of impact

The magnitude of an impact differs among jurisdictions, but involves a combination of various elements:

- **Extent of impact:** The area or number of species affected – impacts over a larger extent therefore typically have a higher significance.
- **Intensity:** The severity of the impact on biodiversity, including habitat loss, species mortality or disruption of ecological functions.
- **Duration:** Whether the impact is short-term or long-term. Long-lasting or permanent impacts are considered more significant.
- **Reversibility:** Whether the impact can be reversed through natural recovery or active restoration. Irreversible impacts (e.g. extinction of a species or permanent habitat loss) are of the highest significance.

29. Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

6.4 Application of the mitigation hierarchy to achieve lasting no net loss or net gain outcomes

The mitigation hierarchy is applied throughout a project's design, construction, operation and decommissioning/closure to meet biodiversity NNL or NG commitments. An 'avoidance first' emphasis throughout each stage of a project lifecycle provides greater assurance that NNL and/or NG targets can and will be met and is the best way to avoid potentially irreversible, non-offsetable and costly risks and impacts.

Companies should demonstrate that a clear, systematic process was used to identify risks to biodiversity at every stage of the project. This involves assessing risks quantitatively or qualitatively and documenting them in a transparent way. You may need to clearly show how alternatives were evaluated to avoid and minimise risks for each project component. This includes documenting the decision-making process that led to the selection of certain project designs, sites or technologies over others to reduce risks.

For certain key infrastructure and activities (e.g. conveying, waste rock storage, product transportation, camp locations, water source, power generation and blasting type), it might be helpful to present tables showing how decisions were made to apply the mitigation hierarchy. It is also important to be transparent about trade-offs, acknowledge that complete avoidance may not always be possible and explain the basis for decisions made. An example might be: "While full avoidance of wetlands was not feasible due to technical constraints, the selected alignment minimises impact by reducing the length of road crossing the wetland by 70%."

For existing operations, opportunities for avoidance should be sought every time new activities are planned. Applying the mitigation hierarchy retrospectively to a project that is already operational is challenging. However, opportunities for avoidance and minimisation exist when site layout and scheduling of activities are reviewed, and opportunities to consider offsetting historic impacts may arise when new or updated corporate nature-related commitments are made.

The hierarchy provides a clear framework to mitigate adverse biodiversity impacts and classifies actions into four categories (see Figure 6.1 and existing guidance on its application, including trade-offs and management[30]):

— **Avoid:** actions to prevent impacts from occurring.

— **Minimise:** actions to reduce or limit the magnitude or significance of impacts.

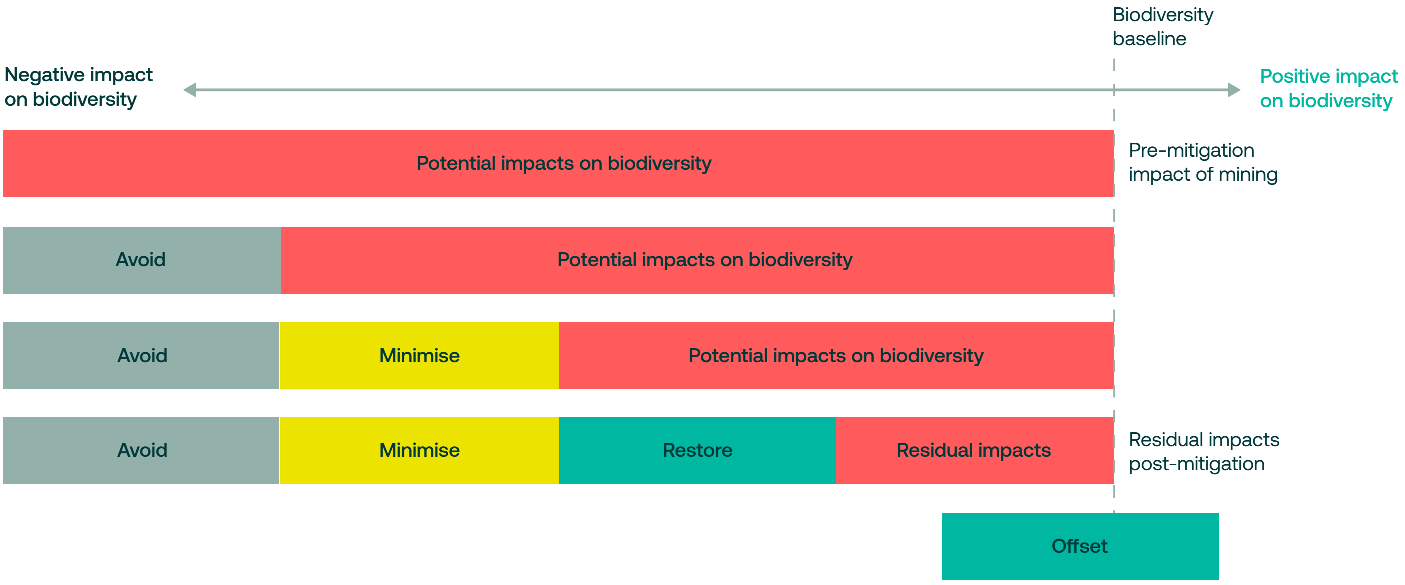
— **Restore:** actions taken to restore impacted ecosystems, habitats or species populations. Achieving NNL of biodiversity through restoration requires achieving a baseline state or conditions, targeting the features and processes to which commitments apply. If not fully effective, residual impacts will remain.

— **Offset:** actions to respond to residual[31] impacts that remain despite efforts to avoid, minimise and restore impacted biodiversity, by compensating for losses with equivalent gains elsewhere in the landscape. In some cases, these equivalent gains could be achieved by rehabilitation activities on pre-2020 disturbance areas to reconstruct equivalent ecosystems and conditions as those being lost post-2020. In those cases, the reconstructed ecosystems would need to be handled in the same way as other offsets. See Section 7 for guidance on offsets.

While the mitigation hierarchy is frequently cited as a cornerstone of environmental and social impact management, its practical implementation often falls short of expectations, particularly measures to avoid adverse impacts on biodiversity. This is due to a variety of challenges, including inadequate planning and competing budgetary pressures. As a result, the focus can shift prematurely to compensation measures like biodiversity offsets, which are more challenging to implement and, in some jurisdictions, a very costly strategy to achieve NNL and NG outcomes.

30. Cross Sector Biodiversity Initiative (2015), A Cross Sector Guide for Implementing the Mitigation Hierarchy. IPIECA, ICMM and the Equator Principles Association.
31. Depending on applicable jurisdiction or standards, offsets may be required only for 'significant' residual losses, not all residual loss.

Figure 6.1: Application of the mitigation hierarchy to achieve NNL/NG



6.4.1 A necessary cultural change: An 'avoidance first' focus

Companies need to create a culture and framework that emphasises the effective application of the mitigation hierarchy and prioritises avoidance as a core part of project planning and execution. Avoidance should be embedded into the project lifecycle, creating clear accountability, fostering collaboration between teams, and aligning avoidance goals with both regulatory requirements and company values. By treating avoidance as a strategic, measurable objective, the engineering teams are more likely to prioritise it as a key part of their decision-making process. The following approaches can help institute avoidance first as an operating principle within companies:

— **Build avoidance into company policy and standards:** Companies should develop and embed in policy clear and specific guidelines on how to implement the avoidance and minimisation steps in the mitigation hierarchy, including a requirement to document the steps taken. This should emphasise the risks – both financial and reputational – associated with the degradation of nature.

— **Incorporate avoidance into the project design process:** Avoidance must be introduced at the earliest stages of project planning. Engineers should be part of cross-functional teams, including environmental and social specialists, to collaboratively identify ways to avoid impacts. This ensures that avoidance is not an afterthought but a primary consideration. This can be supported by undertaking robust biodiversity assessments for consideration alongside technical and financial feasibility assessments and potentially implemented through making these studies a required part of project sign-off before the design moves forward.

— **Define clear metrics and accountability:** Define specific, measurable biodiversity avoidance targets (e.g. 'zero net loss' or 'no disturbance to critical habitats'). These goals should be as tangible as cost or safety metrics.

— **Foster strong collaboration between environmental/ social and engineering teams:** Break down silos by encouraging engineers to work closely with environmental specialists from the start and promote a culture of respect for nature. Require joint reviews of project designs that evaluate both engineering feasibility and environmental avoidance. This builds accountability for avoidance into the technical review process itself.

— **Provide training and tools:** GIS and ecological sensitivity maps can help engineers visualise areas where avoidance is critical, and what the compensation requirements (including costs) would be if avoidance is not achieved.

— **External pressure and stakeholder engagement:** Collaborate with environmental organisations, local communities and government agencies during the planning process. External pressure from stakeholders who prioritise avoidance can be motivational.

— **Celebrate success stories:** Create a system of reporting that makes avoidance measures visible to stakeholders, including senior management and external parties. Publicly disclosed sustainability reports can increase accountability.

Box 6.1: IFC and Equator Banks requirements for third-party audits
Many lenders like the IFC and Equator Principle Banks ask that the company appoint an Independent Environmental and Social Consultant for Category A projects[32]. The Independent Environmental and Social Consultant is a team of environmental and social consultants that regularly audit the project during construction and operation. Having an external check increases accountability and ensures that avoidance is not merely paid lip service.

6.4.2 Avoidance and protected areas

Protected areas play a vital role in the conservation of biodiversity and the preservation of ecosystems that are critical to both wildlife and human wellbeing. These areas are designated to safeguard species, habitats and natural processes from the pressures of human development, ensuring the long-term viability of ecosystems that provide essential services. They also may hold cultural, recreational and economic value, offering spaces for leisure, education and traditional practices. In many cases, they are also essential for climate resilience, acting as carbon sinks.

Avoidance is particularly important when it comes to protected areas and, where possible, internationally designated sites. In addition to ICMM's existing commitments (i.e. Performance Expectation 7.1) and lender obligations (e.g. see Box 6.2 on requirements for access to finance from the IFC), protected areas are often legally protected, and some are subject to international conservation obligations.

32. A Category A project is defined as one that is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented.

Box 6.2: IFC PS6 Provisions for legally protected areas and internationally designated sites

Protected areas are sites of natural, ecological and/or cultural significance, and therefore have been designated as 'protected' for the purpose of conservation. Many different categories and subcategories exist, which can differ between countries. The protected area management categories provided by IUCN are generally accepted as the global standard.

New operations or changes to existing operations:

— Must avoid any activities within legally designated protected areas and internationally recognised areas for biodiversity unless they are compatible with the objectives for which the protected areas were established.

— Must avoid exploration or mining In UNESCO World Heritage Sites.

Existing operations:

— Must ensure that existing activities are compatible with the objectives for which legally designated protected areas or internationally recognised areas for biodiversity have been established.

— Must take all steps to ensure that existing operations in World Heritage Sites, as well as existing and future operations adjacent to World Heritage Sites, are compatible with the outstanding universal value(s) for which these sites are listed and do not put their integrity at risk.

Some areas will not be acceptable for financing, except for projects specifically designed to contribute to the conservation of the area:

— UNESCO Natural and Mixed World Heritage Sites

— Sites that fit the designation criteria of the Alliance for Zero Extinction Guidance Note 11.

When projects are located in legally protected and internationally recognised areas, the client will:

— demonstrate that development in such areas is legally permitted

— act in a manner consistent with recognised management plans for such areas

— consult protected area sponsors and managers, affected communities, Indigenous Peoples and other stakeholders on the proposed project, as appropriate

— implement additional programmes, as appropriate, to promote and enhance the conservation aims and effective management of the area.

6.5 Minimise

There are many ways of categorising minimisation actions. Dividing it into subcategories can help you think through potential options to address biodiversity impacts.

— **Spatial/design minimisation:** Reducing the spatial footprint of a project to minimise impacts on biodiversity such as limiting the area of land cleared for construction, or using wildlife corridors or underpasses to maintain habitat connectivity.

— **Temporal minimisation:** Timing project activities to avoid sensitive periods in the lifecycles of species or ecosystems, such as scheduling construction activities outside of breeding, nesting or migratory periods; avoiding wet seasons to reduce sediment runoff into aquatic habitats; implementing night-time curfews to protect nocturnal species from disturbance.

— **Abatement minimisation:** Using technologies, methods or materials to reduce impacts such as switching to quieter equipment to minimise noise disturbance or implementing advanced waste management systems to reduce contamination.

— **Operational minimisation.** Adjusting operational practices to limit ongoing impacts during the project's lifecycle such as reducing vehicle speeds to minimise wildlife collisions, implementing water-saving measures to reduce extraction from freshwater ecosystems or ensuring the regular maintenance of equipment to prevent leaks or spills.

— **Behavioural minimisation:** Implementing measures to influence human behaviour and reduce ecological impacts such as training workers to avoid disturbing wildlife or educating local communities on sustainable resource use.

Table 6.1 presents a comprehensive overview of the key impact factors associated with mining, potential impacts on biodiversity receptors, and examples of potential measures to avoid and minimise these. To provide a practical illustration of the application of these measures in practice, Table 6.2 provides an illustrative example of how impact factors might affect bats and the likely effectiveness of different minimisation measures. It is important to note that the level of mitigation appropriate to a project or operation will be commensurate with the conservation status of affected species, which will be determined through the baseline work (see Section 4). Therefore, the intensity of mitigation efforts would increase with the threat status of affected species.

Table 6.1: Impact factors, how these may manifest themselves as impacts on biodiversity and examples of mitigation actions to avoid and minimise impacts

Impact factors	Impacts on biodiversity during construction/operation	Examples of mitigation actions to avoid and minimise impacts
Generation of dust and particulate matter PM2.5 and PM10 during mine construction and operation	Habitat degradation: — Reduced light absorption and altered leaf function (reduced photosynthesis) — Disruption of transpiration which is essential for cooling the plant and nutrient transport — Settling on soil can alter its structure and chemistry — Dust particles can cause respiratory problems in animals, particularly small mammals, birds and insects — Can increase turbidity in water	— Compliance with air quality emission standards for particulate matter and deposition thresholds for the protection of vegetation — Dust suppression with water or other dust suppressants — Covering stockpiles and enclosed or covered conveyers — Windbreaks and vegetative barriers — Dust extraction systems equipped with filtration units — Low-emission vehicles — Regular maintenance of vehicles — Controlled blasting techniques — Paving or hardening roads — Revegetation of degraded areas — Tailings management to prevent surface drying and wind erosion
Emission of gaseous pollutants (NO_2 and NO_x, SO_2, CO)	Impact on species and habitat degradation: — Respiratory distress for mammals and birds — NO and NO_2 exposure for a long period can have phytotoxic effects; lichens and mosses are particularly vulnerable to air pollution — Acidification of water	— Comply with NO_x and SO_x emissions limits for the protection of vegetation — Switch to cleaner energy sources — Use low-sulphur or sulphur-free fuels or switch to natural gas — Use mobile equipment with selective catalytic reduction or exhaust gas recirculation; install flue gas desulphurisation systems — Optimise blasting and explosive use — Optimise the efficiency of mining processes — Prohibit open burning of cleared vegetation and waste — Implement strict speed limits on mobile equipment
Changes to the land morphology, surface water flow diversions around various structures	Habitat loss and degradation: — Loss of catchment area may result in reduced groundwater recharge and alter surface flows impacting aquatic habitats — Diversions could reduce downstream surface water flows and impact habitat for aquatic species	— Avoid areas of high biodiversity value — Reduce footprint where possible — Identify sensitive water catchment areas — Ensure ecological flow regimes are maintained

Impact factors	Impacts on biodiversity during construction/operation	Examples of mitigation actions to avoid and minimise impacts
Removal of vegetation	Habitat loss: — Terrestrial habitat loss and loss of associated species — Terrestrial habitat degradation and impacts on species — Increased erosion from loss of vegetative cover impacting wider areas — Changes to water quality and degradation of aquatic habitat through increased sediment deposition	— Avoid areas of high biodiversity value — Implement erosion control measures — Install silt fences/sediment traps — Establish buffer zones around sensitive habitats, rivers and streams — Restore habitats
Demand for groundwater or surface water [Note: May also cause transboundary impacts]	Changes in surface and groundwater: — Loss of springs used as a water supply for species in the dry season — Impacts on aquatic and riparian ecology — Changes in stream habitat and aquatic species due to changes in stream flow (e.g. loss of abundance and diversity, fish mortality, changes in fish health, changes to migratory behaviour) — Effects on wetlands due to loss and alteration of wetland functions — Potential impacts on species whose survival is closely linked to access to water sources, e.g. elephant migrations, beaver, flamingo breeding	Implement a water management plan to address: — Water recycling and reuse — Stormwater management — Dry processing techniques, dry crushing and screening — Use of seawater or treated wastewater for processing — Leak detection and maintenance programmes — Employee training and awareness programmes — Accurate water balance models — Maintenance of environmental flows
Pit dewatering	Changes in hydrology leading to: — Loss of springs used as a water supply for species in the dry season — Changes to habitats dependent on groundwater — Changes to surface flows	— Develop groundwater flow models to simulate the impacts of dewatering on aquifers, rivers, lakes and nearby wells to guide mitigation efforts — Identify ecologically sensitive areas, such as wetlands, springs and groundwater-dependent ecosystems, to help prioritise areas where extra caution and protection measures are needed — Recharge aquifers with water from dewatering to replenish the aquifer and maintain water levels in surrounding areas, through pumped wells or infiltration ponds — Recharge rivers or wetlands that are affected by dewatering, helping maintain ecological balance and flow levels
Discharge of pollutants to groundwater or surface water (acid rock drainage, contaminated runoff, site discharges, accidental spillage, solute release from non-acid forming materials)	Reduced water quality: — Effects on the aquatic species and habitat due to changes in water quality — Potential adverse impacts on biodiversity and people who use affected watercourses as a source of drinking water or food	— Comply with discharge limits or water quality guidelines — Line tailings storage facilities and waste storage areas — Consider alternative tailings disposal methods — Modify surface flows management of waste rock dumps and low-grade ore stockpiles — Bund fuel, chemical and hazardous waste storage areas and facilities — Implement acid rock drainage control

Impact factors	Impacts on biodiversity during construction/operation	Examples of mitigation actions to avoid and minimise impacts
Discharge of wastewater from workers' accommodation camps	Reduced water quality: — Wastewater contains high levels of organic matter, leading to oxygen depletion and impacts on/causes death of aquatic species — Increased nutrients can lead to algal blooms, which can cause oxygen depletion or be toxic, impacting aquatic ecology — Pathogens in wastewater can infect fish, shellfish, amphibians	— Comply with discharge limits or water quality guidelines — Establish wastewater treatment plants — Ensure workers' camps are designed with sustainable waste management, water supply and sanitation systems to prevent negative impacts on local resources
Proximity of construction and operational workforce to sensitive receptors	Spread of diseases, conflict and species depletion: — Many diseases that affect humans can also be transmitted to great apes (COVID-19, common cold, influenza or other respiratory pathogens) and can be fatal to them. Parasites like Giardia and Cryptosporidium can also impact great apes. — Can also lead to increased human-wildlife conflict — May increase hunting pressures	— Limit human contact with wild ape populations through strict controls — Wear face masks and maintain a certain distance from animals when there is a need to be in close proximity — Improve sanitation in areas where humans and great apes may interact — Vaccination programs for and strict health monitoring of workers
Noise emissions from static equipment, vehicles, rail, aircraft, quarrying, blast-induced vibration, airblast overpressure from blasting	Impacts on sensitive species: — Increased noise has widespread impacts on species, disrupting communication, reproductive success, foraging efficiency and habitat use — Prolonged exposure can cause stress in animals, increased heart rates, elevated stress hormones and reduced reproductive success Some examples are: — Many birds use songs to attract mates and defend territories — Bats use echolocation to hunt insects, and increased noise can interfere with their ability to locate prey — Increase in avoidant behaviour; large mammals may avoid noisy roads or human settlements, leading to habitat fragmentation and reducing their access to important resources or migratory routes	— Comply with relevant standards — Apply best management practice and best available technology economically achievable — Consider substitution – quieter equipment — Fit equipment with noise suppression — Install noise barriers — Install noise reduction kits (exhaust dampening) on haul trucks — Optimise internal traffic routing — Install sound barriers, berms or enclosures near equipment (e.g. crushers, grinders and screens) — Undertake blasting only during day-time work hours
Ground vibrations	Habitat degradation and impacts on species: — Affects certain taxa. Frogs, snakes, toads and salamanders can detect and avoid ground vibrations — May disrupt communication, e.g. bison, some frog species and elephants are known to use low-frequency vibrations to communicate, sometimes over long distances — Ground vibrations can affect ground-nesting birds	— Establish buffer zones between construction or mining sites and sensitive species — Avoid areas where species are known to breed, hibernate or migrate, reducing the risk of disrupting essential life processes — Alter the timing and scheduling of blasting activities — Use low-vibration techniques and technologies (controlled blasting) and vibration-dampening equipment — Create physical vibration-absorbing barriers — Relocate sensitive species

Impact factors	Impacts on biodiversity during construction/operation	Examples of mitigation actions to avoid and minimise impacts
Artificial lighting	Habitat degradation – and impacts on species: — Nocturnal animals are adapted to operate in low light or darkness — Certain wavelengths of light, particularly blue or white light, are disruptive to animals' circadian rhythms and behaviours (whereas red and amber light have less impact on many species) — Artificial light can disrupt bat foraging patterns and reduce the hunting efficiency of nocturnal birds	— Use of shielded or directed lighting — Use red or amber LED lighting instead of white or blue — Reduce the brightness of lights, dim them or turn them off during off-peak times, and restrict lighting in sensitive areas — Conduct education and awareness training — Create natural barriers (trees, bushes, etc.)
Introduction of alien invasive species	Habitat degradation: — Alien invasive species can outcompete native organisms for resources, spread diseases or alter habitats, leading to declines or extinctions of native species — Examples include the spread of Chytrid fungus (which causes disease and sometimes death of amphibians in Australia, Mexico, Central America and Andean countries) from one site to another	— Prepare an Invasive Species Management Plan — Implement biosecurity measures through strict controls on the movement of goods, vehicles and people — Establish quarantine and sanitation protocols for equipment by mandating the cleaning of vehicles and machinery before moving them between different ecosystems to prevent seeds, insects or pathogens from being transported to new areas — Install boot-cleaning stations to prevent the spread of invasive plant seeds between ecosystems — Restore and manage degraded ecosystems — Implement eradication and control programmes
Demand for waste disposal services	Habitat loss and degradation: — Impacts of land clearance on habitats — Impacts on water quality from seepage	— Implement a solid waste management plan, including protocols for proper waste storage and containment — Safely dispose of residual waste — Implement measures to minimise, reduce, segregate waste at source and compost organic waste
Demand for rock, sand, gravel and aggregate material	Habitat loss and degradation: — Impacts of land clearance on habitats	— Before the opening of quarries or borrow pits, assess potential impacts on biodiversity and identify alternative sources or develop mitigation strategies
Linear infrastructure	— Habitat fragmentation from transmission lines, rail and access roads and wildlife collisions — Creation of barriers that restrict animal movement — Building bridges and culverts at stream crossings can affect aquatic and adjacent terrestrial habitat — See also 'Noise emissions' above	— Assess alternative alignments and routes to minimise impacts on sensitive areas — Create wildlife crossings

Impact factors	Impacts on biodiversity during construction/operation	Examples of mitigation actions to avoid and minimise impacts
Induced migration	Habitat loss and degradation: — Increased fires — Increased use of resources — Increased conversion of natural habitats — Increased hunting pressure — Changes to water availability and quality — Increased access to remote ecosystems and increase in wildlife trade	— Set up fully serviced workers' camps with housing, food, healthcare and recreational facilities for non-local workers, reducing the likelihood that these workers will settle permanently in the surrounding area — Implement community education and empowerment programmes — Establish policies that prioritise hiring local labour over outside workers — Support development planning outside the project area to reduce migration pressures by providing economic opportunities and services in other locations
Relocation/resettlement	Loss and degradation of habitat: — Increased pressure on natural resources in relocation areas — Introduction of invasive species — Increased human-wildlife conflict	— Selecting resettlement sites to avoid areas of importance for biodiversity — Establishing buffer zones or sustainable agriculture zones — Enable community engagement and participation — Provide training in sustainable resource use and livelihood support

Table 6.2: Example of how impact factors might affect bats, examples of mitigation for affected species and likely effectiveness[33]

Impact factors	Impacts on biodiversity	Potential mitigation measures (see Table 6.1)	Likely effectiveness
Emission of dust and particulate matter	— Habitat avoidance due to degradation of habitat — Reduction in insect prey availability	— Water trucks to limit dust production on haul roads and work areas — Covering stockpiles and enclosed or covered conveyers — Controlled blasting techniques — Tailings management to prevent surface drying and wind erosion	— Dust management methods are expected to be very effective in limiting the dust impact on intact habitat occupied by high-altitude bats in all project phases
Changes to local morphology notably through open pit, waste rock dumps, tailings storage facilities, etc.	— Loss of bat foraging, roosting or hibernation sites — Reduced habitat quality due to changes in microclimate in bat foraging habitat around pits, 900m from the mining — One study showed a significant reduction in total bat activity within 1km of a mine[34]	— Minimise footprint, avoid sensitive areas (minimum of 100m), and avoid a further 1km management zone around roosting sites, including caves — Increase the number of roosting sites in nearby areas (depending on need of affected species) — During mine closure, consider leaving mine shafts open for bats and install gates that allow bats to continue using these sites while preventing human access — In the case of abandoned mine shafts that are used as bat hibernacula, it is important to both restrict human access and maintain access for bats	— Avoidance is preferred as the effectiveness of alternative roosting sites is mixed, and changes in microclimate due to mine pit disturbance are impossible to mitigate — The provision of bat boxes or artificial tree bark structures has been successful for species which roost within tree cavities or exhibit roost plasticity
Removal/disturbance of natural vegetation and topsoil	— Removal of foraging and roosting habitat — Loss or disturbance of maternity roosts (where females gather to raise their young) can significantly impact reproduction and population viability	— Minimising footprint where feasible and establishing buffer zones around important bat habitats to reduce disturbance — Rehabilitation and restoration of nearby degraded habitats	— Available mitigation for removal of habitat is limited; footprint minimisation will be implemented wherever feasible

33. It is important to involve experts if dealing with certain species such as threatened bats. The impacts and efficacy of mitigation can be very species dependent. The presence of a 'significant roost' in the area should trigger the development of a Protection Plan for the roost which should be implemented well in advance of mining.
34. Theobald et al, Mines and bats: the impact of open-pit mining on bat activity.

Impact factors	Impacts on biodiversity	Potential mitigation measures (see Table 6.1)	Likely effectiveness
Artificial lighting	— Sensory disturbance could affect roost emergence timing, foraging efficiency and habitat use	— Directional lights and covers to limit light trespass beyond the project footprint and sky glow (illumination of the night sky) — Reducing light intensity and limiting light usage during critical periods (nighttime)	— Mitigation effectiveness is rated as medium-high; restricting light trespass to the project's footprint is effective in limiting sensory disturbance to bats occupying adjacent habitats
Introduction of surface infrastructure in the terrestrial environment	— Reduction in habitat connectivity can fragment bat habitats, making it harder for bats to navigate, find food or migrate between roosting and foraging areas — The susceptibility of bat species to barrier effects varies in accordance with foraging ecology and wing morphology — Species that forage in open spaces are willing to cross busy highways, whereas clutter specialists rarely do[35]	— Minimising footprint where feasible — Rehabilitation and restoration of nearby degraded habitats	— Bats may be able to fly over/around roads and other small project infrastructure — Larger project infrastructure, such as pits, may represent barriers to movement for bats that cannot be mitigated during operations
Diversion of water courses or reduced water quality	— Some bats are closely associated with water-courses and associated insect populations and may be adversely affected by diversions or reduced water quality	— Avoid diverting streams in the habitat of threatened bat species where possible — Implement mitigation measures to protect water quality (see Table 6.1)	— Avoidance and protection of water quality should be reasonably effective
Emission of noise from static equipment, vehicles, rail, aircraft, quarrying, blast-induced vibration, airblast overpressure from blasting	— Noise from mining can interfere with bats' echolocation abilities, making it difficult for them to locate prey, avoid obstacles or communicate with one another — Noise and vibration can disturb hibernating bats, causing them to wake from hibernation, depleting energy reserves and may result in increased mortality — Studies suggest that noise masks insect-generated sounds and may interfere with the foraging of species that use passive listening to locate prey — Blasting and other vibrations from mining operations can disturb bats roosting in caves or underground structures, causing them to abandon roosts or become disoriented	— Use controlled blasting and low-noise machinery to reduce the impact of noise and vibrations on bats, especially near known roosting or hibernation sites — Optimally, blasting should occur during periods when bats are not occupying the roost — Sound barriers and sound-dampening equipment will be installed wherever possible	— Efficacy of mitigation is highly uncertain for bats — Little is known about bats though some studies suggest they can acclimate to anthropogenic noise after repeated exposure

35. Species that forage in open, uncluttered habitats use long duration and narrow frequency bandwidth calls, whereas species that forage in cluttered habitats use shorter duration and broad frequency bandwidth calls that are better for precise localisation and discrimination of targets from the background.

6.6 Restoration and rehabilitation

Restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed, aiming to recover the ecosystem to the trajectory it would be on if degradation had not occurred, accounting for environmental change. Mine site rehabilitation, in comparison, aims to reinstate a level of ecosystem productivity or functioning on degraded sites, where the goal is renewed and ongoing provision of ecosystem services rather than the full recovery of a specified target native ecosystem.

Restoring functional ecosystems is complex and technical, requiring detailed planning, scientific knowledge and specialised techniques, and the evidence on whether restoration can achieve NNL of biodiversity is mixed. Among the studies that do exist, the results vary widely, reflecting the complexity of achieving NNL across different ecosystems and restoration efforts and the fact that monitoring tends to focus on structural and floral composition as opposed to fauna and there is likely to be underreporting of less successful restoration outcomes.

Studies from the Amazon Basin[36] highlight both challenges and successes in ecological recovery after mining activities. Forest structure recovered faster than species diversity, with pioneer species dominating even after initial regeneration. Natural regeneration was slow and active restoration, such as soil reclamation and enrichment planting, was necessary to accelerate recovery, especially for late-successional species. Restoration outcomes varied depending on site conditions and restoration strategies.

The restoration of Jarrah Forest in Western Australia has also seen some successes and current practices are continuing to evolve. Careful topsoil management and preservation of the native seed bank and soil microorganisms[37], planting a mix of native species, including Jarrah trees (*Eucalyptus marginata*) and associated understorey plants, and supplying organic matter were crucial for successful revegetation. Reintroducing logs, rocks and creating habitat features for native fauna also supported wildlife recovery. Several studies[38] have found that mammal species richness in restored forest was comparable to unmined areas.

However, while restoration can be successful, outcomes are often context-dependent and not all projects fully recover pre-disturbance levels of biodiversity. Even well-executed restoration efforts may not restore the original habitat, especially when dealing with complex ecosystems like tropical forests and full recovery of species composition and ecological function remains challenging and potentially unachievable in some contexts. Additionally, invasive species can sometimes outcompete native species in restored areas, posing another challenge. There is often an assumption that animals will return following the re-establishment of flora. A 2012 review[39] of 71 publications on fauna recolonisation after rehabilitation on Australian mines, showed that recovery of the pre-mining fauna community composition was very hard to achieve. Less than half of the taxa studied in rehabilitated areas achieved equal or better density and species richness than in undisturbed areas. Rehabilitation methodology was the strongest predictor of faunal recolonisation. Creating natural hollows and/or providing nest boxes, and increasing landscape complexity by adding rocks, log piles and coarse woody debris were effective. Persistence of a nearby population increased the chances of colonisation as did connectivity between the population source and rehabilitated areas. Recolonisation by birds was the most successful, as density, richness, diversity and evenness were frequently equal to undisturbed areas, whereas the densities and richness for herptiles and mammals were not as successful.

36. Lozano Baez, S. E. (2013), *Restauración de la Cobertura Vegetal en Áreas Previamente Afectadas por la Minería Aluvial de oro en el Nordeste de Antioquia, Colombia*. Colombia: Pontificia Universidad Javeriana. [PDF]. Available at https://repository.javeriana.edu.co/handle/10554/8982; Valois-Cuesta, H., and Martínez-Ruiz, C. (2017), 'Especies vegetales colonizadoras de áreas perturbadas por la minería en bosques pluviales del Chocó, Colombia'. *Biota Colomb*. 18, pp.88–105. [PDF]. Available at https://revistas.humboldt.org.co/index.php/biota/article/view/459; Kalamandeen, M., Gloor, E., Johnson, I., Agard, S., Katow, M., Vanbrooke, A., et al. (2020), 'Limited biomass recovery from gold mining in Amazonian forests', *J. Appl. Ecol. 57*, pp.1730–1740. [PDF]. Available at https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.13669
37. 75% of native plant species in Jarrah Forests form mycorrhizal relationships.
38. Nichols, O.G. and Nichols, F.M. (2003), 'Long-term trends in faunal recolonization after bauxite mining in the jarrah forest of southwestern Australia', Restoration Ecology 11, pp.261–272. [PDF]. Available at https://www.researchgate.net/publication/227812615_Long-Term_Trends_in_Faunal_Recolonization_After_Bauxite_Mining_in_the_Jarrah_Forest_of_Southwestern_Australia; Thompson G.G. and Thompson S.A. (2005), 'Mammals or reptiles, as surveyed by pittraps, as bio-indicators of rehabilitation success for mine sites in the Goldfields region of Western Australia?', *Pacific Conservation Biology*, 11, pp.268–286. Available at https://ro.ecu.edu.au/ecuworks/2458/; Craig, M.D., Hobbs, R.J., Grigg, A.H., Garkaklis, M.J., Grant, C.D., Fleming, P.A. and Hardy, G.E.S.J. (2010), 'Do thinning and burning sites revegetated after bauxite mining improve habitat for terrestrial vertebrates?', *Restoration Ecology*, 18, pp.300–310. [PDF]. Available at https://onlinelibrary.wiley.com/doi/10.1111/j.1526-100X.2009.00526.x
39. Cristescu, R.H., Frère, C., and Banks, P.B. (2012), 'A review of fauna in mine rehabilitation in Australia: Current state and future directions', *Biological Conservation*, volume 149(1), pp.60–72. Available at https://www.sciencedirect.com/science/article/abs/pii/S000632071200095X

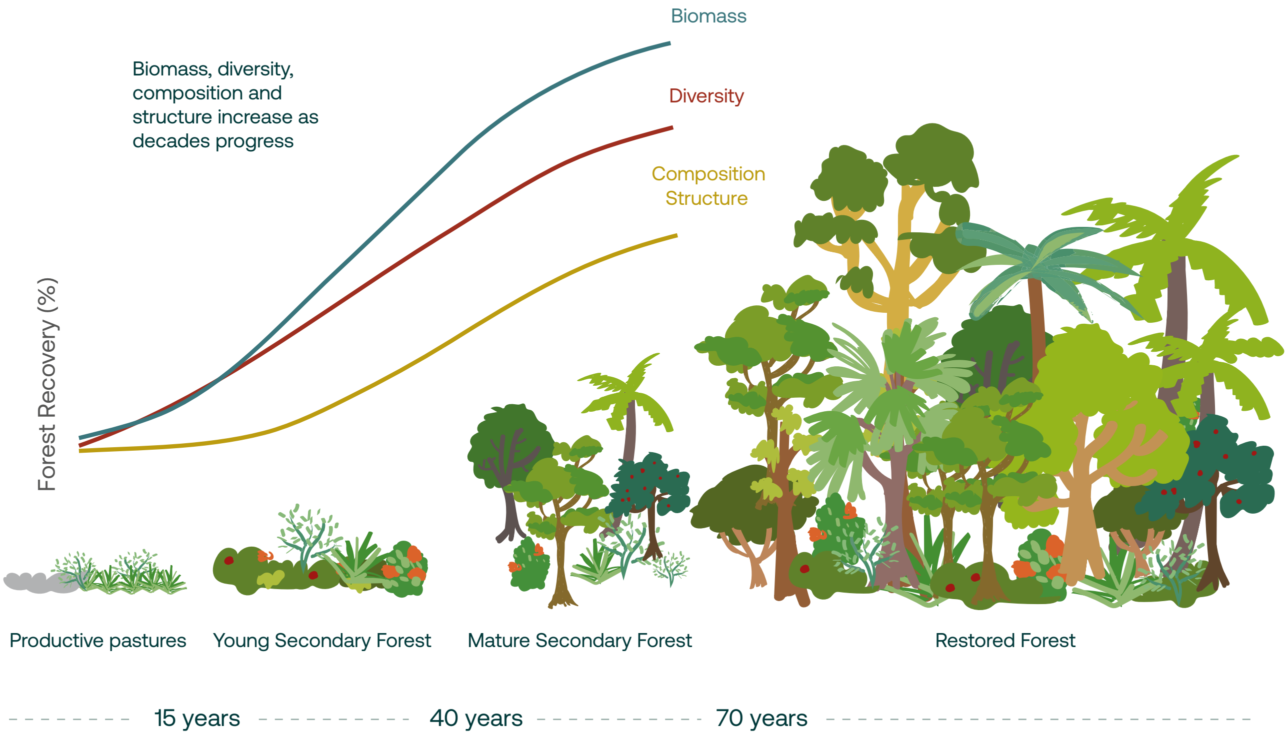
Restoring plant species richness and ecosystem processes (e.g. nutrient cycling and hydrology) can take decades or longer, with soil health and microbial communities playing a crucial role. Topsoil management, diverse planting and the use of local native seeds are key for successful revegetation, as is planning in response to known or likely changes in other environmental pressures, such as climate change. Establishing nurseries and seed banks, conducting growth-media studies, transplanting and ex-situ conservation can help promote species' survival during the restoration period. They also highlight the importance of adaptive management to improve restoration success over time.

6.6.1 To what extent can restoration contribute toward no net loss?

Achieving biodiversity gains through restoration requires careful planning and realistic expectations about the challenges posed by time lags, habitat specificity, ecological function recovery and habitat fragmentation. Each operation must carefully assess the extent to which restoration can contribute to a net gain in biodiversity, taking account of the species impacted as well as the original habitat (see Figure 6.2).

In some cases, offsets based on avoided loss in conjunction with restoration may be more suited to achieving NNL where development impacts on biological features are difficult to fully redress through restoration. In many jurisdictions, multipliers are undertaken to account for uncertainty in outcomes or are legally prescribed and differ according to habitat type or species affected (see Section 7 on offsets).

Figure 6.2: Representation of ecological succession in tropical ecosystems



Source: Partnerships for Forests (2024). Unlocking Nature's value in Colombia

Some species with broad diets and habitat preferences can exploit a wide range of food sources and habitats and are better at adapting to disturbed habitats, so when they are displaced they may find the resources they need elsewhere. However, the type of ecosystem being restored and the time lag between the onset of mining activities can have significant consequences for certain fauna species. This includes those with:

- **Specific habitat requirements:** Species with highly specific diets or habitat needs are especially vulnerable. Even a temporary loss of habitat can be catastrophic, as species that rely on key features – such as old-growth forests or specialised wetlands – may not survive the disturbance. If the structural or hydrological characteristics of these habitats take too long to return, the species may already be lost before restoration efforts are complete.
- **Limited ranges and fragmentation:** Species with limited ranges are more vulnerable and even temporary habitat loss could lead to local or global extinction. Even after a habitat is restored, species may not recolonise due to dispersal barriers, a lack of nearby source populations or competition from invasive species. Many amphibians have limited dispersal capabilities due to their reliance on specific aquatic and forest habitats. Habitat fragmentation, especially the loss of wetland areas, can severely impact their ability to move and find breeding sites. Interim fragmentation can cause local populations to decline due to reduced genetic diversity. This isolation can result in population crashes before the habitat is fully restored. Large mammals can suffer from genetic isolation due to fragmented landscapes.
- **Large ranges or high territorial species:** Time lags are problematic for large mammals which require large territories and continuous habitats for movement, hunting and reproduction. Territorial behaviour is closely tied to the availability of resources like food, shelter and space for social interactions. Gorillas and chimpanzees exhibit strong territorial behaviour, requiring large, contiguous areas of mature forest for foraging, nesting and social structures. Habitat loss often forces great apes to shrink from or abandon their traditional territories, leading to increased competition for the remaining resources. The stress of reduced space can also heighten aggression within and between groups.

Although vegetation may recover relatively quickly, the restoration of underlying ecological processes – such as nutrient cycling, hydrology and soil structure – often lags behind. This is particularly true for complex soil microbial communities and symbiotic relationships, such as those between mycorrhizal fungi and rare plants, which can take decades to fully recover. The delayed return of these functions can significantly hinder the recovery of species that depend on them.

Restoration efforts should carefully consider the condition achievable over time, recognising that full ecological restoration by closure may be unrealistic due to the long ecological timescales involved. Instead of aiming for immediate and complete recovery, the focus should be on achieving stable and improving conditions that place the ecosystem on a clear trajectory towards recovery.

This approach acknowledges the complexity of ecological processes and the need for sustained management post-closure. Restoration plans should set practical, incremental goals, ensuring that the restored ecosystem demonstrates resilience and the capacity to self-recover over time, ultimately progressing toward the desired ecological state.

6.6.2 Apply the mitigation hierarchy (avoid, minimise, restore): using a road as an example

Mining often requires the development of linear infrastructure, such as roads, railways, pipelines and powerlines, which leads to habitat loss and degradation. This infrastructure creates barriers to movement, impacts landscape connectivity and increases wildlife collisions. Table 6.3 below presents an example of how the mitigation hierarchy can be applied to address the biodiversity impacts of road construction and operation

Table 6.3: Potential mitigation measures (avoidance, minisuction, restoration) to be applied during road construction and operation. (Please see Section 7 for examples of offsets.)

Stage of mitigation hierarchy	Potential actions
Avoidance	— Design routes that avoid ecologically sensitive areas — Limit the number of roads – cluster development/fewer access points — Plan construction to avoid critical periods (breeding seasons or migration times)
Minimisation	Road design: — Install noise barriers (vegetation, berms or specially designed noise-reducing structures) — Minimise the width of the road and install wildlife warning signs — Install wildlife detection systems (motion sensors, infrared cameras) that alert drivers — Install wildlife crossings (underpasses, overpasses, canopy bridges (see Figure 6.3)) Road construction: — Minimise vegetation clearing and maintain vegetation close to the roadside in particular areas (if safe) Road operation: — Wildlife is given the right of way on project-controlled roads — Report wildlife sightings, incidents or accidents — Use of the access road will be strictly controlled and speed restrictions enforced — No vehicles at specific times of the day (e.g. 60 minutes after dawn and 60 minutes before dusk) — Use buses to transport workers to the mine
Restoration	— If the road has disrupted wildlife movement, prioritise restoring habitat connectivity — Erect a physical barrier (such as boulders, gates or fencing) at entry points to prevent future vehicle access to the decommissioned road — Remove infrastructure such as culverts and bridges — Recontour the roadbed to match the natural topography, allowing drainage patterns to re-establish — Use machinery to loosen compacted soils, improving conditions for plant root growth and water infiltration and plant native vegetation appropriate for the habitat type — Use hydroseeding or manual seed dispersal methods to establish ground cover — Implement erosion control measures like biodegradable mats, mulch or silt fences to stabilise soil during the early stages of restoration

Figure 6.3 Construction of a canopy bridge for primates

The canopy bridge allows arboreal primates to safely cross an upgraded road that would otherwise have presented a barrier to access important areas of habitat. Note that the design includes not only a walkway, but a cable above the walkway that enables primates to hook their tails on for added stability.

6.7 Preparation of a Biodiversity Management Plan

In areas of high biodiversity, biodiversity-related commitments, mitigation and management actions should be captured in a dedicated Biodiversity Management Plan (BMP). The BMP or equivalent should be auditable and be integrated into a project or operation's ESMS, which defines parties responsible for an action, monitoring and/or verification requirements of an action, and an implementation schedule or frequency for an action. Cross-referencing associated management plans is also very useful.

6.8 Why closure objectives alone may not achieve no net loss

Closure planning can contribute meaningfully to achieving NNL or even NG. The key lies in integrating biodiversity considerations into closure planning, involving communities, conservation organisations and regulators to balance social and biodiversity priorities effectively. It is important, however, to be realistic and not rely on closure planning to offset residual impacts to biodiversity values. Stakeholder expectations of post-closure land use may not align with biodiversity conservation goals or biodiversity restoration may not be feasible or may take decades, while closure objectives may focus on shorter-term deliverables.

Further resources

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Cross Sector Biodiversity Initiative (2013), *Timeline Tool. A tool for aligning timelines for project execution, biodiversity management and financing*. IPIECA, ICMM and the Equator Principles Association.

Graig, M.D. et al (2012), *Identifying unidirectional and dynamic habitat filters to faunal recolonisation in restored mine-pits*, *Journal of Applied Ecology*, 49, pp.919–928. [PDF].

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World Bank (2019), *Forest-Smart Mining: Identifying factors associated with the impacts of large-scale mining on forests*. World Bank Group: Washington DC. [PDF].

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Offset Residual Impacts on Biodiversity

07

Key objective: Demonstrate how to undertake quantitative residual impact assessments and outline good practice in offsetting to achieve NNL or NG outcomes.

7.1 Introduction

This section provides an overview of biodiversity offsets as a key component of the mitigation hierarchy, focusing on their role in addressing residual impacts on biodiversity after avoidance and minimisation measures have been applied. It outlines the principles, design and implementation of offsets to achieve NNL or NG.

The guidance provided in this section reflects good practice standards, which in some cases may exceed the requirements of national legislation.

Offsets can be driven by regulatory requirements, lender requirements or voluntary commitments.

- **Regulatory offsets** are mandated by law and oblige the company to address residual impacts through legally binding requirements. They tend to provide uniform guidelines, methodologies and criteria for offset implementation. The requirements differ hugely between countries. In some jurisdictions, legal compliance will fall short of good practice to demonstrate the achievement of NNL or NG.
- **Offsets required under lender requirements,** such as those stipulated by international financial institutions (e.g. IFC Performance Standards, Equator Principles), are not necessarily legally binding under national laws. However, they become contractually binding for borrowers or clients once agreed upon in project financing agreements. The IFC PS6 guidance document on offsets is based on current best practice and aligns with NNL or NG goals, which may exceed local legal standards. It allows flexibility and context-specific approaches to offsets (see Box 7.1).
- **Voluntary offsets** are implemented voluntarily by companies as part of corporate sustainability initiatives. They tend to follow IFC Performance Standards and, for example, provide for companies to contribute to habitat banks. In some jurisdictions, legal compliance will fall short of good practice to demonstrate the achievement of NNL or NG.

Box 7.1: Biodiversity offsets for IFC or Equator Bank projects

IFC, Multilateral Investment Guarantee Agency, European Bank for Reconstruction and Development, African Development Bank, Inter-American Development Bank and other multilaterals and Equator Principal lenders require biodiversity offsets for projects they finance, especially where critical habitats are affected. IFC PS6 stipulates that offsets should be undertaken to best practice principles[40] and good biodiversity offset design[41], which include:

— be like for like or better

— ensure that gains can be achieved at the offset site

— be secure over the long term (e.g. legal protection)

— have a process whereby communities can participate in the design and implementation

— involve consultation and experts where relevant

— achieve NNL for natural habitat and NG for critical habitat

— meet all applicable laws, regulations and policies pertaining to biodiversity offsets

— have a funding mechanism to support the offset for as long as project impacts persist.

A Biodiversity Action Plan (BAP) is required for projects located in critical habitats and is recommended for high-risk projects in natural habitats. The BAP differs from the BMP, which presents onsite mitigation measures. The BAP describes all the key actions that will lead to achieving NG. It includes:

— The roles and responsibilities for internal staff and external partners.

— How the mitigation hierarchy will be followed.

Additionally, it will:

— refer to the BMP/Environmental and Social Management Plan

— present all off-site actions (offsets and additional actions) and may refer to Offset Strategy, Offset Implementation Plan or Offset Management Plans.

7.2 What are biodiversity offsets?

Biodiversity offsets are conservation actions intended to compensate for the residual impacts on biodiversity that arise from development projects after all earlier stages of the mitigation hierarchy – avoidance, minimisation, restoration – have been applied. They are designed to ensure that biodiversity losses are balanced by measurable conservation gains, often aiming for NNL or NG of biodiversity. Offsets can be close to the impact area or in a more remote location. Theoretically, there are two distinct types of biodiversity offsets:

— Averted loss offsets involve securing land or water areas for conservation, enhanced management of habitats or species and other defined activities.

— Restoration offsets involve deliberate actions to restore an ecosystem, habitat or species population (outside the footprint of the original development project) and thereby improve its biodiversity conservation status or value.

In practice, however, this distinction is artificial and many offsets apply a blend of different measures to achieve NNL or NG outcomes. This may include measures to avert loss (e.g. through strengthening protective measures or threat mitigation), to restore degraded habitats or habitat recreation. The measures to be applied in any given situation will be context-dependent. For example, in some operating areas, there may be limited opportunity for averted loss. This could either be due to the limited availability of suitable land or because there is no scope for additionality in suitable protected areas which are already well-managed.

While companies are increasingly adopting frameworks that integrate biodiversity considerations throughout the project lifecycle, thereby reducing dependence on offsets, the mining sector faces unique challenges due to the fixed location of ore bodies. This geographical constraint limits opportunities to avoid biodiversity impacts completely. It is crucial therefore that mining companies implement high-quality biodiversity offsets as early as possible and demonstrate their contribution towards NNL or NG outcomes.

40. Business and Biodiversity Offsets Program (2009), *Biodiversity Offset Design Handbook*. BBOP, Washington, D.C. [PDF]. Available at http://content-ext.undp.org/aplaws_assets/2469107/2469107.pdf
41. World Bank (2016), *Biodiversity Offsets: A User Guide*. World Bank Group: Washington DC. [PDF]. Available at https://openknowledge.worldbank.org/entities/publication/b0c3427d-39af-52f7-a61f-1b0d2df871d8

7.2.1 Offset principles

Several good practice principles were developed by the Business and Biodiversity Offsets Programme (2009, 2012). They have been adapted and/or added to over the years, but the core principles include:

- **Commence with offsets as early as possible:** Generating biodiversity gains through conservation and restoration approaches can take a long period of time. To minimise the risks of time lags and to increase the likelihood of achieving NNL or NG by completion of closure, best practice is to identify, establish and secure biodiversity offsetting action as early as possible in the mine life.
- **Establishing equivalence:** Biodiversity offsets should ensure that the ecological values – whether species, ecosystems or functions – conserved or enhanced by the offset are equivalent to those lost due to the project's impacts.
- **Achieving additionality:** A successful biodiversity offset must deliver conservation benefits that are above and beyond what would have occurred without the offset intervention. The outcomes should not simply reflect existing conservation efforts but contribute new, tangible improvements to biodiversity, ensuring the offset adds value. For example, purchasing and restoring degraded land would constitute an additional biodiversity gain, whereas restoring land where restoration activities are either already planned by another land user or required by legislation would not.
- **Avoid indirect biodiversity losses ('leakage'):** Indirect biodiversity losses are conservation actions which displace the pressure on biodiversity from the offset site to another area. For example, if not carefully managed, restoring a farmed area could result in the expansion of farmland elsewhere. To protect against this 'leakage' effect, it is essential that landowners and customary users are adequately compensated and strong governance is in place to protect the loss of biodiversity elsewhere.
- **Ensuring long-term outcomes:** Biodiversity offsets are expected to endure as long as the impacts of the project they compensate for. Ideally, this means securing the offset's conservation outcomes for the very long term, often in perpetuity. Long-term success depends not only on today's commitments but also on the support of future generations. This could be achieved through relinquishment to future landholders to ensure robust legal protections, including national or sub-national regulations, community by-laws, binding agreements with private landholders or conservation clauses linked to the land title (e.g. if the mining company is the underlying landholder), to safeguard biodiversity for the long term (see Box 7.2 for further details). The longevity of offsets may also be improved by aligning offset plans with regional and national conservation priorities, strategies and plans.
- **Applying a rights-based approach:** A rights-based approach to biodiversity offsets emphasises the recognition and respect of the rights of Indigenous Peoples, local communities and other stakeholders affected by conservation activities. This principle ensures that biodiversity offsets respect human rights, particularly land and resource rights, and are developed through transparent, participatory processes. It also acknowledges the importance of equitable benefit-sharing and informed consent, ensuring that those with a vested interest in the land or biodiversity are fully engaged in the decision-making process and that their livelihoods and rights are safeguarded.
- **Financially sustainable:** A biodiversity offset must be designed to remain financially sustainable over the long term because it is expected to endure for at least as long as the impacts it mitigates. This means ensuring that sufficient financial resources are in place to support ongoing management, monitoring and protection activities throughout the offset's lifespan. Whether through trust funds, endowments, grants or long-term financial commitments, these mechanisms must ensure that the conservation outcomes can be maintained without interruptions. In practice, financial sustainability avoids scenarios where offsets deteriorate due to a lack of funding or insufficient resources to manage the area over time.
- **'Trading-up' or 'out-of-kind' offsets:** There is a general preference for achieving ecological equivalence of gains through offsetting for biodiversity lost as a result of mining activity, also known as 'like-for-like' (see second bullet point above). However, in some instances 'trading-up' may be preferable (which is also known as 'like-for-like or better'). Trading-up involves the conservation of components of biodiversity through an offset that is a higher conservation priority than those affected by

the development project for which the offset is envisaged (e.g. because they are more irreplaceable and vulnerable). This is referred to as an 'out-of-kind' offset (i.e. where gains are delivered for different biodiversity features than those that have suffered damage). The use of trading-up offsets is usually not appropriate for highly threatened or range-restricted species, or for highly threatened habitats, as projects may increase the risk of extinction at sites which support globally/regionally significant numbers of congregatory individuals.

7.3 'Could do better'

Numerous countries have incorporated biodiversity offsets into national environmental legislation, often as part of Environmental and Social Impact Assessments, to address the residual impacts of development projects. However, weak governance, inadequate monitoring, insufficient guidance and inconsistent implementation have generally resulted in poor outcomes. For example, according to Terrasos[42], records from Colombia's environmental authority (National Authority for Environmental Licensing, 2022), show that the country's unexecuted biodiversity offsets represented a funding loss for nature of approximately US$1.6 billion for 2022 (28.3% of the shortfall coming from the mining sector).

A recent independent review of the New South Wales Biodiversity Conservation Act 2016 (Henry Review, 2023) concluded that avoidance and minimisation were not considered early enough, the Offset Scheme was undermined by enabling companies to make payments in lieu instead of sourcing credits, that there was a serious undersupply of credits and a lack of transparency around losses and gains. This creates reputational risks for mining companies, given that stakeholders may see these shortfalls in biodiversity gains as non-compliance with their NNL or NG commitments, despite payments for these outcomes having been made by developers to governments.

Box 7.2: Ensuring long-term outcomes are sustained through biodiversity offsets

Biodiversity offsets are expected to endure as long as the impacts of the project they compensate for. Ideally, this means securing the offset's conservation outcomes for the very long term, often in perpetuity. Long-term success depends not only on today's commitments but also on the support of future generations. This is typically achieved through robust legal protections, including national or sub-national regulations, community by-laws or binding agreements with private landholders to safeguard biodiversity for the long term.

To provide a strong foundation for the long-term maintenance of NNL or NG outcomes, biodiversity offset designers should seek to ensure that the following features are in place:

— **Formal protection of the land and water area, as needed for a successful conservation outcome:** This protection might be: (i) legally secured through national, sub-national or local governments, through laws and regulations; (ii) organised communities, through negotiated agreements that both parties commit to be bound by; or (iii) private landholders (individual or corporate), through easements, long-term concession agreements or other legally binding mechanisms.

— **On-the-ground protection and management:** This involves physical demarcation; management plans; zoning maps of allowed and prohibited uses; co-management agreements; appropriate number of trained conservation staff; protected area infrastructure (headquarters, outposts, staff housing, access roads, trails, docks, etc.); office and field equipment; adequate law enforcement; and, where relevant, support for communities for any impacts to livelihoods, agricultural programs, conservation incentive payments, etc.

— **Financial sustainability:** Biodiversity offsets entail set-up costs alongside recurrent costs for the restoration, protection, management and monitoring of ecosystems and species. Sufficient funding needs to be mobilised to cover long-term recurrent costs. There are a number of mechanisms that can be used (which are outside the scope of this guidance) but it should be stressed that offsets have failed in situations where companies have not set aside money (endowments) and have insisted on using budgets from operational costs.

For details see: World Bank (2017), *Biodiversity Offsets: A User Guide*.

42. Terrasos is a Colombian company specialised in the structuring and operation of environmental investments.

7.4 Improving methodologies and accountability

There is a growing recognition that offset frameworks could provide clearer guidance and improved indicators/metrics to better track progress and ensure greater transparency and disclosure, alongside the need for stronger enforcement to ensure NNL is achieved.

From a government perspective, Chile has updated its Biodiversity Compensation Methodological Guide and Peru is refining its metrics and institutional frameworks to better enforce offset policies and ensure long-term conservation success. Similarly, following the Henry Review (2023) of New South Wales' Biodiversity Conservation Act, both New South Wales and the Australian Federal government have introduced reforms aimed at ensuring offsets deliver net positive outcomes for nature. While Canada has had offset requirements relating to fisheries and wetlands for many years, Environment and Climate Change Canada has recently introduced a draft Offsetting Policy for Biodiversity (2023) which covers terrestrial biodiversity to provide clearer, rights-based guidance with NNL as a central objective.

From a company perspective, there is an increasing trend to improve the disclosure of progress towards achieving NNL of biodiversity, driven by growing stakeholder demand for transparency and accountability in environmental performance. Standards like the TNFD and GRI are supporting this movement by providing guidelines for companies to disclose biodiversity-related risks and outcomes (see also Section 9). It is interesting to note that GRI 101-2 on the management of biodiversity impacts is asking companies, from 2026, to report on the goals and geographic location of their impacts and offsets, if and how principles of good practice to offsetting are met and whether their offset has been independently verified, and this is likely to be the direction of travel (see also Section 9).

7.5 Key steps in implementing offsets

The key steps in implementing offsets are as follows, noting that consultation is integral to many stages throughout this process and is iterative:

1. Quantify residual impacts
2. Determine the preliminary offset requirement
3. Identify possible offset sites and undertake feasibility studies
4. Finalise loss and gain calculations
5. Finalise offset sites and implement offset activities

7.5.1 Step 1: Quantify residual impacts

Residual impacts are the impacts that remain following the earlier steps in the mitigation hierarchy – avoidance, minimisation, restoration. Quantifying residual impacts is essential for achieving NNL because it provides a clear understanding of the gains required. It also allows regulators and other stakeholders to scrutinise the operation's understanding of loss. Several examples are presented in Section 7.5.5 below.

- Identify the type of ecosystem or species lost. It is important to assess the loss of natural (or semi-natural habitat) as well as threatened ecosystems (see Section 4.3).
- Estimate the quality/condition of the ecosystem or biodiversity element (see Section 4.3).
- Identify the area lost (see Section 6).
- Identify the area degraded (air, noise, water, vibrations) in a buffer zone. Buffers are project- and receptor-specific (see Section 6).
- Quantify the extent to which habitat connectivity is lost. Fragmentation multiplies the impacts by reducing the quality of the remaining habitat (i.e. the size and quality of remaining patches).
- Where relevant, assess loss associated with induced impacts. This is challenging and is site-specific. Some practitioners add a standard 10–15%, while others derive calculations from 2–3km buffers placed around influx hot spots.
- If residual loss includes threatened or range-restricted species or significant concentrations of congregatory or migratory species, it is likely that species-specific metrics are required (density/ha or abundance etc.)

Residual impact assessments are then used to quantify the amount of biodiversity gains required for each biodiversity value.

7.5.2 Step 2: Determine the preliminary offset requirement

For projects with a NNL commitment, the biodiversity gains achieved by offsetting must equal the residual losses. However, for projects that make NG commitments, the biodiversity gains required will be larger. There are several approaches to deciding on 'how much' gain constitutes a NG outcome. Gains need to be explicitly measured against a reference scenario (i.e. a fixed baseline, like the 2020 baseline required in the ICMM commitment).

Use of counterfactuals

In some jurisdictions, gains can be measured against a counterfactual scenario of what would have likely happened to the protected biodiversity in the absence of the offset. There are concerns that relying solely on averted loss to achieve NGs does not align with global conservation objectives to reverse biodiversity loss (Simmonds et al., 2022)[43]. Some practitioners prefer to improve biodiversity conditions at the offset site rather than measure gains relative to a counterfactual scenario. For example, NNL commitments relative to a 2020 baseline need to measure gains against the 2020 baseline rather than a counterfactual scenario.

Use of multipliers

The quantified residual impacts are not necessarily the same as the gains required. This is because offsetting often involves a significant time lag between loss and gain, and outcomes are subject to other risks and uncertainties. These include uncertainty in ecological systems, imperfect metrics and exchange rules, offset delivery risks and durability of offsets.

This has resulted in many practitioners and regulators using multipliers. Biodiversity offset multipliers are based on the precautionary principle and describe the ratio between the amount of area (or number of individuals) impacted and the area/individuals that will be compensated. While there is little empirical evidence to support the efficacy of multipliers in practice, the overwhelming consensus, given the levels of uncertainty around offset outcomes, is that multipliers provide an important degree of insurance, or even that they are critical for achieving NNL.

Multipliers may be set by regulation or policy, or companies may need to make informed choices depending on each situation. As a general principle, the higher the conservation value of the features being lost, the greater the uncertainty regarding the likelihood of achieving gains; and the longer the lag time between loss and gain, the larger the multiplier. For example, in the Chilean offsetting regulatory guide, the level of protection of the impacted site serves as a multiplier to estimate how much gain is required, alongside the time lag between loss and gain.

Because certain types of restoration offsets can take a long time to achieve biodiversity gains, time-discounting multipliers are sometimes used. They adopt principles from accounting and are often based on 'Net Present Value', i.e. they devalue biodiversity in the future compared with its present value, resulting in a larger offset. Net Present Value rates vary[44] so it is also good practice to engage experts on this and be able to justify the discount rate used in a transparent manner with stakeholders and decision-makers.

An alternative to using multipliers is to limit uncertainty to the extent possible. Some of the risks and uncertainties associated with offsetting are foreseeable and manageable. The Offset Strategy (see Section 7.6 below) should demonstrate to stakeholders that residual impacts and gains are realistic and that offset risks will be addressed to the extent possible.

Assumptions around population growth rates

It is challenging to reliably predict the future trajectory of animal populations as many intrinsic and external factors affect population growth. These include the conditions prevailing at the offset site such as hunting pressure, deforestation rate and resource availability as well as density-dependent factors. For example, the population growth rate decreases as it nears the carrying capacity of the environment. Care is needed when choosing population growth rates if nothing is known about the carrying capacity of the chosen offset site[45].

43. Simmonds, J.S., von Hase, A., Quétier, F., Brownlie, S., Maron, M., Possingham, H.P., Souquet, M., zu Ermgassen, S.O.S.E, ten Kate, K., Costa, H.M., and Sonter, L.J. (2022), 'Aligning ecological compensation policies with the Post-2020 Global Biodiversity Framework to achieve real net gain in biodiversity', *Conservation Science and Practice*, volume 4(3). Available at https://doi.org/10.1111/csp2.12634
44. UK Treasury (2022, updated May 2024), The Green Book. (Social Time Preference Rate (STPR), is set at 3.5% in real terms although this should decline over the long term due.)
45. Boesch et al (in preparation)

Likelihood of achieving gains

When assessing loss/gain, it is good practice to assess the likelihood of achieving a NG, although this can be challenging in the absence of long-term monitoring or research. Findings of 'low confidence' as opposed to 'likely' or 'confident' should trigger an iterative process that should include revisiting the mitigation hierarchy or obtaining the necessary information to improve confidence in the offset design, and/or revising the offset design (e.g. using more precautionary multipliers or demonstrating offset certainty in advance of the impact). The likelihood of achieving gain is dependent on many factors such as the efficacy of offset measures, knowledge about species or ecosystems and the extent of residual impact and gains required.

7.5.3 Step 3: Identify possible offset sites and undertake feasibility studies

Initial screening of sites is based on literature, stakeholder engagement and previous surveys done as part of the baseline. Sites are screened based on the extent to which sites could help achieve NNL or NG for the project including the following criteria:

- Sites containing relevant ecosystem types (e.g. in the case of IFC this may include threatened or unique ecosystems – criterion 4 – as well as 'natural' habitats).
- Sites containing a relevant priority species (e.g. in the case of IFC this would be Critical Habitat Qualifying Species).
- Sites located within the same landscape as those ecosystems affected (if possible).
- Size of the site, area of high-value habitats or population size/density of priority species within the site.
- Threats and social context.

As some offsets are complicated and expensive, depending on the specific context, feasibility studies are often done to examine all aspects of a proposed offset (ecological, technical, social, political, financial and legal considerations). This is to ensure that all the risks are understood and manageable. They also help demonstrate to regulators, lenders and stakeholders that the proposed offset is likely to achieve the stated outcomes.

7.5.4 Step 4: Finalise loss and gain calculations

Once sites have been selected, adjustments might need to be made to the calculation of gains made in Step 2 based on certain conditions at the offset site. For example, the quality of the ecosystem might be lower, the abundance of a particular species is less than originally anticipated, or threats are more difficult to manage. It is valuable to build in 'safety margins' unless uncertainty has been addressed through the use of multipliers.

7.5.5 Step 5: Finalise offset sites and implement offset activities

Once a decision has been made to proceed with a site, a biodiversity offset implementation plan and/or an offset management plan is required, see Section 7.7 for more details.

7.5.6 Examples of assessing loss and gain

The examples below relate to Steps 1 and 2 above. They are not intended to be prescriptive, rather, they show a variety of options that practitioners can consider based on their specific project context, ecological setting and regulatory requirements.

Example 1: Loss of threatened ecosystem

In 2018, Colombia updated the *Manual de Compensaciones Ambientales del Componente Biótico* (Biotic Component of the Environmental Compensation Manual) under Resolution 256. Offsets must follow the NNL principle alongside ecosystem equivalence for all projects with environmental licences granted by the National Authority for Environmental Licensing. Colombia prepared the National Map of Ecosystems based on 399 units called 'Biome units'. These maps assist practitioners with identifying areas of equivalence. In addition, each unit is associated with a specific multiplier based on a set of criteria. Multipliers range 4–9.5 depending on their threat status and/or how rare they are.

Table 7.1: Examples of multipliers applicable to ecosystems in Colombia

Ecosystem (Biome units)	Impact (ha)	Degradation (ha)	Condition	Residual impact (area x quality)	Multiplier (Compensation factors)	Offset target (ha)
Zonobioma[46] Humedo Tropical Cartagena y delta del Magdalena	300	75	0.8	300	x 8	2,400
Halobiome Cartagena and Magdalena Delta	500	125	0.8	500	x 5.5	2,500

46. Equatorial Humid Zonobiome are evergreen humid forests (no water deficit for plants throughout the year equivalent is tropical rain forest or very humid and pluvial tropical forests of Holdridge (1967). Colombian Vegetation System is derived from Walter's (1985) Vegetation of the Earth and Ecological Systems of the Geo-biosphere the Biome definition and later modified by Campbell 1996. as quoted in Etter, A. et al (2015), *Colombia: Estado de los ecosistemas colombianos-2014: una aplicación de la metodología de Lista Roja de Ecosistemas*. IUCN.

Example 2: Sierra Leone Prinia (*Schistolais leontica*)

This bird species is range-restricted and globally Endangered with only approximately 1,000–2,499[47] pairs remaining. The species habitat is limited. It generally inhabits thickets between montane savanna and montane forest, often bordering streams, usually over 700m. The species usually occurs in pairs or small groups. The project footprint and historic disturbance overlap with a total of 283ha of critical habitat for the Sierra Leone Prinia which equates to ten breeding pairs. This increases to 478ha by the inclusion of a 100m buffer zone. Habitat within the 100m buffer is likely to be avoided due to sensory disturbance from the project. Observations during exploration suggest that this species is tolerant of some level of anthropogenic disturbance.

Offsetting for this species is tied to improving the quality of open and forested habitats within selected offset sites that support this species. This will primarily be achieved through protection with measures including fire and invasive species management. The total available hectares at each offset site are presented in Table 7.2. A 20% increase in habitat quality results in a 1.5 multiplier within the three key sites. The 20% increase was based on trial plots that had been running for six years. Consultation with species specialists is needed to further understand the potential for improving habitat quality and to determine whether improving the quality of habitat for this species will translate into increased breeding pairs to achieve NG for the 10 breeding pairs potentially displaced.

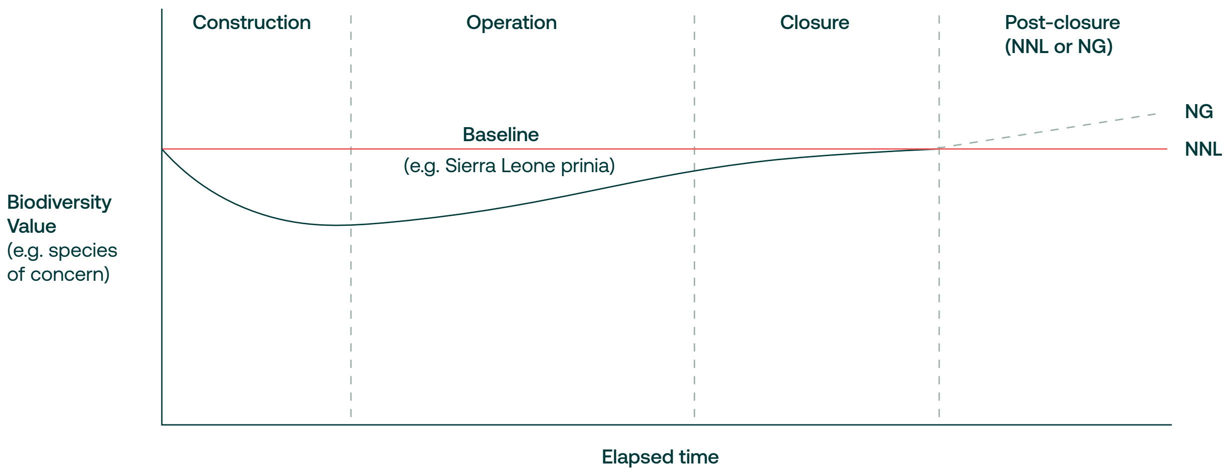
Table 7.2: Habitat availability at different offset sites for Sierra Leone Prinia

Loss (ha)			Gain (ha)			
Disturbance footprint	100m buffer zone	Total	Site 1	Site 2	Site 3	Total
263	215	478	638	178	3,719	4,535
20% increase in critical habitat quality			128	36	744	908
Multipliers			1.5			

Table 7.3: Likelihood of net gain and rationale

Species	Likelihood of net gain	Rationale
Sierra Leone Prinia	Probable	— Moderate loss/gain ratio — Three offset sites are subject to significant fire threats and cattle trampling — Site 3 will be a new protected area and will help ensure NNL

Figure 7.1: Illustrative example of progress towards NNL or NG across the project cycle



47. BirdLife International (2024), Species factsheet: Sierra Leone Prinia *Schistolais leontica*. Available at https://datazone.birdlife.org/species/factsheet/sierra-leone-prinia-schistolais-leontica on 01/12/2024

Example 3: The woodland caribou

This section provides an example of calculating the residual impact of the woodland caribou (*Rangifer tarandus caribou*) Southern Mountain population in British Colombia. Caribou habitats will be adversely affected due to habitat loss and degradation during the lifetime of a mining project. In addition to compensation, the project is implementing a Caribou Management Plan which comprises a range of avoidance and mitigation measures. Aboriginal groups were involved in the development of the management and offset plan.

The Southern Mountain population of caribou is listed as Threatened on Schedule 1 of the Species at Risk Act. It is Endangered because of habitat alteration, disturbance/displacement and changes to predator-prey dynamics. Critical habitat for southern mountain caribou is identified as the habitat possessing those biophysical attributes required by southern mountain caribou to carry out life processes. The following is critical habitat for woodland caribou:

— **High-elevation winter range:** Refers to areas at high elevations where caribou find resources and shelter during winter. These areas often provide access to forage despite harsh winter conditions, like deep snow (within Alpine tundra).

— **High-elevation summer range:** Represents high-elevation habitats used during summer for food, water and cooler temperatures. These ranges support vital activities like breeding and foraging.

— **Low-elevation winter range:** At lower altitudes, this range is crucial for animals seeking more accessible forage and milder conditions during winter (primarily spruce).

— **Type 1 Matrix habitat:** This refers to landscapes that serve as core habitat or connecting areas for species, allowing movement between critical habitats, maintaining genetic diversity and supporting ecosystem processes.

The habitat lost on the mine is Matrix 1 and High-elevation winter range. The indicator used to quantify preliminary residual impacts is hectares (ha) of critical habitat lost. Hectares (ha) of critical habitat lost were estimated by overlaying the project footprint and buffer scenarios described below.

The spatial boundaries of the project footprint pit area and all other infrastructure (plus 50m) account for uncertainty in the final project design and the ability to strictly adhere to the project footprint during construction and operation. It represents the maximum extent of direct habitat loss due to the project footprint. A taxon-specific buffer of 500m was applied which reflects habitat degradation (including sensory disturbance) up to 500m from the project footprint.

The total estimated habitat loss is 4000ha of Matrix 1 and 248ha (in the buffer zone) of High-elevation winter range. The multiplier was based on a range of factors such as time lag, type of action and offset risk. The offset ratio was 8:1. This resulted in the following offset requirements which combined habitat securement and restoration as follows:

— 12,000ha offset (averted loss habitat securement) for 50 years

— 26,000ha additional restoration in key habitats for Caribou.

Example 4: Western chimpanzee

For some species, habitat quality is a sufficient measure for losses and gains. However, for species like great apes with long reproductive histories, a more nuanced approach is required. Their slow reproductive rates make monitoring their population growth over time challenging. Given their critically endangered status and the complex dynamics of their populations, relying solely on population data may not provide timely insights. In the short to medium term, proxy indicators may be necessary in addition to the population monitoring program. These indicators might include habitat extent and quality, or indicators of reproductive health which can provide earlier signals of population trends.

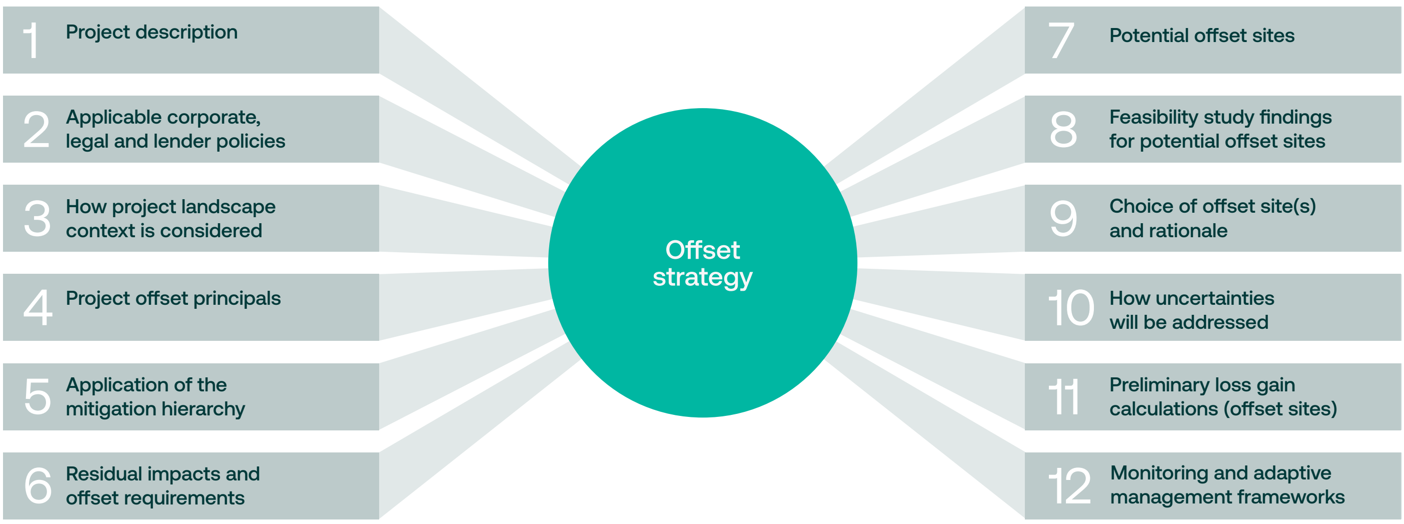
Typically, calculations on projected population loss are often derived from detailed surveys that calculate population densities. However, gains based solely on habitat restoration may not be appropriate for great apes as the recovery of ape populations is heavily influenced by density-dependent factors. This means that population growth rates can vary significantly depending on the availability of resources and social structures within a given area. As stated in Section 7.5.2, gains at offset sites are particularly complex, as they must account for how population density and reproductive rates interact over time.

7.6 Offset strategy

It is helpful to prepare a detailed offset strategy that presents the company's approach to offsetting which can be shared at different stages with experts and stakeholders on an iterative basis. It is important to engage stakeholders and species experts on loss/gain calculations, the selection of potential offset sites and the efficacy of management actions that could have the greatest potential for increasing biodiversity. Figure 7.2 outlines elements of a detailed offset strategy including:

- The project description (a brief description of the project and associated facilities).
- Corporate, legislative, lender and policy requirements, i.e. are there legislative, policy or lender requirements that influence the offsetting process?
- How project context (landscape) has been considered. Offsets located within an ecologically appropriate landscape help maintain habitat connectivity, allowing for wildlife movement and gene flow between populations. A patch of restored habitat, even if well-designed, may not provide full ecological benefits if it is isolated.
- The project's offset principles (see Section 7.2.1).
- Application of the mitigation hierarchy (showing alternative analysis/quantification where possible) and with an avoidance-first focus.
- Assessment of residual impacts and related offset requirements (see Section 7.5.1).
- The screening process for and final selection of offset sites (see Sections 7.5.2 and 7.5.3).
- Findings from any feasibility studies at each offset site (see Section 7.5.3).
- The preferred choice of offset site(s) and rationale for why these were chosen (see Sections 7.5.4 and 7.5.5).
- How uncertainties will be addressed, e.g. through the adoption of multipliers (see Sections 7.5.2).
- Preliminary loss/gain calculations based on selected site(s) (see Section 7.5.4).
- Monitoring and adaptive management framework (see Section 8.2.3).

Figure 7.2: Process steps to develop offset strategy



7.7 Offset Implementation Plan and Offset Management Plans

Designing and implementing biodiversity offsets according to best practices can be complex, time-intensive and costly wherever your operations are. However, achieving good outcomes is likely to be more challenging in regions with weak governance, inadequate land use planning, insecure land tenure and high rural poverty levels. Offset Implementation Plans are likely to include elements such as who is responsible for implementing the offset (e.g. if on state land, what is the role of the state or local authority?), staffing and capacity, site governance, the site's values, what measures are being undertaken to achieve gains (protection or restoration), how communities' considerations are taken on board and how social issues are being addressed, and lastly, what the financing arrangements are to ensure the long-term success of the offsets. Offset management plans will also be prepared. These are site-based operational plans that are updated periodically.

Box 7.3: GRI 101-2 (see Section 9)

States that companies should report for each offset:

- the goals
- the geographic location
- whether and how principles of good offset practices are met
- whether and how the offset is certified or verified by a third party.

7.7.1 Additional conservation action

Additional conservation actions (ACAs) can be very valuable, enhance broader conservation outcomes and demonstrate a company's commitment to biodiversity stewardship beyond its legal or NNL obligations. However, they should not be used to address impacts at an operation to achieve NNL or NG. ACA's may include strategic actions that support biodiversity in collaboration with third parties, such as scientific experts, NGOs or local communities. For example, joint research projects, technical and scientific cooperation, capacity-building, training or knowledge sharing.

Seeking opportunities for restoration and offsetting to achieve NNL and/or NG may also require 'back-casting', and retrospective baselines (see Section 4). In some cases, NNL may not be possible at existing sites where biodiversity losses have already occurred and no options for offsetting historical impacts exist. In these cases, ACAs, which generate biodiversity gains but not specifically for the targeted biodiversity features, should be used and prioritised to generate gains in features that are of greater conservation significance than those impacted. The biodiversity gains made by ACAs contribute towards broader biodiversity conservation goals but do not count towards delivering NNL or NG targets. Where NNL is not feasible at existing operations, it is important to avoid making a NNL or NG claim and instead disclose how the mitigation hierarchy has been rigorously applied as well as describe the ACAs and how they contribute to conservation outcomes. The amount and type of ACAs required will likely differ among sites but should be informed by stakeholder expectations and other factors, including the extent of historic biodiversity losses and the conservation significance of residual biodiversity losses.

Figure 7.3: Illustrative content of offset implementation plans

Governance and accountability

- Who is responsible for implementing the offset?
- Which parties have a say in offset decision-making and how will that work?
- If on public lands, what is the role of the responsible authority?
- Have accountabilities been clearly defined with respect to the offset?

Good design and planning

- Have we documented and understood the sites values?
- Do we understand external pressures/threats that might affect achieving outcomes?
- Have we engaged local communities and integrated their input to address the social impacts of offsets?
- Have we designed measures to sustain the biodiversity values of interest?

Effective management

- Do we have the right people in place, skills and capacity?
- Are we clear on the measures to be undertaken to achieve gains (protection/restoration)?
- Have we integrated identified threats, enabling access for certain uses, etc.?
- Have we built in sufficient points of engagement with offset decision-makers?
- Are we monitoring progress?

Achieving desired outcomes of offsets

- Can we demonstrate progress towards the achievement of outcomes?
- Where progress may fall short, have we got mechanisms in place to adjust?
- Where the outcomes for biodiversity values are being achieved, are we confident these can be sustained?

Box 7.4: Key lessons learned from offset case studies

This summarises the key lessons learned from an analysis of five mining-related detailed offset case studies undertaken in 2019 as part of a World Bank study on forest smart mining. It included:

1. ArcelorMittal's iron ore project in Liberia;
2. Newmont's Akyem project in Ghana;
3. Compagnie des Bauxites de Guinée and Guinea Alumina Corporation's bauxite projects in Guinea;
4. Wildlife Works' carbon offset project in Kenya; and
5. Aston Coal's Maules Creek coal mine in Australia.

Together, they highlight the spectrum of challenges faced by those aiming to implement enduring offsets. The selection of studies was to reflect different types of forest landscapes, the inclusion of World Bank Group projects, a variety of minerals and, most importantly, the availability of data which constrained the geographical spread of case studies.

— If offsets are to contribute permanently to the conservation estate of a country after the application of the mitigation hierarchy, there needs to be an enabling environment for this to happen. Governments should ensure there exists a supportive environment that enables offsetting through legislation, policy and willingness to partner with the private sector.

— Offsets will only succeed with the support of local communities. That support is conditional on ensuring that subsistence and livelihood needs are not adversely impacted or are adequately compensated for. Ideally, community support for offsets stems from mutual recognition that the offset offers the potential for communities to thrive sustainably.

— Indicators/metrics provide a structured way of assessing losses and gains. However, this does not mean that companies need to establish reliable quantities and qualities of every biodiversity component affected. In some cases, it is also valuable to initiate conservation activities that will contribute positively to the landscape.

— Securing the long-term protection of land is essential to provide companies with a sufficient degree of certainty to invest in offsets, and civil society needs to know that these offset areas will not be eroded in the future. Where protective measures are weak or absent, considerable resources may be required to secure an adequate level of protection. Government should ensure that there are options for long-term protection while also recognising the rights of communities.

— Effective implementation and monitoring are important if conservation outcomes are to be demonstrated, but this may happen over the long term and monitoring can be expensive. No single index can monitor all outcomes; a suite of indicators is likely to be needed. This reinforces the need to derive pragmatic, defensible and replicable ones.

— Partnerships are essential for offsets to be achieved and then to endure. The requisite authority and skills to implement and ensure the protection of an offset successfully are rarely present within a single organisation. However, partnerships are also intrinsically complex and require active management if the collaborative advantage that partnerships promise to deliver is to be achieved.

— Given that all offsets depend on partnerships, their effective governance and oversight is extremely important. The skill lies in ensuring participatory oversight while limiting bureaucracy.

— Outside regulated markets, securing adequate finance from project proponents to support offsets is a major risk to implementation. Companies should ensure there is adequate financing, and financial and other institutions should expend more effort to establish a broader range of financing options.

Note: For details see World Bank (2019), *Forest Smart Mining: Offset Case Studies*. World Bank Group: Washington DC.

Further resources

Business and Biodiversity Offsets Programme (2009), *Biodiversity Offset Design Handbook*. Washington, D.C. [PDF].

Business and Biodiversity Offsets Programme (2012), *Standard on Biodiversity Offsets*. The Business and Biodiversity Offset Programme. Washington, DC. [PDF].

Fauna & Flora International (2015), *Biodiversity offsets: lessons learnt from policy and practice. Synthesis report*. Business & Biodiversity Programme, Fauna & Flora International. [PDF].

IUCN (2016), *IUCN Policy on Biodiversity Offsets*. International Union for Conservation of Nature. [PDF].

Maron, M., et al. (2021), *Guidance for estimating biodiversity offset benefits and costs using expert elicitation*. Threatened Species Recovery Hub. [PDF].

World Bank (2016), *Biodiversity Offsets: A User Guide*. World Bank Group: Washington DC. [PDF].

World Bank (2019), *Forest-Smart Mining: Offset Case Studies*. World Bank Group: Washington DC. [PDF].

Monitor and Apply Adaptive Management

08

Key objective: To explore the rationale for monitoring progress to achieve NNL or NG and highlight the value of applying an adaptive management approach given inherent uncertainties.

8.1 Introduction

Monitoring is the process of collecting information to determine progress against agreed biodiversity objectives. Indicators are the factors that are measured during monitoring, e.g. to assess the extent of impact on biodiversity, the success of mitigation measures or the outcomes of measures to enhance biodiversity conservation (ICMM, 2006).

This section builds on Section 5, which sets out how companies can measure progress toward NNL and NG through the selection of biodiversity indicators and metrics for biodiversity values of interest within a Pressure-State-Response framework. The choice of a combination of indicators, linked to the biodiversity values of interest, enables us to understand and quantify the relationships between the pre-mining (or related activity) state of biodiversity within a project's AoI, the human-induced pressures affecting these biodiversity values and the effectiveness of the responses implemented to mitigate those impacts.

It also builds upon Section 6, which sets out how to assess residual risks to biodiversity and implement offsets where required to achieve either NNL or NG.

8.2 What are we interested in monitoring?

Monitoring is undertaken at both the operational areas of influence and at offset sites. At its most basic, monitoring is undertaken for the following reasons:

— To verify that measures intended to achieve NNL or NG (though avoidance, minimisation, restoration or offsetting) have been implemented fully in line with what has been set out in related management plans (**process** monitoring).

— To verify if impacts were as predicted and how the biodiversity values of interest have responded to the implementation of agreed mitigation measures and the status of progress to achieve NNL or NG of biodiversity (monitoring **outcomes**).

— Where progress towards NNL or NG is not progressing as planned, to guide the application of an adaptive management approach based on learning by doing to adjust mitigation efforts to achieve desired outcomes.

An often neglected component of monitoring is that the data (if shared) can build up a wealth of information on good practice and efficacious mitigation measures.

8.2.1 Verify that measures to achieve no net loss have been implemented

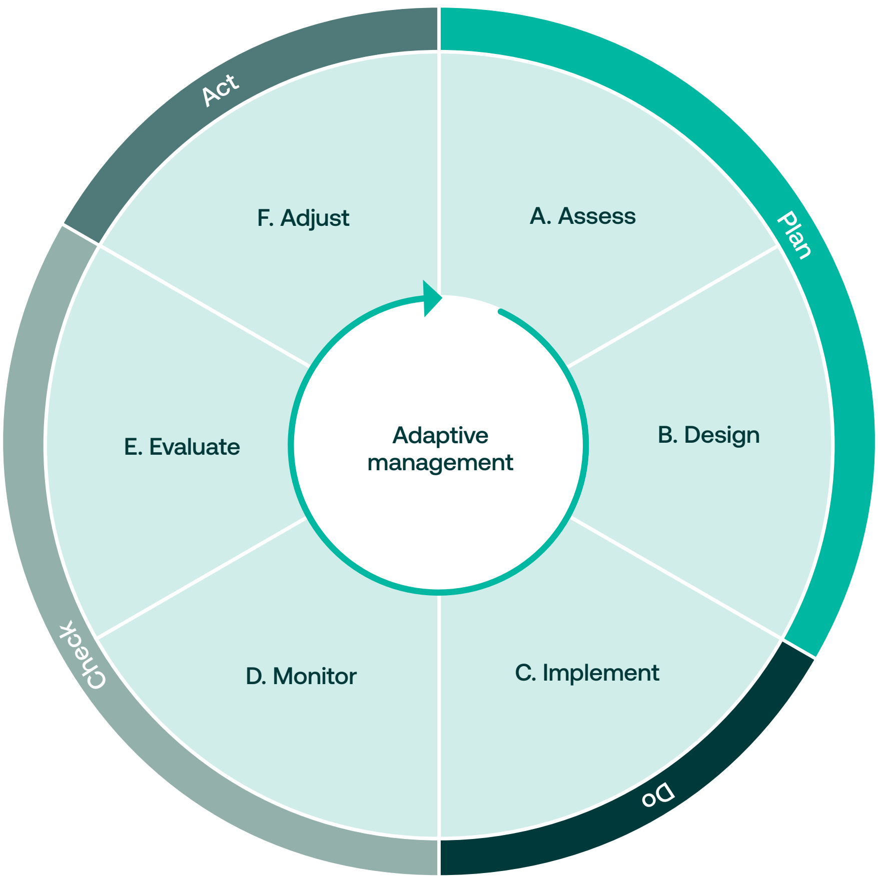
As outlined in Section 6, there is a broad range of mitigation actions that can be implemented to address potential adverse impacts on biodiversity and achieve NNL, which focus on the application of the mitigation hierarchy to address the impacts of projects or operations. In addition, there are a range of measures that can be applied to address external threats to (or pressures on) biodiversity. These mitigation actions should be captured in plans (including BAPs, BMPs or Environmental Management Plans) that set out more detailed specific activities, associated responsibilities, timeframes for implementation and resources. These should form the basis for monitoring implementation progress. Monitoring of the implementation of mitigation measures and management controls is sometimes referred to as process monitoring.

8.2.2 Measure responses of biodiversity values of interest

The choice of indicators or metrics (as set out in Section 5) for biodiversity values of interest will enable monitoring of how they have responded to the implementation of agreed mitigation measures. This monitoring of the status of biodiversity values throughout the life of a project or operation, relative to the baseline, is sometimes referred to as outcome monitoring. The timescales for responses will vary depending on what is monitored. For example, the ecological responses to mitigation measures aimed at reducing the over-harvesting of plant and animal species will depend on factors such as the lifecycles of species of concern, fecundity rates, the size of residual populations at the point when mitigation measures were introduced, etc.

Record keeping and data management are essential but often neglected components of biodiversity monitoring. Whether monitoring involves field surveys, remote sensing or the use of camera traps, data collection, management and storage protocols are important to observe to support the analysis of collected information.

Figure 8.1: Adaptive management for biodiversity mitigation measures



Source: Adapted from https/ww.essa.com/approach

8.2.3 Apply adaptive management where necessary

Adaptive management is a structured approach to decision-making that is well suited to situations where there is a moderate to substantial degree of uncertainty and has been widely applied in environmental management. This uncertainty is typical when it comes to choosing the most appropriate mitigation measures for affected biodiversity values or their likelihood of success.

This is explicitly acknowledged by IFC in PS6 and Guidance Note 6 which states: "*Given the complexity in predicting project impacts on biodiversity and ecosystem services over the long term, the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.*" This adaptive management logic is reflected in IFC's requirement for clients to produce a Biodiversity Monitoring and Evaluation Plan.

In simple terms, adaptive management is a systematic process for continuously improving management practices over time by learning from the results of biodiversity monitoring and adapting accordingly. Adaptive management emphasises the need to monitor progress at regular intervals, evaluate success and adjust your approach where necessary. A schematic approach to adaptive management is provided in Figure 8.1.

In the context of monitoring progress to achieve NNL or NG, the process steps can be summarised as:

1. **Assess impacts on biodiversity and identify mitigation options to achieve NNL:** This is the subject of Sections 3–6 of this guidance.
2. **Design mitigation measures:** To achieve NNL through the application of all stages of the mitigation hierarchy (see Sections 6 and 7 of this guidance).
3. **Implement mitigation measures:** Through actions taken by the company, often in partnership with government agencies and not-for-profit organisations.
4. **Monitor the effectiveness of mitigation measures:** Collecting and analysing data based on the choice of indicators and metrics as set out in Section 5 of this guidance, which may also involve partners engaging in monitoring activities.
5. **Evaluate progress:** Against the objectives of the mitigation efforts to see whether progress is being made towards the desired outcomes in accordance with anticipated timelines.
6. **Adjust if necessary:** Where progress towards no NNL or NG is not progressing as anticipated, use the results of monitoring to adapt accordingly and make changes, e.g. to management practices.

The establishment of thresholds for the monitoring results of specific biodiversity values can be useful in determining the need to adapt the management plans to address shortcomings in the achievement of objectives. 'Warning' and 'critical' thresholds can indicate the need for interventions to either avoid material risks or manage them to acceptable levels before they escalate or irreversible tipping points are reached. For example, warning/critical thresholds could be established for the levels of dissolved oxygen needed to prevent the distress/death of aquatic life in a water body. Another example of a critical threshold could be the minimum population size needed to sustain a viable population of an endangered (EN) species before decline is inevitable.

Where thresholds are exceeded, the results of monitoring should be further interrogated to understand the causal factors, e.g. is it because actions specified in the management plans are not being implemented as intended, the extent of project impacts to biodiversity values were underestimated, or that the anticipated benefits from management actions were overestimated? This will help to adjust management plans in a way that is responsive and helps deliver the desired outcomes. An example of where a project developer produced a monitoring plan that included quantitative or quantitative triggers that will require the modification of existing (or the development of new) mitigation measures is provided in Box 8.1.

Box 8.1. Caribou monitoring and adaptive management plan in British Colombia

In line with legal requirements, Blackwater Gold developed a Caribou Mitigation and Monitoring Plan to avoid, reduce and offset the adverse effects of a gold project in British Columbia. Approximately half of the mine site lies within the Tweedmuir caribou herd local population unit considered to be critical habitat by Environment and Climate Change Canada. As a result, Blackwater Gold proposed a caribou offset in 2018.

Through engagement with Aboriginal groups, the Ulkatcho First Nation and Lhoosk'uz Dené Nations, it was proposed that a habitat model be developed to: identify priority areas for habitat restoration; restore the areas identified; and monitor and manage the restoration areas using Ulkatcho First Nation and Lhoosk'uz Dené Nations monitors.

The Caribou Mitigation and Monitoring Plan is a living document that is intended to evolve over time through adaptive management. Examples of what the Monitoring and Adaptive Management Plan is legally required to include are the:

— monitoring programme including methods, location, frequency, timing and duration of the monitoring

— baseline information to be used or collected where data gaps exist to support monitoring

— scope, content and frequency of reporting monitoring results

— qualitative or quantitative triggers that will require the modification of existing (or development of new) mitigation measures, and process/timing for these to take effect

— identification of modified or new mitigation measures, and updated monitoring programme and reporting requirements.

The caribou monitoring programmes are designed to achieve the following:

— verify the accuracy of the environmental assessment

— determine the effectiveness of the mitigation measures

— determine the effectiveness of the offset.

The environmental assessment identified five potential adverse effects on caribou: (1) habitat loss and alteration; (2) changes in caribou population dynamics; (3) changes in caribou movement patterns; (4) mortality risk; and (5) changes in caribou health. The monitoring programme has been designed to address each of these effects and includes specific details on indicators to be monitored. Indigenous monitors from the Ulkatcho First Nation and Lhoosk'uz Dené Nations will be involved in the monitoring programmes for caribou, including field-based studies. The monitoring of caribou is conducted as part of the broader wildlife monitoring programme, which includes monitoring the project effects on vegetation, wildlife habitat, air quality and fugitive dust management, country foods monitoring, and monitoring the effectiveness of reclamation.

Note: Full information on the Caribou Mitigation and Monitoring Plan is available via Blackwater Mine's Public Plans and Reports.

8.3 Considerations in designing monitoring programmes

The design of monitoring programmes and selection of suitable indicators or metrics should consider the following:

— Are the indicators and metrics simple and clear to understand and repeatable over time through monitoring efforts? Indicator selection should follow the SMART philosophy, which is broadly reflected in the SBTN's principles for measurement indicators (see Box 8.2).

— Are the indicators and metrics technically robust and responsive to the biodiversity values of interest (see Sections 4–6), and have the methods and intervals for monitoring been clearly specified?

— Are we clear on the assumptions and limitations of each metric or indicator and monitoring method? Have we documented these clearly and used monitoring indicators/methods in combination to address any limitations and increase confidence in the monitoring data?

— Is there a need to involve experts in monitoring? For example, in situations where great apes are present, the IUCN Species Survival Commission's Primate Specialist Group should be engaged.

- Are there opportunities for participatory monitoring for mutual benefit to the company and communities? Explicit consideration of how to involve communities, stakeholders and interested or affected parties to utilise their contextual knowledge can support a successful monitoring programme. Capacity building may be required to deliver an informed and participatory approach. For example, participatory monitoring is integral to the example provided in Box 8.1.
- How will the monitoring data be managed, stored and reported over time? The critical importance of record keeping and data management over time is covered in Section 8.2.2 above.
- Is any training in monitoring methods or techniques and data management required?
- Have we identified thresholds for the monitoring results of specific biodiversity values and where these are not being met, the types of actions we may undertake to address this?

Box 8.2. Science Based Targets Network's principles for measurement indicators

Given that nature is multifaceted, the SBTN proposes a series of principles to use for selecting indicators at the corporate level that can underpin quantitative targets for nature. Many of these principles are also applicable to indicators for monitoring progress towards NNL or NG. The commentary in italic text is guidance-related and not part of SBTN's principles.

- **Location-specific:** Since nature is place-specific, measurement must also be place-specific whenever possible. *This is especially true in terms of monitoring progress towards NNL or NG.*
- **Practical:** Ideally, companies can measure their impacts to set targets and track their performance using existing data sets and methods. *While practicability is important, existing data sets may not always be sufficient for monitoring progress towards NNL or NG.*
- **Controllable:** Companies have control, or significant influence, over the value of the indicator measured, which enhances action planning and target achievement. Indicators on larger-scale impacts, like landscape-level state indicators, may be less controllable by a single company but are also important to track. When used, they should be coupled with controllable indicators on activities or pressures.
- **Predictable:** It is possible to assess in advance (with relative certainty) how different potential actions will affect the indicator. If an indicator is predictable, it assists companies in planning actions to reduce impacts or help regenerate/restore nature. *While this is broadly correct, it does not negate the need for adaptive management for site-level NNL or NG.*
- **Transparent:** Companies should, ideally, use open-source and freely available data and tools. Doing so bolsters their accountability, increases chances of replicability, and creates fewer burdens to validation and verification. *While correct in principle, in practice open-source data will need to be complemented by site-specific indicators that reflect biodiversity values and mitigation measures.*
- **Incentives:** The indicator incentivises the right actions in the right locations, or at least does not lead to perverse incentives; this requires that the indicator be sufficiently sensitive with respect to the scale of the company's impacts. *This is fundamentally important.*
- **Comprehensive:** Collectively, the target and indicator set covers a large percentage of the company's impacts (and dependencies) on nature. *This is less relevant for site-based monitoring of NNL or NG.*
- **Science-based ambition (alignment):** It is possible to measure alignment of the indicator with Earth's limits and societal sustainability goals. In practice, this often means that the indicator is either the same as or closely related to indicators used to set Earth's limits or measure societal targets. *This is less relevant for site-based monitoring of NNL or NG.*

Note: For details see SBTN's initial guidance available at this website.

Box 8.3. Alcoa's rehabilitation of Jarrah Forest informed by monitoring and adaptation

The nature of bauxite mining operations requires the integration of progressive rehabilitation of land during the mine operations, mine closure and post-closure phases. The intention of this approach is for mined areas to be progressively returned to functioning ecosystems suitable for hand back to the landholder, within a compressed timeframe.

In Western Australia, Alcoa has been operating for more than 60 years. In the early decades, agreed completion criteria allowed for the use of non-native plant species, focused on supporting a timber industry. Since 1988, the requirement has been to use a wider selection of native Jarrah Forest species in the progressive rehabilitation process as the desire for a production forest has been replaced by the desire for a more natural ecosystem. Alcoa's bauxite mining is typically confined to discrete mine pits within the surrounding Jarrah Forest with the relatively small pit size and large boundary supporting and enhancing the ongoing recruitment of plant species and fauna recolonisation. Alcoa's rehabilitation objective (endorsed by the Mining and Management Program Liaison Group (MMPLG)) is to establish and return to the State, a self-sustaining Jarrah Forest ecosystem planned to enhance or maintain water, timber, recreation, conservation and/or nominated forest value.

The completion criteria have evolved through a process of continuous improvement having been informed by research and practice with four revisions since 1966 and including the current sets of criteria, 2016–present, being reviewed and updated. Over these successions, key completion criteria have related to the establishment of a native species overstorey, which is the primary indicator of vegetation cover and primary productivity in a forest ecosystem, and understorey species, which are the predominant floristic diversity in the Jarrah Forest. Details of the rehabilitation approach are included in the long form of a case study developed by Alcoa.

Importantly, Alcoa's rehabilitation quality monitoring program is linked to the completion criteria that were developed in consultation with the post-mining land use manager, the DBCA and other key stakeholders and endorsed by the MMPLG in 2016, and include:

- Integrated landscape
- Sustainable growth and development
- Catchment protection
- Vegetation establishment
- Resilience of vegetation
- Land use (including timber production).

For each of these principles, there are rehabilitation quality requirements, objectives, completion criteria and monitoring methods. For example, for 'vegetation establishment' in the first five years, one of several objectives is for "*The overstorey stocking of both jarrah and marri to meet standards*". The associated completion criteria describe the standard-specific requirements for the number of stems/ha of tree species (with maximum, minimum and target numbers specified). Monitoring is by field observation at nine months and 15 months and aerial photography at five years. That same level of specificity applies to several indicators related to vegetation establishment and resilience.

Alcoa has integrated adaptive management practices within its rehabilitation monitoring program to ensure that the rehabilitation quality is on an appropriate trajectory towards achieving the completion criteria. In some cases, where monitoring indicates that rehabilitation is not on an appropriate recovery trajectory, remediation works take place to address relevant issues such as plant species richness (species range and spatial distribution) or landform stability (subsidence, erosion and sedimentation).

Note: For details see this website.

Further resources

Dalton, D., et al. (2024), *A framework for monitoring biodiversity in protected areas and other effective area-based conservation measures: Concepts, methods and technologies*. IUCN WCPA Technical Report Series No. 7, Gland, Switzerland: IUCN. [PDF].

ICMM (2006), *Good Practice Guidance for Mining and Biodiversity*. [PDF]. Available at https://www.icmm.com/en-gb/guidance/environmental-stewardship/2006/mining-and-biodiversity

SBTN (2020), *Science-Based Targets for Nature: Initial Guidance for Business*. Science-based Targets Network. [PDF].

Stephenson, P.J. and Carbone, G. (2021), *Guidelines for planning and monitoring corporate biodiversity performance*. Gland, Switzerland: IUCN. [PDF].

UNEP-WCMC, Conservational International and Fauna & Flora International (2020), *Biodiversity Indicators for Site-Based Impacts*. Cambridge, UK. [PDF].

UNEP-WCMC (2017), *Biodiversity Indicators for Extractive Companies: An Assessment of Needs, Current Practices and Potential Indicator Models*. UNEP-WCMC: Cambridge, UK. [PDF].

Transparently Disclose

Key objective: To identify disclosures relating to NNL and NG required of ICMM members and other potential disclosures and how these might be achieved.

9.1 Introduction

ICMM's Nature Position Statement Commitment 1.3 relating to direct operations requires member companies to:

> *Assess and address material risks and impacts to biodiversity and ecosystem services by implementing the mitigation hierarchy actions to achieve a minimum of NNL or NG of biodiversity by completion of closure. This includes:*
>
> — *Applying the mitigation hierarchy with an avoidance-first focus from the earliest feasible stage of exploration and continuing throughout project lifecycles.*
>
> — *Pursuing progressive restoration, rehabilitation and/or reclamation where feasible, and commencing with offsets (where appropriate) for residual adverse impacts as early as possible.*
>
> — ***Transparently disclosing the relevant methodology used to calculate NNL or NG, objectives, and site-level performance in 2030, 2040 and 2050, or more frequently.***

The two reporting obligations that this sets up from the outset are therefore to: (i) disclose the methodology used to calculate NNL and NG for a given project or operation; and (ii) disclose site-level performance at regular intervals, starting no later than 2030 and at intervals of no longer than a decade.

Beyond these required disclosures for ICMM members, there may also be obligations or voluntary commitments linked to reporting on NNL or NG arising from:

— **Regulatory disclosures:** This might include requirements to disclose Environmental and Social Impact Assessments and related management plans (such as BMPs or BAPs which may include provisions relating to NNL or NG – see Section 6.5) or to disclose the results of monitoring reports.

— **Lender requirements:** For example, the IFC and Equator Banks require the disclosure of Environmental and Social Impact Assessments and related management plans (BMPs or BAPs) which may include provisions relating to NNL or NG.

— **Reporting obligations:** This could include biodiversity reporting in line with voluntary reporting standards such as the GRI, International Sustainability Standards Board or regulatory equivalents such as the European Union CSRD and its ESRS.

— **Voluntary disclosure of biodiversity information for broader benefit:** For example, the Equator Banks encourage clients to share commercially non-sensitive project-specific biodiversity data with the Global Biodiversity Information Facility and relevant national and global data repositories, using formats and conditions to enable such data to be accessed and re-used in future decisions and research applications

The disclosures required under the TNFD are aggregate and high-level and provide no specific line of sight to the achievement of NNL or NG at the project or operational level, so they are not considered further here. However, both GRI and CSRD/ESRS specify detailed disclosures that go far beyond matters related to NNL or NG. While companies should be aware of these, they are not considered further in this section.

9.2 Disclosing no net loss or net gain methodologies and site-level performance

9.2.1 Disclosing no net loss or net gain methodologies
Transparent disclosures of the methodology used to calculate NNL or NG is an essential component of good practice in addition to being a requirement of ICMM members. In addition, disclosures under CSRD/ESRS (which companies based in – or supplying a significant quantity of materials to – the European Union are required to report against) and under GRI (which is currently required of ICMM members) are also setting expectations of greater transparency and disclosure on the part of companies.

For example, the ESRS Disclosure requirement E4-3 requires the following disclosures:

25. The undertaking shall disclose its biodiversity and ecosystems-related actions and the resources allocated to their implementation.

28. In addition, the undertaking:

a. may disclose how it has applied the mitigation hierarchy with regard to its actions (avoidance, minimisation, restoration/rehabilitation, and compensation or offsets)

b. shall disclose whether it used biodiversity offsets in its action plans. If so, the disclosures shall include details on:

i. the aim of the offset and key performance indicators used;

ii. the costs of offsets; and

iii. a description of offsets including area, type, the quality criteria applied and the standards that the biodiversity offsets comply with.

c. shall describe whether and how it has incorporated local and indigenous knowledge and nature-based solutions into biodiversity and ecosystems-related actions.

Meanwhile, GRI 101: Biodiversity Disclosure 101-2-a requires an organisation to report how it applies the mitigation hierarchy by describing:

i. actions taken to avoid negative impacts on biodiversity

ii. actions taken to minimise negative impacts on biodiversity that were not avoided

iii. actions taken to restore and rehabilitate affected ecosystems, including the goals of the restoration and rehabilitation, and how stakeholders are engaged throughout the restoration and rehabilitation actions

iv. actions taken to offset residual negative impacts on biodiversity.

v. transformative actions taken and additional conservation actions taken.

Specifically in relation to (iii) restoration and rehabilitation and (iv) offsets, GRI 101-2 outlines more prescriptive reporting requirements where these mitigation measures are undertaken. For each offset report: (i) the goals; (ii) the geographic location; (iii) whether and how principles of good offset practices are met; and (iv) whether and how the offset is certified or verified by a third party.

As noted in Section 9.1 above, many regulators and lenders (including IFC and Equator Banks) also require disclosure of BMPs or BAPs which may include provisions relating to NNL or NG.

Based on these lender or emerging reporting and disclosure expectations on NNL and/or NG disclosures, the following disclosures may be required depending on the applicable requirements:

- **Scope of the commitment to NNL or NG:** The biodiversity values included within the scope of NNL or NG commitment should be clearly identified, together with a rationale for why these were selected.
- **Biodiversity losses and gains:** Quantitative (wherever possible) assessments of the state and condition of biodiversity values at the baseline (2020 or earlier) and current year should be provided.
- **Mitigation measures:** A description of the measures to be applied to achieve NNL or NG for each biodiversity value, the related targets/objectives and whether these represent NNL or NG, the indicators and metrics used to measure progress, related measurement methods and a timeline for when the targets/objectives will be achieved.
- **Approach to measuring NNL or NG:** A clear overview of the approach used to quantify biodiversity losses and gains, including residual impacts and how the mitigation hierarchy was applied, as well as the comparison of losses and gains over time to demonstrate that the project is on track to achieve biodiversity targets.
- **Governance structures:** The long-term success of mitigation measures depends on the governance structures and financing arrangements for monitoring, and any ongoing management requirements in place at the time of site relinquishment.
- **Any feasibility constraints:** Including an assessment of anticipated barriers to achieving NNL for any biodiversity values, a plan and justification for proportional compensatory measures (i.e. ACAs) to address expected residual losses and their expected biodiversity gains.

9.2.2 Disclosing site-level performance

The main consideration with respect to performance reporting is to report on progress towards the achievement of NNL or NG targets/objectives, including biodiversity gains achieved by mitigation actions and other compensatory measures until the NNL or NG target is achieved for all biodiversity values. The requirement as specified in ICMM's position statement on nature is as follows: "*Transparently disclosing the relevant methodology used to calculate NNL or NG, objectives, and site-level performance in 2030, 2040 and 2050, or more frequently.*"

This suggests that disclosure should take place at intervals of no less than 10 years. While annual or even biennial reporting is both too onerous and unlikely to reveal material changes, intervals of 3–5 years are suggested as good practice.

Lastly, the ICMM position statement on nature also states that: "*Where NNL is not feasible at existing operations, disclose how the mitigation hierarchy and additional conservation actions are applied to appropriately address negative impacts on biodiversity.*"

Where an existing operation determines that NNL is not feasible, good practice would be to disclose the basis for this determination, as well as how the mitigation hierarchy and additional conservation actions are applied to appropriately address negative impacts on biodiversity.

Further resources

Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards: ESRS 4 delegated Act 2023 5303 Annex 1.

Equator Principles Association (2020), *Equator Principles EP4: A financial industry benchmark for determining, assessing and managing environmental and social risk in projects*. [PDF].

GRI (2024), GRI 101: Biodiversity 2024. Global Reporting Initiative. [PDF].

IFC (2019), Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. IFC, Washington DC. [PDF].

Annexe 1

Glossary

Term	Acronym	Description (and/or link to further information)
Additional Conservation Action	ACA	ACAs are conservation or compensation actions that are positive for nature/biodiversity which can't be accounted for using the mitigation hierarchy and loss/gain metrics and may target ecosystem types and species not impacted by an operation. They may include out-of-kind actions taken when in-kind offsets/ compensation cannot be pursued. Members should consult their own specific rules for the legitimate use of ACAs.
Alliance for Zero Extinction sites		The Alliance for Zero Extinction sites aim for global recognition of sites with a key role in preventing global extinctions. Alliance for Zero Extinction sites must meet three criteria (endangerment, discreteness, irreplaceability) to qualify. www.zeroextinction.org
Area of Analysis	AoA	The AoA is the area that encompasses the study area used for the purposes of baseline data collection and impact assessment. It typically includes the project footprint, areas directly affected, areas indirectly affected and affected populations of species of concern (see Figure 3.1).
Area of Influence	AoI	The AoI is the area that encompasses, as appropriate, areas likely to be affected by: current construction or operational activities and predictable developments that could occur later, and/or indirect project impacts on biodiversity or ecosystem services upon which affected communities' livelihoods are dependent; and associated facilities, not controlled by the project/operation but that would not have otherwise been constructed or expanded and without which the project/operation would not be viable.
Biodiversity		The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems. https://www.ipbes.net/glossary/biodiversity
Biodiversity Action Plan	BAP	A BAP is a management plan identifying actions that will be taken to implement mitigation measures for biodiversity affected by an operation, including NNL or NG commitments.
Biodiversity baseline		Describes and explains the compositional, structural and functional state of biodiversity in the AoA and/or wider landscape before a planned operation/expansion. A retrospective baseline is developed by gathering historic information and/or back-casting from current conditions to derive baseline estimates for a time period in the past. NNL and NG are measured against the baseline.
Biodiversity Indicators Partnership	BIP	BIP is a global initiative to promote the development, delivery and use of biodiversity indicators. www.bipindicators.net/
Biodiversity Monitoring and Evaluation Plan		A plan designed to generate data to track progress towards NNL or NG outcomes. May include action thresholds that can be used as the basis for adaptive management.
Biodiversity Management Plan	BMP	A management plan identifying requirements for biodiversity affected by an operation, including NNL/ NG commitments.
Biodiversity Offset Management Plan		A management plan focused on the delivery of biodiversity offsets, often applied to areas offsite. It may include actions to be undertaken by third parties.

Term	Acronym	Description (and/or link to further information)
Business and Biodiversity Offsets Programme		The Business and Biodiversity Offsets Programme was an international collaboration of organisations and individuals including companies, financial institutions, government agencies and civil society organisations, that tested and developed best practice on biodiversity offsets and conservation banking worldwide. www.forest-trends.org/bbop/
Closure		The process of releasing land from operational use, then stabilising and restoring environments that have been affected by operational activities. This can start when or before operations have ceased and ends when all decommissioning, demolition and restoration activities have been completed. Some monitoring, management and ongoing mitigation measures for specific aspects may still occur after this point (i.e. during post-closure). Adapted from: ICMM (2025), *Integrated Mine Closure: Good Practice Guidance*, 3rd ed.
Charismatic megafauna		Charismatic megafauna are large, well-known and popular animals that are often used to generate public support for conservation efforts, e.g. great apes, elephants, bears and large cats.
Critically endangered	CR	A species considered to be facing an extremely high risk of extinction in the wild. www.iucnredlist.org/
Critical habitat		A term with specific meaning in IFC's Performance Standard 6 (IFC, 2012) denoting a subset of both natural and modified habitat that has high biodiversity value (determined using criteria and thresholds). The term is also used by regulators (such as the US Fish and Wildlife Service and the Australian Department of Climate Change, Energy, the Environment and Water). It refers to areas within the geographical area occupied by the species at the time of listing that contain physical or biological features essential to the conservation of the species and that may require special management considerations or protection. There is a strong emphasis on avoidance and a net gain requirement applies to areas of critical habitat. https://www.ifc.org/content/dam/ifc/doc/2010/20190627-ifc-ps-guidance-note-6-en.pdf
Corporate Sustainability Reporting Directive	CSRD	A European Union regulation that mandates large companies to disclose detailed information on their environmental, social and governance impacts. It aims to enhance transparency, accountability and comparability of sustainability data to help investors and stakeholders make informed decisions.
Cross-Sector Biodiversity Initiative		A partnership between IPIECA, the International Council on Mining and Metals (ICMM) and the Equator Principles Association to develop and share good practices related to biodiversity and ecosystem services in the extractive industries. www.csbi.org.uk/
Cumulative impact		Change in biodiversity caused by the effects of past, present and reasonably foreseeable future actions of an operation when considered in combination with those of other developments in the same landscape and background environmental changes as appropriate.
Dispersal barriers		Any environmental feature that prevents organisms from relocating.
Ecologically Appropriate Areas of Analysis	EAAA	The EAAA is the spatial area (as defined by an ecologically relevant unit) for determining if a project is located in a critical habitat. https://www.ifc.org/content/dam/ifc/doc/2010/20190627-ifc-ps-guidance-note-6-en.pdf
Ecosystem services		Ecosystem services are 'the benefits that people, including businesses, derive from ecosystems' (MEA 2005)[48].
Endangered	EN	A species considered to be facing a very high risk of extinction in the wild. www.iucnredlist.org/
Endemic		A plant or animal native and restricted to a single, defined geographical area, for example, an island, region, state, river basin or other defined zone.
Environmental and Social Impact Assessment		Method of analysis that identifies the potential implications of a proposed development on the social, biological and physical environment potentially affected by a proposed development.

48. MEA. *Millennium Ecosystem Assessment: Ecosystems and Human Well-being*: Synthesis. Washington, DC: Island Press, 2005.

Term	Acronym	Description (and/or link to further information)
Environment DNA	eDNA	Traces of DNA in the environment (eDNA). eDNA is used to identify individual species from samples of soil, sediment, water and air.
Environmental Management Plan		A management plan detailing the strategy for assessing and measuring compliance for environmental mitigation and monitoring.
European Sustainability Reporting Standards	ESRS	A set of reporting requirements developed by the European Financial Reporting Advisory Group to ensure companies disclose relevant, comparable and reliable sustainability information. These standards aim to enhance transparency and accountability in environmental, social and governance performance across companies in Europe.
Existing operations		Existing operations include, at a minimum, exploration areas in or beyond the feasibility phase, operating mine sites and significant linear infrastructure.
Geographic Information System	GIS	A software system and database used to view and manage information about geographic places, analyse spatial relationships and model spatial processes.
Global Biodiversity Framework	GBF	Framework to support the achievement of the Sustainable Development Goals, including pathways to reach the global vision of a world living in harmony with nature by 2050. Among the GBF's key elements are four goals for 2050 and 23 targets for 2030. www.cbd.int/gbf
Global Biodiversity Information Facility		An international organisation that focuses on making scientific data on biodiversity available. www.gbif.org
Global Forest Watch		An online platform that provides data and tools for monitoring forests. Provides open access to 'near real-time information' about where and how forests are changing around the world. www.globalforestwatch.org
Global Reporting Initiative	GRI	Global common language to communicate an organisation's impacts. https://www.globalreporting.org/
Indirect impact		Effects on biodiversity that are mediated or transmitted via an intermediary receptor or effect, e.g. spread of an alien invasive species displaces a native species over time; or loss of a tree used by chimpanzees for nesting causes human-wildlife conflict.
Induced effects/ impacts		A form of indirect impacts that result from activities that occur in response to socio-economic opportunities associated with new developments, e.g. access to previously remote areas and resources, potential employment and/or enterprises to service a mine or new settlements.
Integrated Biodiversity Assessment Tool	GRI	Online access to data, reports and mapping on protected areas and biodiversity areas such as Key Biodiversity Areas. www.ibat-alliance.org
International Finance Corporation	IFC	An international financial institution that works with the private sector and is part of the World Bank Group. www.ifc.org
International Union for Conservation of Nature	IUCN	An international organisation working in the field of nature conservation and sustainable use of natural resources. www.iucn.org
Key Biodiversity Area		Internationally recognised areas of importance for the conservation of biodiversity across terrestrial, freshwater and marine ecosystems, selected using Key Biodiversity Area criteria. Key Biodiversity Areas are not necessarily protected. www.keybiodiversityareas.org

Term	Acronym	Description (and/or link to further information)
Landscape context		Information and understanding that characterises the landscape where a project/operation is located, using information on the types, and distribution of ecosystems and species populations and their relative irreplaceability and vulnerability, observations of threatened species, locations of protected areas, biodiversity hotspots and other areas designated for conservation.
Locate, Evaluate, Assess and Prepare	LEAP	TFND guidance on the identification and assessment of nature-related issues. https://tnfd.global/
Material (issue or risk)		Risks with the potential to influence key decisions or compromise the achievement of biodiversity-related commitments, eligibility for finance, financial risk, compliance with applicable legal or regulatory requirements, social license to operate, or others which may need to be determined on a site-by-site basis. Companies should use the definition provided by the recognised or established standards which they follow, e.g. as part of their membership commitments or sustainability reporting and disclosure processes. Increasingly, biodiversity- and climate-related issues are considered material, requiring systematic assessment to guide mitigation, management and transparent reporting as appropriate.
Mitigation hierarchy		Actions to be taken in order of priority throughout a project lifecycle to anticipate and avoid impacts on biodiversity. If impacts do occur, efforts should be made to minimise them and then restore the affected features. Significant residual losses should then be offset to achieve NNL of biodiversity as a minimum.
National Biodiversity Strategies and Action Plans		A national policy which aims at providing strategic direction at a national level on the management and protection of biodiversity as per the UN Convention on Biological Diversity. https://www.cbd.int/nbsap
Natural habitat		Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. https://www.ifc.org/content/dam/ifc/doc/2010/20190627-ifc-ps-guidance-note-6-en.pdf
Nature positive		A global societal goal to halt and reverse nature loss by 2030 and achieve full recovery by 2050, relative to a 2020 baseline – or, in other words, 'bend the curve' of nature loss. ICMM's nature new commitments are designed to contribute to a nature positive future across the mining and metals sector's areas of influence.
Net gain	NG	An outcome whereby biodiversity gains exceed losses resulting from a project or operation, relative to its baseline state or condition.
No net loss	NNL	An outcome whereby losses (due to a project/operation) and gains (achieved through mitigation) are balanced out for biodiversity overall or a specific biodiversity feature.
Net positive impact		A situation in which a facility, operation or specific action is implemented together with actions that benefit biodiversity or achieve net gain. Often used synonymously with NG.
Non-governmental organisation	NGO	Organisations that are not-for-profit and typically not affiliated with any government or business.
Normalized Difference Vegetation Index		Image processing technique to quantify vegetation health and density using a band ratio from spectral data.
Performance Standard 6 (Guidance Note 6)	PS6 (GN6)	International Finance Corporation (IFC) Performance Standard 6 and Guidance Note 6. https://www.ifc.org/content/dam/ifc/doc/2010/20190627-ifc-ps-guidance-note-6-en.pdf

Term	Acronym	Description (and/or link to further information)
Post-closure		The period after decommissioning, demolition and site restoration activities have been completed during which ongoing actions may be needed to reach or maintain NNL or NG.
Primate Specialist Group (IUCN)		IUCN Species Survival Commission Specialist Group. https://iucn.org/our-union/commissions/group/iucn-ssc-primate-specialist-group
Reclamation		A broad term used to describe multiple post-mining activities, often the process of reconverting disturbed land to its former or other productive uses. In some areas, it may be synonymous with or a subset of rehabilitation, whereas in others, it is more closely related to and may include ecological restoration. **Source:** Society for Ecological Restoration (2022), *International principles and standards for the ecological restoration and recovery of mine sites*.
Rehabilitation		Management actions that aim to reinstate a level of ecosystem productivity or functioning on degraded sites, where the goal is renewed and ongoing provision of ecosystem services rather than the recovery of a specified target native ecosystem. Rehabilitation is encouraged and valued where it: (1) improves ecological conditions and functions; (2) is the highest standard that can be applied at present; and (3) improves conditions that could lead to the recovery of a native ecosystem in the future. **Source:** Society for Ecological Restoration (2022), *International principles and standards for the ecological restoration and recovery of mine sites*.
Restoration		The process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. Ecological restoration differs from other types of restorative activities in that it aims to assist in recovering the ecosystem to the trajectory it would be on if degradation had not occurred, accounting for environmental change. **Source:** Society for Ecological Restoration (2022), *International principles and standards for the ecological restoration and recovery of mine sites*.
Retrospective baseline		Retrospective biodiversity baselines are needed when the NNL commitment is made after biodiversity losses (or gains) have occurred and no information exists on the site's baseline condition. A retrospective biodiversity baseline uses historical data and best available biodiversity information to establish benchmarks for a historical point in time and is developed in the absence of relevant pre-impact data or to supplement it.
Science Based Targets Network	SBTN	A global initiative that helps companies and cities set science-based targets to reduce their environmental impact and achieve sustainability. It provides guidance and resources for setting targets in areas such as biodiversity, land use and water, in alignment with climate goals and planetary boundaries.
Section on Great Apes (IUCN)		A group of experts active in research on and conservation of great apes. https://www.iucngreatapes.org/
Specific, Measurable, Achievable, Relevant, Timely	SMART	A clear framework for setting and tracking progress against goals that are specific, measurable, achievable, relevant and timely. This method ensures that goals are well-defined and actionable, increasing the likelihood of success.
Species Survival Commission (IUCN)		The Species Survival Commission is a science-based network of thousands of volunteer experts, including a number of Specialist Groups. https://iucn.org/our-union/commissions/iucn-species-survival-commission-2021-2025
Species Threat Abatement and Restoration	STAR	The metric allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk across the world.

Term	Acronym	Description (and/or link to further information)
Pressure-State-Response framework		A widely accepted approach/framework for monitoring the implementation of mitigation strategies, generally considered to reflect industry and conservation best practice.
Taskforce on Nature-related Financial Disclosures	TFND	The TNFD has developed a set of disclosure recommendations and guidance that encourage and enable businesses and finance to assess, report and act on their nature-related dependencies, impacts, risks and opportunities. https://tnfd.global/
Trading-up		Trading-up (also known as 'like-for-like or better') involves conserving components of biodiversity through an offset that is a higher conservation priority than those affected by the development project for which the offset is envisaged[49,50].
UN Environment Programme World Conservation Monitoring Centre	UNEP-WCMC	Provider of a number of global environmental spatial datasets.
United Nations Educational, Scientific and Cultural Organization	UNESCO	The agency of the United Nations aimed at promoting world peace and security through international cooperation in education, arts, sciences and culture. Specifically, UNESCO has responsibility for administering World Heritage Properties.
Vulnerable		A species considered to be facing a high risk of extinction in the wild. www.iucnredlist.org/
World Wide Fund for Nature	WWF	A global conservation organisation dedicated to protecting the environment and endangered species through research, advocacy and sustainable practices. It focuses on addressing major environmental issues such as habitat loss, climate change and overexploitation of natural resources.

49. The Business and Biodiversity Offset Programme (2012). *Standard on biodiversity offsets*. The Business of Biodiversity Offset Programme. Washington DC
50. IUCN (2016). *Policy on Biodiversity Offsets*. International Union for Conservation of Nature.

Annexe 2

Examples of online resources on biodiversity and potential applicability to sections in this report

Examples of online biodiversity resources	Section 3 AoA	Section 4 Baseline	Section 5 Metrics	Section 6 Impact/ Mitigation	Section 7 Offsets	Section 8 Monitor
Biodiversity A-Z – provides clear, concise and relevant information about various topics relating to biodiversity written and reviewed by experts. It is designed to be a useful reference to all sectors including business, government and environmental agencies. The content of Biodiversity A-Z is structured around themes. https://www.biodiversitya-z.org/about	✓	✓	✓		✓	
Biodiversity and Ecosystem Services Trends and Conditions Assessment Tool – web-based mapping application for the mapping of ecosystem and biodiversity value condition at corporate sites. http://bestcat.org.s3.amazonaws.com/index.html		✓				
Biodiversity Intactness Index – measures biodiversity change using abundance data on plants, fungi and animals worldwide. The Index shows how local terrestrial biodiversity responds to human pressures such as land use change and intensification. https://www.nhm.ac.uk/our-science/services/data/biodiversity-intactness-index.html		✓				✓
Conservation Evidence – website that summarises documented evidence for and provides insights into the effectiveness of mitigation measures. https://www.conservationevidence.com/		✓		✓		
Forest Integrity Assessment Tool – a simple and user-friendly tool for assessing and monitoring biodiversity conditions in forests and forest remnants developed with support from WWF. https://www.hcvnetwork.org/library/forest-integrity-assessment-tool-fiat-manual		✓	✓			✓
Freshwater Ecosystems Explorer – a tool developed by UNEP to help users understand the state of freshwater ecosystems in geospatial time-series data that is considered accurate, up-to-date and high resolution. https:/Umap.sdg661.app/	✓	✓				✓

Examples of online biodiversity resources	Section 3 AoA	Section 4 Baseline	Section 5 Metrics	Section 6 Impact/ Mitigation	Section 7 Offsets	Section 8 Monitor
Global Biodiversity Information Facility – an online platform for accessing global biodiversity datasets, where thousands of institutions from more than 130 countries share data that provides free and open access to more than 2.6 billion species occurrence records. https://www.gbif.org		✓	✓			✓
Global Forest Watch – an online platform that provides data and tools used to build an understanding of the extent of deforestation, pressures and for monitoring forests. https://www.globalforestwatch.org	✓	✓	✓			✓
Group on Earth Observations Biodiversity Observation Network – a global network of scientists, researchers and institutions working together to improve the collection, management and analysis of biodiversity data. https://geobon.org		✓				
Integrated Biodiversity Assessment Tool – provides biodiversity data for defined areas from a range of datasets including BirdLife International, United Nations Environment Programme –World Conservation Monitoring Centre, IUCN and Conservation International. https://www.ibat-alliance.org	✓	✓	✓	✓	✓	✓
IUCN Global Ecosystem Typology – a comprehensive classification framework for Earth's ecosystems that integrates their functional and compositional features. This new typology helps identify the ecosystems that are most critical for biodiversity conservation, research, management and human wellbeing into the future. https://iucn.org/resources/conservation-tool/iucn-global-ecosystem-typology		✓	✓			
IUCN Red List of Ecosystems – the global standard for assessing risks to ecosystems. https://iucnrle.org	✓	✓	✓			
IUCN Red List of Threatened Species – comprehensive information source on the global conservation status of animal, fungi and plant species. https://www.iucnredlist.org	✓	✓	✓			
Living Planet Index – provides a measure of the state of the world's biological diversity based on population trends of vertebrate species. https://www.livingplanetindex.org		✓	✓			
Natural Capital Measurement Catalogue – an open, scientifically rigorous resource for users to identify suitable metrics, methods and data sources for the measurement of natural capital assets, flows of services or benefits, and organisational impacts or dependencies on nature. https://naturalcapitalmeasurement.org/		✓	✓			

Examples of online biodiversity resources	Section 3 AoA	Section 4 Baseline	Section 5 Metrics	Section 6 Impact/ Mitigation	Section 7 Offsets	Section 8 Monitor
Nature Positive Initiative – represents conservation organisations, institutes, and business and finance coalitions coming together to drive alignment around the use of the term 'nature positive' and support broader, longer-term efforts to deliver nature positive outcomes. https://www.naturepositive.org/		✓	✓			✓
Protected Planet – a comprehensive global database for protected areas and other effective area-based conservation measures. www.protectedplanet.net	✓	✓				
Species Threat Abatement and Restoration (STAR) metric – the STAR metric measures the contribution that investments can make to reducing species extinction risk and helps organisations target their investments and activities to achieve conservation outcomes and contribute to global policy aims. https://iucn.org/resources/conservation-tool/species-threat-abatement-and-restoration-star-metric		✓	✓	✓		
The Nature Conservancy Conservation Gateway – website containing a library of documents and information for biodiversity and conservation planning and practices. https://www.conservationgateway.org/Pages/default.aspx			✓			
Taskforce for Nature-related Financial Disclosures Tools catalogue – an online catalogue of nature-related data tools to help assess nature-related issues aligned with the TNFD's Locate, Evaluate, Assess, Prepare (LEAP) approach. It includes a blend of freely available and commercial resources. https://tnfd.global/guidance/tools-catalogue/	✓	✓	✓	✓		✓
Tropical Forest Monitoring – an online platform tracking long-term deforestation and degradation in tropical moist forests. https://forobs.jrc.ec.europa.eu/TMF			✓			✓
UN Biodiversity Lab – a spatial data platform for accessing curated collections that integrate spatial data for insight and action. https://unbiodiversitylab.org	✓	✓				
World Resources Institute Aqueduct, Water Risk Atlas – designed to help organisations identify and evaluate water risks based on geography, including geospatial data of water-stressed regions that can be overlayed with operations and supplier locations. https://www.wri.org/applications/aqueduct/water-risk-atlas/	✓	✓				

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ICMM stands for mining with principles.

We bring together a third of the global metals and mining industry, along with key partners to drive leadership, action and innovation for sustainable development, ultimately delivering a positive contribution to society.

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