Gold, Nature & Biodiversity

An Introduction

2025

About World Gold Council

The World Gold Council leverages its broad knowledge and experience to improve understanding of the gold market and underscore gold's value to individuals, investors, society and the world at large.

Collaboration is the cornerstone of the World Gold Council's approach. It is an association whose members are the world's most forward-thinking gold mining companies. With its membership and its many industry partners, the Council seeks to develop gold's evolving role as a catalyst for advancements that meet societal needs.

It initiates and raises standards, expands access to gold, and supports innovation to a ensure vibrant and sustainable future for the gold market and its many stakeholders. From its offices in Beijing, London, Mumbai, New York, Shanghai, Singapore and Dubai, it seeks to deliver positive impacts worldwide.

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The *Nature Risk Profile* data and analysis in this report was produced by nature and biodiversity specialists at *S&P Global Sustainable1.*

About S&P Global Sustainable1

Sustainable1 is S&P Global's centralised source for sustainability intelligence, offering comprehensive coverage across global markets combined with ESG products, insights and solutions from across various divisions to help customers assess risks, uncover opportunities and inform long-term sustainable growth.

Mine site images courtesy of World Gold Council members - Agnico Eagle, AngloGold Ashanti, Equinox Gold, Eldorado Gold, and Pan American Silver; all other images from Getty Images, unless otherwise credited.

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1. Executive Summary

Nature and biodiversity are crucial for sustaining economic stability, prosperity, and human well-being, providing essential ecosystem services such as pollination, water purification, climate regulation, and soil fertility. These services underpin agriculture, forestry, fisheries, and tourism, contributing significantly to global economies and human livelihoods. Healthy ecosystems also offer cultural and recreational benefits, enhancing the quality of human life.

However, escalating demands for natural resources have pushed ecosystems to the brink. Scientists have been very clear in highlighting we are now facing the dual crises of biodiversity loss and climate change. Governmental and non-governmental organisations, including institutional investors of scale, have come to recognise this - catching up with the scientific evidence - and introduced frameworks and regulations to address these threats. While climate and biodiversity are deeply connected, they have largely been addressed independently. Encouragingly, momentum is building towards a more unified global approach – one that integrates solutions for both crises and recognises their shared impacts.

Mining, which by its very nature has a substantial impact on the physical environment, poses some quite specific conservation challenges and has, at least historically, been responsible for significant negative impacts on ecosystems. But, as others have noted, responsible mining can also play a strategic role in providing resources, infrastructure and capacities that may have positive environmental consequences; *'mining can also be a means for financing alternative livelihood paths that, over the long-term, may prevent biodiversity loss'*.[1]

We recognise that further work will likely be required to gain a more comprehensive understanding of the wider nature-related and biodiversity impacts of the gold supply chain, from mine to market, but we are assuming, partially informed by our work on climate change, that the most substantial impacts will be located upstream at locations where gold is mined.

The World Gold Council (WGC), representing 31 major, most forward-thinking gold mining companies, has (with its members) developed and committed itself to the *Responsible Gold Mining Principles (RGMPs),* which reference actions to address environmental factors and halt biodiversity loss. But the WGC also acknowledges that the level of analysis and available data on these issues is still insufficient to offer a clear overview of the sector's nature-related impacts and strategies. This is something the whole mining industry is striving to rectify, as it is currently seen as a major barrier to progress and wider stakeholder understanding. This is reflected in the recent comments of the investor-led Global Investor Commission on Mining 2030 which has stated that, currently, *'there is a critical lack of data on mining land-use and associated impacts on nature'*.[2]

The purpose of this paper is to start to address this challenge and to contribute to a more substantial understanding of gold mining's impacts on - and responses to - biodiversity. We hope this will then prompt and advance further discussions on how the industry's environmental impacts and dependencies can be assessed, evaluated, and prioritised in corporate and mine site plans.

The WGC and its members have made great strides in recent years in their understanding of the industry's climate impacts and its responses to climate-related risks.[3] Many gold mining companies have also made specific plans to better manage their local environmental impacts and conservation challenges. However, for a more coherent industry-wide understanding and response, there is a clear need for a broader perspective on the sector's impacts on nature and its potential contributions to reversing biodiversity loss. This study therefore aims to map out the **global picture of nature-related risks and vulnerabilities as they apply to gold mining across a range of key locations in which mining operations are sited. We then look at a range of company and mine site plans and actions focused on biodiversity conservation,** to better understand the current status of industry in addressing key risks and impacts, and its responses at a local level. Together, we hope these insights will represent a key initial step to support the gold mining industry in moving towards a more holistic view of the interconnectedness of environmental and social systems and how it might support greater resilience in both.

We begin this report by defining nature and biodiversity, before discussing the major governing bodies and frameworks. Besides national regulation, the main

1. *Mining and biodiversity: key issues and research needs in conservation science* (2018), Laura J. Sonter, Saleem H. Ali, and James E. M. Watson, The Royal Society
2. https://mining2030.org/issues/biodiversity-land-and-protected-areas/
3. See, for example, https://www.gold.org/esg/gold-and-climate-change

frameworks are the Kunming-Montreal Global Biodiversity Framework (GBF)[4] and the Task Force on Nature-related Financial Disclosures (TNFD)[5]. The GBF is an intergovernmental agreement specifying biodiversity targets and goals over the medium and long term. TNFD is a framework which provides guidance on how companies can assess, report and act on their nature-related dependencies, impacts, risks and opportunities. TNFD is very closely related to the well-established TCFD (Task Force on Climate-related Financial Disclosures), and this extension of climate-focused measurement and reporting processes to nature-focused considerations is also evident in the outputs and recommendations of the Science Based Targets Network (SBTN)[6]. The SBTN is a global alliance, which builds on the success and momentum of the corporate climate mitigation and decarbonisation pathways work of the Science Based Targets initiative (SBTi)[7], to help companies and cities set targets for both climate *and* nature.

The complex interconnections between nature and climate are now widely acknowledged and are increasingly reshaping our understanding of systemic risks and corresponding mitigation, adaptation and resilience strategies.[8] Simply put, there is now a firm and clear understanding that to stabilise the climate, we also need to preserve water resources and healthy oceans, regenerate land, and protect biodiversity.

Our key findings are derived from an analysis of 122 gold mines (owned and operated by our member companies) in the context of the nature- and biodiversity-related characteristics of their locales. Specifically, we apply a methodology (the ***Nature Risk Profile***) developed by the United Nations Environment Programme and S&P Global[9] to study company - and, in this case, mining site - impacts and dependencies around the world and across various biomes. The methodology is aligned with the LEAP approach set out in TNFD,[10] which offers a standardised and normalised assessment to allow for comparisons both between individual mines, and between mines and non-mining enterprises or sites (although we focus on the former, not the latter).

Using the *Nature Risk Profile* methodology we find, perhaps surprisingly, that **the majority of mines in our study have a relatively low impact on ecosystems.** But a selected number of mines are identified as having a high impact, which usually reflects a combination of high levels of 'Ecosystem Degradation'[11] in locations with high 'Ecological Significance'. These locations, and those overlapping with Protected Areas or Key Biodiversity Areas, are focal areas for risk management and are therefore given closer attention in this study. Our analysis seeks to highlight **areas of high 'Ecological Significance',** which can be driven both by their importance to species, but also by nature's 'Contribution to People'. Disaggregating these further gives insights into species that are protected and / or endangered, as well as into impacts that mining activities can have on local populations.

Dependencies describe nature's ecosystem services that businesses depend on for continued operation. For the gold mining industry, we find several materially significant ecosystem services – however, they are not equally material in all locations. These insights, in combination with an assessment of the current state of local ecosystems, allows for a more detailed picture of risks emanating from potential disruptions to essential ecosystem services.

These insights are then augmented by an examination of site-level considerations in order to better capture local nature-related risks and realities and offer a more in-depth analysis of what constitutes industry 'good practice' in addressing and mitigating those risks. Our local findings are summarised via a range of ***Case Study*** examples of (anonymised) mine sites, in contexts where, for example, they might both shed light on the benefits and limitations of our high-level analysis and risk metrics, whilst also representing **examples of good practice** in site-level responses to particular local challenges and conditions.

In the subsequent sections of this report, we use the learnings from our initial analysis – drawing, specifically, from the data provided by the S&P Global Sustainable1 team – mapping out the global biodiversity 'risk landscape' for gold mining (via the *Nature Risk Profile* methodology). This analysis is then overlaid and extended with the WGC's exploration of the current conditions, risks and responses at some of the mine sites of our member companies, to consider the implications for the wider gold mining sector. We have also included additional commentary on the status of key risk factors and impact drivers, framed by a consideration of current **industry reporting and disclosures** on nature and biodiversity-related risks and impacts.

Ultimately, we hope our findings will contribute to more informed discussions between gold mining companies and their many stakeholders, including local communities. By cultivating a deeper, shared understanding of the industry's environmental impacts, dependencies, risks, and opportunities, we can collaboratively identify and implement more robust strategies. This collective effort might then pave the way for enhanced environmental stewardship and the potential for achieving nature positivity.

4. https://www.cbd.int/article/cop15-final-text-kunming-montreal-gbf-221222
5. https://tnfd.global/
6. https://sciencebasedtargetsnetwork.org/
7. https://sciencebasedtargets.org/
8. See, for example, *Time to integrate global climate change and biodiversity science-policy agendas* (2012), N. Pettorelli et al., *BES Journal of Applied Ecology*, Vol. 58, Issue 11
9. https://www.unep.org/news-and-stories/press-release/unep-and-sp-global-sustainable1-launch-new-nature-risk-profile
10. *Guidance on the identification and assessment of nature-related issues: the LEAP approach* (2023), TNFD (tnfd.global)
11. See *Appendix 1* for a description of how ecosystem degradation is defined and measured.

2. Introduction to the Nature and Biodiversity Impacts of Economic Activity

Human societies, economies, and financial systems are deeply intertwined with the natural environment, which provides for human well-being via the provision of *natural capital* in the form of renewable resources – such as fertile soil, fresh air, water, plants and animals – and the ecosystem services these provide support businesses and economies, both directly and indirectly. Research suggests that an estimated US$44 trillion of economic value generation – more than half of the world's total GDP – is moderately or highly dependent on nature and its services.[12] Threats to these natural services are therefore a very significant socio-economic risk, with current declines in ecosystem functionality estimated to cost the global economy more than $5 trillion a year.[13]

Relatively recent disruptions in supply chains, caused by, for example, water shortages and congestion in major rivers like the Mississippi, Yangtze, and Rhine, underscore the significance of this interconnectedness.[14] Food supply chains may be particularly vulnerable to environmental stresses and shocks[15], but nearly all industries or sectors are exposed, to some extent, to the risks that will ripple across supply chains from stressed or failing ecosystems.

There is a scientific consensus that biodiversity is rapidly deteriorating, with several key areas of human activity having negative impacts. Scientists warn of a swift decline driven by human activities such as overexploitation of resources, pollution, climate change, and agricultural expansion. The *Stockholm Centre of Resilience,* represented by 28 eminent scientists, has identified nine planetary boundaries crucial for humanity's sustained development and prosperity, many of which intersect with biodiversity and ecosystem health. Research indicates that six out of the nine planetary boundaries have now been crossed, while the pressure on all them is increasing.[16] This state of emergency and existential threat is echoed in the stakeholder perceptions revealed by the World Economic Forum's *Global Risk Report*[17], which underscores that biodiversity loss and ecosystem collapse are now widely recognised as key long-term systemic risks. In this context, it is vital that we strive to better understand the various impacts that particular economic activities have on nature and biodiversity.

Red-Eyed Tree Frog, Nicaragua

12. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy* (2020), World Economic Forum
13. *The Biodiversity Crisis Is a Business Crisis* (2021), Torsten Kurth, Gerd Wübbels, Adrien Portafaix, Alexander Meyer zum Felde, and Sophie Zielcke, BCG
14. *Droughts Are Creating New Supply Chain Problems. This Is What You Need to Know* (2022), Ewan Thomson. World Economic Forum, https://www.weforum.org/agenda/2023/10/drought-trade-rivers-supply-chain/
15. *Towards food supply chain resilience to environmental shocks* (2021), Davis, K.F., Downs, S. & Gephart, J.A., *Nature Food* Vol. 2
16. *Earth beyond six of nine planetary boundaries* (2023), K. Richardson et al, Science Advances (Vol. 9, No. 37)10 idem
17. *The Global Risks Report 2024*, World Economic Forum

2.1 Defining Nature and Biodiversity

'Nature' refers to the natural world, emphasising the diversity of living organisms (including people) and their interactions among themselves and their environment.[18] Nature can be divided into four realms - ocean, land, freshwater and the atmosphere - which differ in their functioning and organisation.[19]

According to the Convention on Biological Diversity, 'biodiversity' describes the variability among living organisms across these natural realms (land, ocean, freshwater and the atmosphere). This diversity of living entities includes diversity both *within* species and *between* species, and of the ecosystems they comprise.[20] In other words, biodiversity encompasses the rich mosaic of all life on Earth, including plants, animals, bacteria and fungi; it refers to both genetic diversity and species variation, and also the intricate web of ecosystems.

Biodiversity and nature are intimately connected. While biodiversity constitutes a part of nature, not all elements of nature are living. Nature extends beyond living organisms to encompass everything else, from weather patterns to the expanses of the sea and mountain ranges. In essence, nature embodies the entirety of the natural world (excluding, perhaps, humanity[21]). In this report, we use the term *nature* to signify a broad reference to environmental factors and systems, and *biodiversity* is used more specifically when referring to living organisms - that is, flora (plants) and fauna (animals).

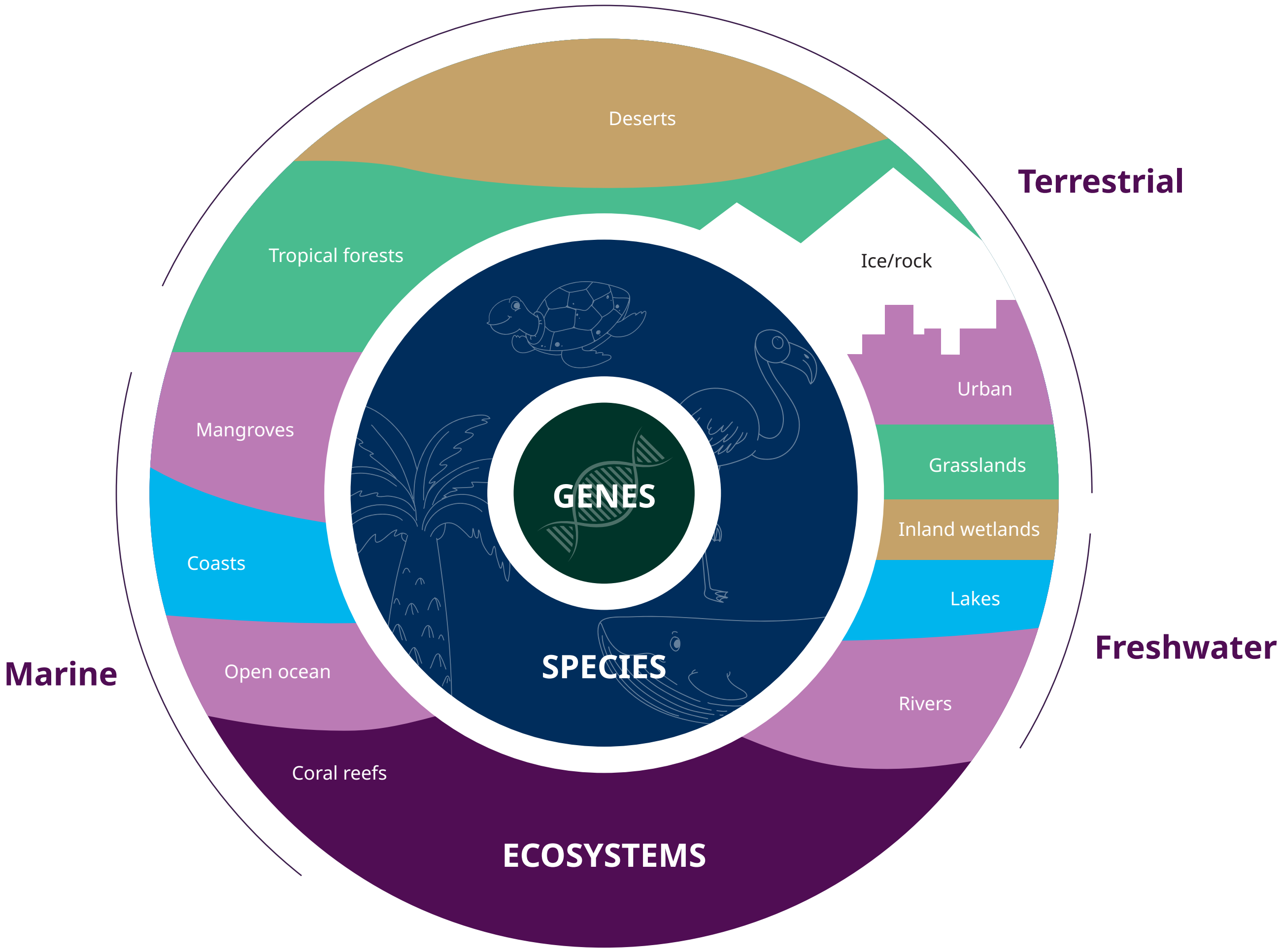


Figure 1. Nature and biodiversity – the range and variety of genes, species and ecosystems
(Adapted from 'The Biodiversity Crisis Is a Business Crisis' (2021), BCG)

18. *The IPBES Conceptual Framework — connecting nature and people* (2015), Díaz et al., Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)
19. There are, of course, other classifications which can be used to describe the Earth's systems – such as the five 'spheres': geosphere, biosphere, cryosphere, hydrosphere, and atmosphere.
20. *Convention on Biological Diversity* (1992), Convention on Biological Diversity, Article 2 Use of Terms
21. The question of whether *nature* should include humanity has caused much recent discussion, including a campaign (see https://wearenature.org/) which seeks a more inclusive definition than that featured in many dictionaries. The Oxford English Dictionary (OED) definition of nature, for example, clearly separates humankind from the natural world: "*The phenomena of the physical world collectively; esp. plants, animals, and other features and products of the Earth itself, as opposed to humans and human creations*".

2.2 Current Governing Bodies and Guidance

Several international conventions and treaties are in place to address biodiversity concerns. A pivotal treaty in this realm is the 1993 Convention on Biological Diversity, which aimed to delineate the sustainable utilisation of biodiversity and ensure fair and equitable sharing of benefits from genetic resources. Additionally, notable efforts include the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (1975) and the International Treaty on Plant Genetic Resources for Food and Agriculture (2004), both playing significant roles in safeguarding nature and biodiversity.

However, this paper will focus its attention on two recent frameworks that build upon these initiatives: the Task Force on Nature-related Financial Disclosures (TNFD) and the Kunming-Montreal Global Biodiversity Framework (GBF). These frameworks are particularly pertinent given ongoing endeavours to integrate financial, economic, and risk considerations concerning nature and biodiversity. Understanding these frameworks can provide insights into best practices and requirements amidst evolving scientific and societal consensus.

Plant Nursery, Greece

Kunming-Montreal Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (GBF) is a landmark framework addressing biodiversity loss.[22] Adopted by 196 countries during the 15th meeting of the Conference of the Parties (COP 15) to the UN Convention on Biological Diversity in December 2022, it replaces the Aichi Biodiversity Targets established in 2010[23], and outlines four primary goals, to be achieved by 2050, as described below:

- **Goal A:** Substantially increase the area of natural ecosystems by maintaining, enhancing or restoring the integrity, connectivity and resilience of all ecosystems. Reduce by tenfold the extinction rate and risk of all species and increase the abundance of native wild species. Maintain the genetic diversity of wild and domesticated species and safeguard their adaptive potential.
- **Goal B:** Ensure nature's contributions to people are valued, maintained and enhanced, with those contributions currently in decline being restored.
- **Goal C:** Share the monetary and non-monetary benefits of the utilisation of genetic resources, digital sequence information on genetic resources, and traditional knowledge associated with genetic resources with Indigenous people and local communities. Additionally, ensure traditional knowledge associated with genetic resources is appropriately protected.
- **Goal D:** Ensure all parties (specifically developing countries) have adequate means to implement the GBF. This includes financial resources, capacity building, technical and scientific cooperation, and access to technology.

The GBF also includes 23 specific targets for 2030 to enhance the framework and provide nearer-term guidance in ensuring progress on longer-term global goals. Amongst the most prominent targets are:

- Restore 30% of all Degraded Ecosystems
- Conserve 30% of Land, Waters and Seas

In light of the limited success achieved by the 2010 Aichi Biodiversity Targets, efforts have been applied to establish a more robust monitoring framework and reporting mechanism for the GBF targets. The aim of this monitoring framework is to ensure consistent and standardised tracking of global goals and targets.

22. https://www.cbd.int/gbf
23. https://www.cbd.int/sp/targets

Currently, work is underway to develop indicators and methodologies for the 23 targets.[24]

The effective achievement of the GBF relies on domestic targets and actions, reflected in National Biodiversity Strategies and Action Plans (NBSAPs). All participating countries are required to revise their NBSAPs to align with the framework's ambitious goals to reverse biodiversity loss by 2030. The level of response and action on these commitments has, to date, been mixed and a review of the first wave of national plans submitted by nations in advance of COP16 (in October 2024) suggests they are failing to be ambitious enough to meet the GBF's key targets: *"With 5 years remaining until the intended realization of the GBF, countries will need to increase both their ambition and action if the biodiversity crisis of the Earth is to be abated."*[25]

As we have witnessed in the implementation of low carbon energy systems and infrastructure, the vacuum created by government delays or inaction may, in some countries, be at least partially filled by responsible, pro-active corporate entities striving to implement positive environmentally focused actions at or near their operations. Gold mining companies operating in remote and relatively undeveloped locations frequently find they are the 'first movers' in defining and implementing solutions that may then contribute to regional or national capacity and progress with potential positive environmental outcomes.

The Relevance of the Global Biodiversity Framework to Gold Mining

In addition to prompting companies to act in a more systematic way to relieve pressures on ecosystems, the framework will likely affect mining companies in several ways, including **how they approach reporting on their biodiversity impacts, manage their biodiversity risks, and fund nature-positive projects.** In addition to its implications for company risk mitigation strategies, the framework may also provide opportunities for the development of more integrated and holistic approaches to mining's socio-environmental impacts which may, in turn, help mine sites build and cement stronger symbiotic bonds with local stakeholder groups and neighbouring communities.

Below, we outline key targets and aspects of the framework that may significantly impact mining companies.

Monitoring biodiversity impacts

Target 15 of the framework affects businesses most directly. It states that parties[26] shall promote and ensure that large and transnational companies and financial institutions fulfil a range of obligations:

- Regularly monitor, assess, and transparently disclose their risks, dependencies, and impacts on biodiversity, including requirements for all large as well as transnational companies and financial institutions along their operations, supply and value chains, and portfolios.
- Provide needed information to consumers to promote sustainable consumption patterns.
- Report on compliance with access and benefit-sharing regulations and measures, as applicable.

These requirements focus on large and transnational companies and financial institutions because they potentially have a sizeable net impact on biodiversity. Any improvements in their monitoring, assessment, and disclosure processes and outputs might therefore have significant consequences in generating positive outcomes for biodiversity. This may impact international mining companies if, for example, they need to set up new monitoring systems that enable them to better report on their biodiversity impacts. Although there are clearly cost and resource implications associated with building new or enhanced capacities – to allow companies to report in ways that are demonstrably aligned with global disclosure frameworks – there are also clear benefits. Improved monitoring of local biodiversity should provide companies with greater knowledge and data, leading to the development of more robust and integrated environmental management strategies. Furthermore, the process of deepening the mine operator's understanding of surrounding ecosystem risks and impacts should also present opportunities for local information exchange, potentially contributing to stronger collaborative relationships with local stakeholders and communities.

Limiting pollution

Target 7 underscores the necessity to reduce pollution risks from all sources by 2030, aiming for levels that are non-detrimental to biodiversity. Mining is an industrial process that is potentially reliant on possibly harmful substances for minerals extraction and could therefore be affected by this target. Whilst there are already considerable regulations applied to

24. https://gbf-indicators.org/
25. *Ambitions in national plans do not yet match bold international protection and restoration commitments* (2025), Justine Bell-James & James E. M. Watson., *Nature Ecology & Evolution*, Vol. 9
26. In UN terminology, *parties* here refer to the entities – typically, nations - that have agreed to be bound by the terms of an agreement or treaty.

(and precautionary measures taken in) the handling of potentially toxic and hazardous materials, mining companies might need to further reevaluate these practices, focusing on the imperative to protect local biodiversity. If compliance with targets requires additional action, such as more stringent monitoring and associated new equipment and operational or management processes, this may increase operational costs. However, such costs might also be evaluated against the potential costs of inaction, non-compliance or system failure, and consideration might be given to the value of the additional resilience associated with enhanced pollution and waste management controls.

Eliminating harmful subsidies

Target 18 states that subsidies for activities and commodities that negatively impact biodiversity shall be eliminated or reformed by at least US$500 billion per year until 2030. Mining operations may benefit from national subsidies which, if reassessed and restructured or redirected (or even eliminated), could result in increased operational costs or require substantial adjustments in business strategy. However, the academic literature identifying subsidies associated with mining operations tends to assume that such operations are intrinsically environmentally harmful without offering sufficient evidence of the linkage between specific subsidies and activities deemed to negatively impact biodiversity.[27]

Integrating human rights

It should be noted that the GBF represents **a significant advance in integrating human rights into environmental policy** and actions. Indigenous peoples and local communities are identified as custodians of biodiversity and partners in its conservation, restoration, and sustainable use. This inclusion is highly significant when we consider that Indigenous peoples and local communities are estimated to collectively hold over half of the world's land under customary tenure[28] and studies have found that when Indigenous peoples have the right to govern their land, biodiversity increases and forests are better protected.[29]

The mining industry has increasingly come to recognise that respecting and protecting human rights helps companies to bolster transparency, accountability, and their social license to operate, whilst also promoting long-term conservation benefits. For example, the International Council on Mining and Metals (ICMM) recently reaffirmed the commitment of its members in respecting the rights of Indigenous groups and recognising their importance as partners in the development of sustainable mining projects on their lands and territories.[30] These perspectives are also reflected in the World Gold Council's RGMPs, and it can be argued that initiatives like the GBF, which encourage **a more integrated view of the social implications of conservation strategies,** will likely reinforce the case for the diligent application of industry frameworks focused on ensuring responsible and sustainable mining practices.[31]

Task Force on Nature-related Financial Disclosures (TNFD)

The *Task Force on Nature-related Financial Disclosures* (TNFD) is an international initiative that has developed a framework for disclosing and managing nature-related financial risks. In September 2023, it launched its final recommendations, which are enabling and shaping the way companies report on their use of natural resources, nature-related risks, and how they integrate such considerations into their overall strategy.[32] TNFD recommendations are structured around four key pillars:

- **Governance:** Disclose the organisation's governance of nature-related dependencies, impacts, risks, and opportunities.
- **Strategy:** Disclose the effects of nature-related dependencies, impacts, risks, and opportunities on the organisation's business model, strategy, and financial planning, where such information is material.
- **Risk & Impact Management:** Describe the processes used by the organisation to identify, assess, prioritise, and monitor nature-related dependencies, impacts, risks, and opportunities.
- **Metrics and Targets:** Disclose the metrics and targets used to assess and manage material nature-related dependencies, impacts, risks, and opportunities.

Although the TNFD recommendations contain a range of reporting guidelines that many organisations may still not be wholly familiar with, it is also likely that some of those companies will already be collecting or reporting on information that will allow them to implement and align with the Taskforce guidance. This is especially true for entities already adhering to TCFD recommendations, which share a similar structure and are closely aligned with the TNFD guidelines.

27. See, for example, the discussion of the possible environmental implications of 'metals mining' subsidies in *The costs of subsidies and externalities of economic activities driving nature decline* (2025), Reyes-García, V., Villasante, S., Benessaiah, K. et al., *Ambio*, Vol. 54
28. *The tragedy of public lands: The fate of the commons under global commercial pressure* (2011), International Land Coalition
29. *Indigenous peoples proven to sustain biodiversity and address climate change: Now it's time to recognize and support this leadership* (2021), *One Earth*, Vol. 4, Issue 7
30. https://www.icmm.com/en-gb/our-principles/position-statements/indigenous-peoples
31. See also the *Consolidated Mining Standard Initiative* (*https://miningstandardinitiative.org/*), which is seeking to combine and harmonise these different industry standards
32. These recommendations very much mirror the structure and direction of the climate-related guidance of the Task Force on Climate-related Financial Disclosures (TCFD), and there is some expectation that over time the climate- and nature-focused disclosure frameworks will merge.

Recognising the substantial variations in companies' impacts on nature, TNFD has issued sector-specific recommendations for various industries, such as metals and mining.[33]

The Relevance of TNFD to Gold Mining

The TNFD is a voluntary framework, and no regulator has adopted it as part of national regulation yet. However, at the time of writing, over 500 organisations from over 54 jurisdictions and 62 different sectors have committed to implementing the TNFD recommendations.[34] This includes high-profile financials and corporates. As such, it is anticipated that TNFD will increasingly shape market trends and reporting expectations in the coming years. ICMM is the official TNFD piloting partner for the mining and metals sector and has led the development of TNFD's sector-specific guidance, supporting mining companies in managing the risks and nuances of specific relevance to the industry.

Moreover, the TNFD is not an actionable manual, but a framework for identifying business risks and dependencies on nature. To establish concrete goals, the TNFD refers to the Science Based Targets Network (SBTN), which will establish processes to set specific targets for areas such as water and land use.

For adopters, the TNFD recommends a four-stage process to assess the management of nature-related risks and opportunities, which it calls **'LEAP'** – a mnemonic for **Locate, Evaluate, Assess and Prepare.** The approach aims to facilitate and guide how companies evaluate their business interaction with nature, their exposure to nature-related risks, and the potential opportunities that may arise from their interactions and responses.

The enhanced reporting and risk management practices expected from TNFD adopters necessitate additional data collection, the setting of metrics and targets, and improved risk management processes specifically tailored to nature-related risks. Rather than producing a one-size-fits-all solution for adopters, the TNFD invites companies to self-examine and enhance transparency within their disclosures. That said, the framework prompts companies to use a shared set of sector-specific metrics and indicators that will help stakeholders, particularly financial institutions, to compare organisations which, within the mining sector, are likely to be facing similar nature-related issues.

Overall, the TNFD recommendations should help mining and gold mining companies integrate nature-related considerations into their decision-making processes, promoting and enhancing sustainable and responsible mining practices.

Responsible Gold Mining Principle 9

The World Gold Council has been highly supportive of the development of this sector guidance, not least as it formalises commitments embedded in its Responsible Gold Mining Principles. Principle 9 (*Biodiversity, land use and mine closure*), for example, states that adhering companies *'will work to ensure that fragile ecosystems, habitats and endangered species are protected from damage, and will plan for responsible mine closure'*. More specifically, **Principle 9.1** asks companies to commit to the following:

- Implement biodiversity management plans.
- At a minimum, seek to ensure that there is no net loss of critical habitat.
- Where opportunities arise to do so, to work with others to produce a net gain for biodiversity.
- To incorporate both scientific and traditional knowledge in designing adaptation strategies in ecosystem management and environmental assessment.

Additional clauses include commitments to minimise deforestation and plan for the environmental and social aspects of responsible mine closure, whilst in consultation with (and giving meaningful consideration to the needs of) local communities.[35]

The ICMM's Guidance on "Achieving No Net Loss or Net Gain of Biodiversity"

The International Council on Mining and Metals (ICMM) has produced a detailed 'good practice' guide[36] outlining a seven-step process applicable at each stage of the mining lifecycle, from project design to production and post-closure. This process helps companies establish baseline assessments, apply the mitigation hierarchy, and transparently disclose progress towards their *'No Net Loss'* (NNL) or *'Net Gain'* (NG) biodiversity goals.

The **recommended seven steps** are:

1. Establishing a Biodiversity Area of Analysis (AoA):

Companies are guided on how to establish a comprehensive biodiversity Area of Analysis, which is foundational to establishing an effective baseline.

33. The sector guidance for metals and mining was published in draft form in December 2023. Following a stakeholder consultation process and incorporation of industry feedback, a further version of the guidance was published in July 2024. See https://tnfd.global/publication/additional-sector-guidance-metals-and-mining/
34. https://tnfd.global/tnfd-adoption-now-over-400-organisations-and-new-sector-guidance-released/
35. For an introduction to 'adaptive managment', see *Adaptive Management: A Science-Based Approach to Managing Ecosystems in the Face of Uncertainty* (2003), Murray and Marmorek, 5th International SAMPAA Conference
36. https://www.icmm.com/website/publications/pdfs/environmental-stewardship/2025/guidance_nnl.pdf

2. Baseline Assessments:

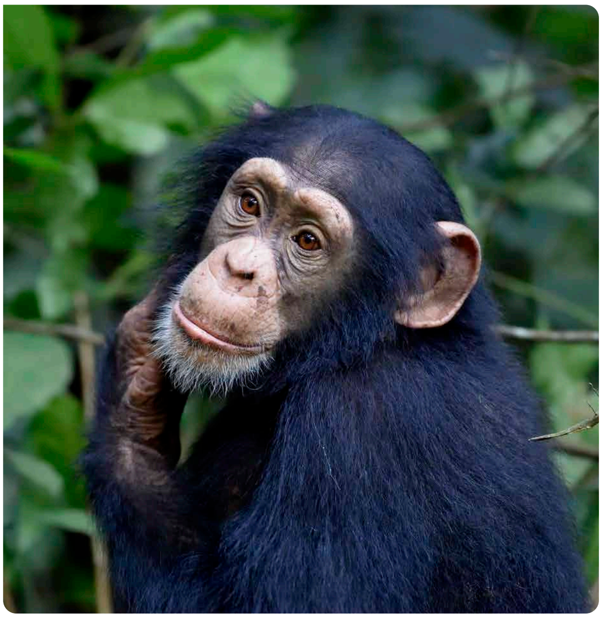
The importance of robust baselines is emphasised, with guidance provided for conducting new or retrospective baselines.

3. Biodiversity Indicators and Metrics:

The guide outlines ways companies can measure progress towards NNL or NG of biodiversity using biodiversity indicators within a Pressure-State-Response framework.

4. Mitigation Hierarchy:

An iterative approach to assessing impacts and effectively applying the mitigation hierarchy is detailed to support the achievement of biodiversity goals.



West African Chimpanzee, Guinea

5. Offsetting Residual Impacts:

Guidance is provided on undertaking quantitative residual impact assessments and outlining good practice offsetting principles to achieve biodiversity outcomes.

6. Monitoring and Adaptive Management:

Explanations are offered of the rationale for monitoring progress of biodiversity conditions and impacts, and the value of applying an adaptive management approach given the inherent and ongoing uncertainties associated with conservation locations and plans.

7. Transparent Disclosure:

The guide identifies the biodiversity-focused disclosures required of ICMM members, as well as other associated regulatory or voluntary commitments and how these might be achieved.

Local Regulation

Biodiversity-specific regulation is still in its early stages. However, many countries have implemented environmental legislation with biodiversity and conservation objectives. In Appendix 3, we highlight a number of local regulatory initiatives, milestones, and recent developments. These are still emerging and evolving rapidly, and although momentum was, until recently, gathering at pace and scale, there is still a strong indication of global trends to embed nature-focused considerations within legal and policy frameworks, including in countries that host significant mining activity. However, we also need to acknowledge that recent geo-political shifts, and policy decisions that have explicitly pivoted away from environmental science, have raised challenges and increased uncertainties regarding the direction and resilience of legislative changes.

3. Identifying and Measuring Gold Mining's Nature-Related Risks

3.1. Methodology

To provide an overview of the global nature-related risk landscape, as it pertains to gold mining operations, we use the ***Nature Risk Profile*** methodology developed by the United Nations Environment Programme and its World Conservation Monitoring Centre (UNEP-WCMC) and S&P Global.[37] This methodology is also in line with the TNFD framework and the *LEAP* process. As part of this methodology, we overlay mine site-level data with nature-related geospatial data, allowing us to identify and assess in a comparable way the nature-risk profile of gold mining assets (mine sites) operated by the World Gold Council's members (and, by implication, the risks likely associated with the wider gold mining sector). This approach is especially useful to assess and compare nature-related risks within and across a diverse set of assets in a normalised way, using a common set of metrics. This analytical perspective is particularly useful to investors and industry leaders considering the risk profiles of multiple assets and sites. However, as we explain in later sections of this report, this investor-focused lens to identify hotspots of risk must also be complemented by localised site-level analysis.

The *Nature Risk Profile* methodology, at its core, distinguishes between nature-related risks as *impacts* and *dependencies*. 'Impact' refers to changes in the state of nature that can potentially affect the capacity of nature to provide social and economic functions. 'Dependency' refers to the degree to which an asset or a business in a given location is dependent on ecosystem services (as defined by ENCORE[38]). For a more detailed description of the methodology, the relevant factors and their decomposition into sub-factors, please refer to *UNEP's Nature Risk Profile Methodology* documentation.[39]

Although this methodology allows for normalised comparisons across sites and locations, there are inevitable compromises and limitations in how data and metrics are used to represent local conditions and impacts. These are summarised in the comments on *Methodological Limitations*, below.

The members of the World Gold Council are committed to addressing pertinent environmental factors and impact drivers, not least via the *Responsible Gold Mining Principles* (and other industry standards focused on improving sustainability performance[40]). As part of this commitment, companies have put in place biodiversity management plans that may have implications for how nature risk indicators are interpreted, which we reference throughout this document to complement and enhance our high-level analysis. However, detailed assessments of specific plans and actions are beyond the scope of this study.

Impact Metrics

Impacts are made up of two sub-factors, which are the magnitude of the impact and the significance of the location.[41]

'Magnitude of impact': Refers to the scale and size of impact on nature in a given location. It is a measure for capturing the level of ***Ecosystem Degradation.***

'Significance of location': Refers to the ***Ecological Significance*** of a location that is impacted by the business or specific operations. It is a measure of how valuable the location is for biodiversity conservation as well as for people and society.

37. https://www.unep.org/news-and-stories/press-release/unep-and-sp-global-sustainable1-launch-new-nature-risk-profile
38. ENCORE is a tool maintained and continously improved by the ENCORE Partnership between Global Canopy, UNEP FI and UNEP-WCMC (https://encorenature.org/en). As applied in our analysis, it described 21 ecosystem services that business rely on, although this has since been expanded to 26 – see *Appendix 1* for further details.
39. *Nature Risk Profile: A methodology for profiling nature related dependencies and impacts* (2023), UNEP (https://resources.unep-wcmc.org/products/WCMC_RT496)
40. See also, for example, the Biodiversity Conservation Management Protocol from the Minerals Council of Australia (MCA) – an extension of its Towards Sustainable Mining (TSM) Guiding Principles (https://content.tsmining.com.au/wp-content/uploads/2023/03/MCA-TSM-Biodiversity-Conservation-Management-Protocol-Australia-2022.pdf)
41. For a detailed description of these metrics, consult the *Nature Risk Profile Definitions – Impacts and Dependency Metrics* section of *Appendix 1*.

A higher level of **Ecosystem Degradation** and a higher **Ecological Significance** are the principal drivers of negative impacts. These effects are assessed on the physical location of the mining asset – in this analysis, this is primarily scoped with reference to the scale and dimensions of the mine site, not the total land licensed or controlled under the company's mining concession.

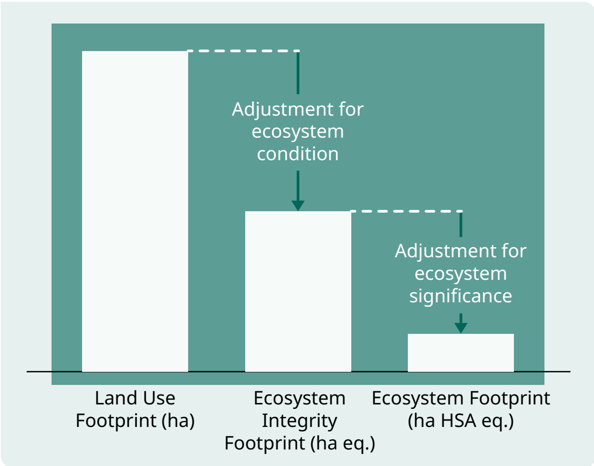


Figure 3. Conceptual approach to assess ecosystem impacts

The starting point of the analysis is the physical footprint of the mine (in hectares), referred to as the ***'Land Use Footprint'*** (or *Land Area Impacted*), which is assessed via satellite imagery. The land use footprint is adjusted to reflect the condition of the ecosystem, using the **'Ecosystem Integrity Index'**, to then arrive at the **'Ecosystem Integrity Footprint'**.

Ecosystem Integrity Index (EII)

The '*Ecosystem Integrity Index'* is a metric designed to assess the overall health and functionality of terrestrial ecosystems on a global scale. It combines three key components:

'Structure': This refers to the physical organization of an ecosystem, including the arrangement of its various elements such as vegetation layers, water bodies, and soil composition.

'Composition': This involves the diversity and abundance of species within the ecosystem, reflecting its biological richness.

'Function': This assesses the ecological processes and interactions that sustain the ecosystem, such as nutrient cycling, energy flow, and habitat provision.

The EII is measured against a natural baseline, representing the ecosystem's potential state without human interference, on a scale from 0 to 1. A higher EII value indicates a healthier and more intact ecosystem.

Ecosystem Integrity Footprint (EIF)

The '*Ecosystem Integrity Footprint'* is a measure used to assess the impact of human activities on the health and functionality of ecosystems. It evaluates how different actions, such as land use changes, pollution, and resource extraction, affect the natural processes and biodiversity within an ecosystem. It essentially strives to measure the degree to which human activities degrade or maintain the integrity of ecosystems, allowing for summary estimations of environmental sustainability.[42]

Ecosystem Significance Index (ESI)

The '*Ecosystem Significance Index'* is a composite metric that measures the relative environmental and ecological importance of a given geographic area in terms of its contribution to biodiversity conservation and the provision of ecosystem services – potentially critical both locally and globally. It is calculated based on the maximum value between **'Species Significance'** (reflecting the importance of a location for species conservation, rarity, and biodiversity) and **'Ecosystem Contribution'** (reflecting the relative importance of a location for the provision of ecosystem services to people, communities and society).

The 'Ecosystem Significance Index' is used as a relative weighting factor in the calculation of the **'Ecosystem Footprint'**, which integrates the physical land area impacted with the quality and significance of the ecosystem affected.

The relationship between the 'Ecosystem Footprint' (that is, the *ha. HSA eq.* metric[43] in ***Figure 3***) and the 'Land Use Footprint' (*ha*) is another metric to assess relative impact intensity, which is referred to as the ***'Impact Ratio'*.**

$$\text{'Impact Ratio'} = \frac{\text{'Ecosystem Footprint' (ha HSA eq)}}{\text{'Land Use Footprint' (ha)}}$$

A high 'Ecosystem Footprint' compared to the 'Land Use Footprint' - resulting in a larger '*Impact Ratio'* - points to a higher ***concentration of impact*** and can be used to compare assets of different sizes. This is the indicator we are generally referring to when commenting on the high-level impact of a mine on its local environment (unless a specified more granular impact metric is under discussion).

42. The Ecosystem Integrity Footprint (EIF), unlike the Ecosystem Integrity Index (EII), doesn't have a single standardised metric or scale. It does, however, allow for a scoring system to be developed to quantify the extent of a particular impact (or impacts) based on specific indicators relevant to the ecosystem being studied, such as species loss, habitat degradation, or changes in water quality.
43. 'ha HSA eq' stands for 'hectares-equivalent of the most pristine and significant area globally'.

Enhancing the *Nature Risk Profile* with Site-level Insights

MINE #1, NICARAGUA

Mine #1 is a site rated as being of 'Moderate Impact' on the local ecosystem. While the 'Species Significance Index' is very low for this location, the 'Ecosystem Contribution Index' is high, driven by the significance of threats to the local forest ecosystem and its associated services.

Reviewing the site-level actions and plans, we can identify an awareness of the importance of the local forest and polices and initiatives in place to mitigate the mine site's impacts. Only necessary vegetation is cleared, with seeds collected for rehabilitation. The company plants ten trees per every one removed. In 2023, they produced 129,260 trees in Nicaragua, surpassing their 70,000-tree target. Their nurseries produce over 100,000 seedlings annually, with 91% survival rates, and their reforestation efforts involve both local communities and government institutions.

In addition, the mine owners have taken a proactive stance towards preventing biodiversity loss, even though the *Nature Risk Profile* indicators and metrics appear to suggest low 'Species Significance' threats and that the pressures come from elsewhere. Specifically, the threats to species, distributed across amphibians and birds and, to a lesser extent, to mammals, are largely attributed to agro-industry, local livestock farming and ranching, and hunting. Mining is not identified as a material source of 'pressure'.

Although the site is not identified as an ecologically sensitive area, the company has implemented a biodiversity monitoring programme, with surveys undertaken every six months to identify affected species. The site's owners specifically reference the Kunming-Montreal Global Biodiversity Framework (see above) in their efforts to integrate biodiversity protection measures at their operations.

Tree planting, Nicaragua

Dependencies

Dependency risks are, at the highest level, made up of two sub-factors: the level of **'Reliance'** on an ecosystem service and the level of **'Resilience'** of an ecosystem service. Ecosystem services are the various benefits that ecosystems provide to humans and society.[44]

'Reliance': Refers to the degree to which a particular ecosystem service is material to the type of business and the relevance of the ecosystem service in the region.[45]

'Resilience': Refers to the ability of an ecosystem within which a business operates to sustain a continued flow of ecosystem services.

The more reliant a business is on an ecosystem service, and the more the ecosystem service is at risk of breaking down, the higher the dependency.

Methodological Limitations

We acknowledge that the granularity and level of geographic specificity of some indicators or 'inputs' in our *Nature Risk Profile* analysis (with the key finding detailed in Section 4 of this report) may not always fully capture localised conditions as experienced at a site level. That is, in adopting this methodology, we accept we are examining sites in a manner that may mask some localised risks and opportunities.

The main limitations in the current state of the *Nature Risk Profile* methodology are as follows:

- **Attribution to operations:** Certain elements of the methodology capture only the totality of human pressures on the ecosystem. They are not necessarily site-specific or may be associated with

44. The relevant ecosystem services for the mining industry are: ground and surface water; water flow maintenance; climate mitigation; and mass stabilisation and erosion control.
45. For example, while the ecosystem services related to the provision of water are material for the mining industry, their functioning is most relevant in areas of high water 'stress'.

(or reflective of) additional or 'external' operations and actions. In addition, metrics seeking to refer to mining impacts make no distinction between formal, regulated mining and unregulated, often illegal activity – typically associated with Artisanal or Samm-scale Mining (ASM) activity. This latter limitation may, partially, be mitigated by applying the methodology to a tight 'area of analysis', defining a perimeter around the formal mining operation (not the full concession) which seeks to focus on a fairly exact location to derive quite locationally specific data. But several Case Studies presented here highlight the challenge of translating indicators into solution-focused actions if the data does not support insights that particular conditions or impacts can be linked mine site operations or their consequences. This challenge is also intrinsically related to the limitation, described below, of a lack of historical or temporal perspective in the *Nature Risk Profile* approach.

- **Temporal and mine lifecycle perspectives:** This analysis sets out to provide a 'snapshot in time' of the state of nature around specific mining operations. That means improvements over time and the trajectory of the ecosystem condition are not captured by a single observation but, rather, would need to be observed between different analyses (observation) dates. The impact of a mine will also vary substantially over its lifecycle. Some of the impacts may stem from mining or other human activity before the commencement of the current operations but the *Nature Risk Profile* data does not allow impacts to be attributed to past activities. That said, the current state of nature is assessed (in 'risk profiling') as a consequence of current or ongoing pressures and, even if such pressures may have started before the operations at a particular mine, they are likely still relevant to local actors seeking to improve ecosystem performance and resilience. Fortunately, we see evidence in a number of our Case Studies that many mine sites accept responsibility for positive nature-focused interventions even where there appears to be no direct link between their activities and the ecosystem. Lastly, plans for post-closure activities may support the future rehabilitation or restoration of the ecosystem, but an aspirational or 'target' future state cannot be considered at this point in time.

- **Granularity of impact:** The methodology follows a top-down approach, combining numerous sources of data. These range from highly granular inputs related to local species habitats as per IUCN, all the way to satellite imagery. To enable a standardised, transparent, globally applicable and comparable approach, the level of analysis is typically on a 1x1kilometre perimeter. Within the cells of this grid, naturally, there may still be substantial variance in site-based data, and some aggregate measures might be skewed by exceptional/'extreme' data from specific sources. Inversely, some localized aspects might not be captured due to the averaging effect at this resolution.

- **Consideration of local or alternative sources:** The data sources used in the methodology capture a wide range of issues, alongside issues related to species, human well-being, economic activity and business risk — all of which seek to follow the most stringent scientific principles applied by reputable organisations (e.g., UNEP-WCMC, IUCN, NASA). However, there will be certain inputs that are not part of the methodology, for example, national laws or nationally protected species.

- **Consideration of compensatory actions and 'offsetting':** The National Risk Profile analysis is confined to the perimeter of the mining operations. That means that activities in an adjacent area - such as reforestation, or the relocation of species - will not be considered. Initial analysis interpreted these actions, beyond the immediate area of analysis, as being positioned as direct compensatory actions seeking to balance (or offset) negative impacts within the mine's direct perimeter. However, while there is an ongoing debate around the relative merits of such activities, and whether they can effectively compensate for disruptive impacts, we note that many actions (documented in our Case Studies) beyond mine sites were not initiated, defined or measured as 'offsets'. As the *Nature Risk Profile* metrics only apply to a very specific location, they cannot offer insights on either type of action – those scaled as directly compensations or those that are more extensive and ambitious.

The methodological challenges described in this report arise in large part due to the tension between the complexity and highly location-specific subject matter on the one hand, and the need for globally applicable, standardised methodologies on the other.

Some key aspects biodiversity, such as freshwater ecosystems, are simply not yet covered by the *Nature Risk Profile*, although its developers are aware of these omissions and state they may be covered in future iterations. This limitation also highlights the benefits of our additional site-level analysis, which can look beyond the above limitations (and still undeveloped indicators), as evidenced in those Case Studies which, for example, highlight freshwater ecosystem improvements.

46. *Ecological civilization: China's effort to build a shared future for all life on Earth* (2021), Fuwen Wei, Shuhong Cui, Ning Liu, Jiang Chang, Xiaoge Ping, Tianxiao Ma, Jing Xu, Ronald R Swaisgood, Harvey Locke, *National Science Review*, Volume 8, Issue 7
47. *What is Sumak Kawsay? A Qualitative Study in the Ecuadorian Amazon* (2021), C. A. Coral-Guerrero, F. García-Quero, & J. Guardiola, *Latin American Perspectives*, Vol. 48, Issue 3
48. *https://www.centerforenvironmentalrights.org/news/press-release-rights-of-nature-victory-in-ecuador*
49. https://apnews.com/article/brazil-environment-protection-bill-climate-fb3fb4207bd6c6ae4e0e6c85399c4c39
50. Federal Decree No. 12,017/2024; and Resolutions No. 42/2024; No. 43/2024; and No. 44/2022, from the Genetic Heritage Management Council
51. https://www.unep.org/news-and-stories/press-release/unep-and-ministry-environment-sign-agreement-reinforce-environmental

However, regardless of the limitations of the *Nature Risk Profile* methodology, the application of this approach is highly relevant when we consider it represents the lens through which many investors and stakeholders will view or assess the nature-related conditions and impacts of gold mining locations and operations. Even without a historical perspective, the ability to derive 'snapshot' locational risk profiles is of particular value when used to establish 'indicative' and broadly comparable baselines from which future progress can be tracked.

Furthermore, and importantly, we have sought to compensate for these methodological limitations by including additional site- and company-level insights (as summarised in the featured Case Studies) to overcome some of the challenges of using high-level, aggregate scores and static 'snapshot' data. Examining a range of sites in different locations and biomes, whilst reviewing recent company and site plans, allows us to present a more detailed perspective on the gold mining industry's plans and actions to address localised nature and biodiversity risks. Whilst not comprehensive, these case studies represent a wide range of examples of site-level sensitivities and responses, with sufficient detail to counter some of the limitations of a top-down methodology and metrics. Ultimately, we suggest a combinational approach is needed. That said, to define and implement practical solutions, localised knowledge and data is of prerequisite importance.

Note that, in describing some of the key features from our examination of a number of local mine sites (for the featured Case Studies), we have chosen to anonymise the mine sites and owning or operating company. This is simply because we primarily want to direct attention to specific site characteristics, key biodiversity impacts, and company and site-level responses of potential relevance to the wider industry. The owning/operating companies of these mines are not specified here but we have reviewed their corporate disclosures and plans to extract relevant insights regarding their associated strategies and plans, particularly as they relate to the local sites we examined. Please note again that no company or site requested anonymity - this choice was simply made by the report's authors to encourage the reader's focus on salient (site-level) details.

The Challenge of Attributing Ecosystem Degradation Impacts

MINE #2, CANADA

The challenge of attribution and determining the local relevance of high-level 'Ecosystem Degradation' metrics is reflected in an examination of Mine #2, selected from our wider sample on the basis of its apparent high impact (as identified via the *Nature Risk Profile* methodology). This mine scores the highest of all the mines we examined in terms of its level of degradation. More specifically, its extreme score (1.0/1.0) reflects the local environment's functional inability to provide ecosystem services – its reduced 'productivity' - compared to its ideal 'natural' state. However, this metric does not provide information on the activities that might have caused this degradation and when or how it might have occurred.

Examining the location in more detail, we discover that although the current site was first developed into a productive gold mine in 2008, the location has been extensively explored over the last century, and industrial development projects have been implemented in previous decades. Therefore, whilst consideration of local history and land use here offers us a stronger indication that gold mining has played a significant part in reducing the net productivity of the ecosystem, the data does not offer insights into the sources of degradation, or the current activities' marginal impact compared to its pre-2008 baseline.

Another current limitation in the *Nature Risk Profile* methodology is that it offers no indicators of the potential future profile or 'trajectory' of ecosystems. Without more granular data and an associated time series, any consideration of trends and future impacts – and potential improvements in ecosystem services – will likely require a closer examination of current site-level responses and plans (and associated corporate disclosures). Exploring disclosures relating to plans at Mine #2, for example, we note a rehabilitation project to detoxify abandoned tailings and reclaim local land that is already having a positive impact – with the site operators reporting that "as rehabilitation progresses many species of flora and fauna have returned to the surrounding wetlands".

Rehabilitated tailings site, Canada

Nature-related Risks

Impact on nature

Metric:
Ecosystem Footprint (***EF***)

Unit:
Hectares of Highest Significant Area equivalent (ha HSA eq.)

Interpretation:
An indicator expressing nature-related impacts as an area equivalent to a mine site's total physical footprint perceived as fully degraded if the impact took place in the most significant ecosystem

Magnitude of impact

Scale and size of nature-related impacts in a given location

Metric:
Ecosystem Integrity Footprint (***EIF***)

Unit:
Hectares equivalent (ha. eq.)

Interpretation:
'Condition-adjusted' footprint of the site's operations, considering the size and degradation of the land area

Significance of location

Ecological importance of a given location

Metric:
Ecosystem Significance Index (***ESI***)

Unit:
0 (lowest) — 1 (highest)

Interpretation:
A measure of the value of the ecosystem (in which the asset is sited)

Dependency on nature

Metric:
Dependency Score

Unit:
0 (lowest) — 1 (highest)

Interpretation:
A risk indicator expressing **a)** the level of reliance a business has on different ecosystem services and **b)** the risk to the resilience of those ecosystem services in the location(s) where the business operates

Reliance on ecosystem service

Extent to which company activities depend on ecosystem services

Metric:
Reliance score

Unit:
0 (lowest) — 1 (highest)

Interpretation:
A measure of the extent to which the business/asset relies on an ecosystem service. Reliance determines the level of risk exposure

Resilience of ecosystem service

Risks to the ability of ecosystems to reliably provide a service that a company relies on

Metric:
Resilience score

Unit:
0 (lowest) — 1 (highest)[52]

Interpretation:
Risks to the ability of an ecosystem (within which a business operates) to sustain a continued flow of ecosystem services. Resilience determines the likelihood of risk

Figure 2. *Nature Risk Profile* Methodology - Key Measures and Metrics

52. A high score means high risk/low resilience; a low score means low risk/high resilience.

4. Ecosystem Impacts and Dependencies of Gold Mining

In this chapter, we describe the results of our initial examination of the relationship between ecosystems and gold mining assets. We begin with a broad overview of the mining assets in scope before discussing the associated environmental impacts and dependencies.

4.1. Descriptive Statistics – Sample Mines

In this section, we describe the individual gold mining assets of the member companies of the World Gold Council covered by this study.[53] The sample is restricted to mines with gold as the primary commodity. It only includes productive mines, or those initiating closure activities (but still defined as operational) in 2023. **In total, this resulted in 122 individual gold mines across 34 countries.**

Total number of mines gold mines in sample
122

These assets produced approximately 995 tonnes (around 32 million ounces) of gold in 2023, representing a very substantial portion (around a third) of the annual production from the formal, industrialised gold mining sector.[54]

It should also be noted that this report is focused on industrialised gold mining and **does not attempt to consider the biodiversity impacts of Artisanal and Small-scale Gold Mining (ASGM)**. This does not imply that these impacts are not significant. In many instances, particularly with regards to the potential destructive consequences of deforestation, mercury use, and unregulated waste management, ASGM impacts are likely far more substantial than those of the formal mining sector. Unfortunately, however, the very opaque, diverse and informal (and often illegal) nature of ASGM operations means that there is little available or reliable data for such sites and identifying clear plans and policies that might be applied to them is currently an extremely challenging task beyond the scope of this report.

Looking beyond this analysis, to consider some of the previous research and commentary focused on gold mining's nature-related risks and local impacts on biodiversity, we note an unfortunate and potentially misleading failure to differentiate between the very different nature and consequences of formal, regulated mining and unregulated, often illegal ASGM activities. Or, rather, even when that distinction is acknowledged, it is often not adequately reflected in the data. Research summaries which imply that the nature-related impacts of gold production from both Large-Scale (LSM) and ASM sources can be captured under single conflated data points[55] are therefore fundamentally flawed, particularly if they seek to contribute to identifying practical local solutions.

Breakdown by region and biosphere

Gold mines in the sample can be found on all continents. North America has the largest share of the examined assets (29%), followed by Africa (27%), and South America[56] (21%). Asia-Pacific and Oceania combined feature another 21% of mines, while Europe has only 2 mines in the sample.

Continent	Number of assets	Share of sample
Africa	33	27%
Asia-Pacific	12	10%
Europe	2	2%
North America	35	29%
Oceania	14	11%
South America	26	21%

53. https://www.gold.org/about-us/our-members (Note that the 31 member companies of the WGC include 6 royalty and streaming companies that do not directly participate at a mine site level and are therefore not included in this analysis.)
54. Source: World Gold Council, from individual mine/asset-level production data
55. A recent example of this can be found in the statement, "*...gold was the commodity that caused the highest direct deforestation through the expansion of mining areas between 2000 and 2019. This data includes both large and small-scale mining activity and the area accounts for 36% of the total mining induced direct deforestation area that could be allocated to specific commodities.*" Taken from *Extracted Forests* (2023), World Wildlife Fund. While the *Nature Risk Profile* metrics do not specifically delineate deforestation impacts, consideration of the wider implications of the data from the gold mines in our sample suggests there is little indication they are responsible for the substantial 'mining-induced direct deforestation' others have identified. This might imply that ASGM activity is responsible for a significant portion of the identified deforestation and this would certainly warrant further investigation.
56. Including the Caribbean.

A more useful lens to look at the geographic distribution of these mines and their potential impacts and dependencies is offered by consideration of the ***biome*** in which the mine is located. Biomes are regions and zones with distinct climatic conditions (e.g., temperature, precipitation), vegetation, and animal life (see Figure 4).[57] The 13 biomes[58] can be further broken down into 846 ecoregions in our classification.[59] However, the biome-level will serve as the lens through which we analyse mining assets because it provides a perspective on nature-related risks that are similar, even in geographically dispersed locations.[60] This level of granularity is also more manageable for a global risk management framework. The mining assets are spread across a variety of biomes — from colder spheres in Tundra and Taiga to temperate forests and grasslands, to tropical and subtropical regions, to deserts, to wetlands.

Breakdown by Mine Type

The sample includes both open-pit and underground mines. 74 open-pit mines are included, representing 61% of the assets.

Mine Type	Number of assets	Share of sample
Open pit	74	61%
Underground	48	39%

Biome	Count
Tundra	3
Montane Grasslands & Shrublands	10
Boreal Forests/Taiga	15
Temperate Broadleaf & Mixed Forests	10
Temperate Conifer Forests	1
Temperate Grasslands, Savannas & Shrublands	7
Tropical & Subtropical Coniferous Forests	7
Tropical & Subtropical Dry Broadleaf Forests	5
Tropical & Subtropical Moist Broadleaf Forests	20
Tropical & Subtropical Grasslands, Savannas & Shrublands	21
Mediterranean Forests, Woodlands & Scrub	7
Deserts & Xeric Shrublands	15
Mangroves	1
Rock and Ice	0
Flooded Grasslands & Savannas	0

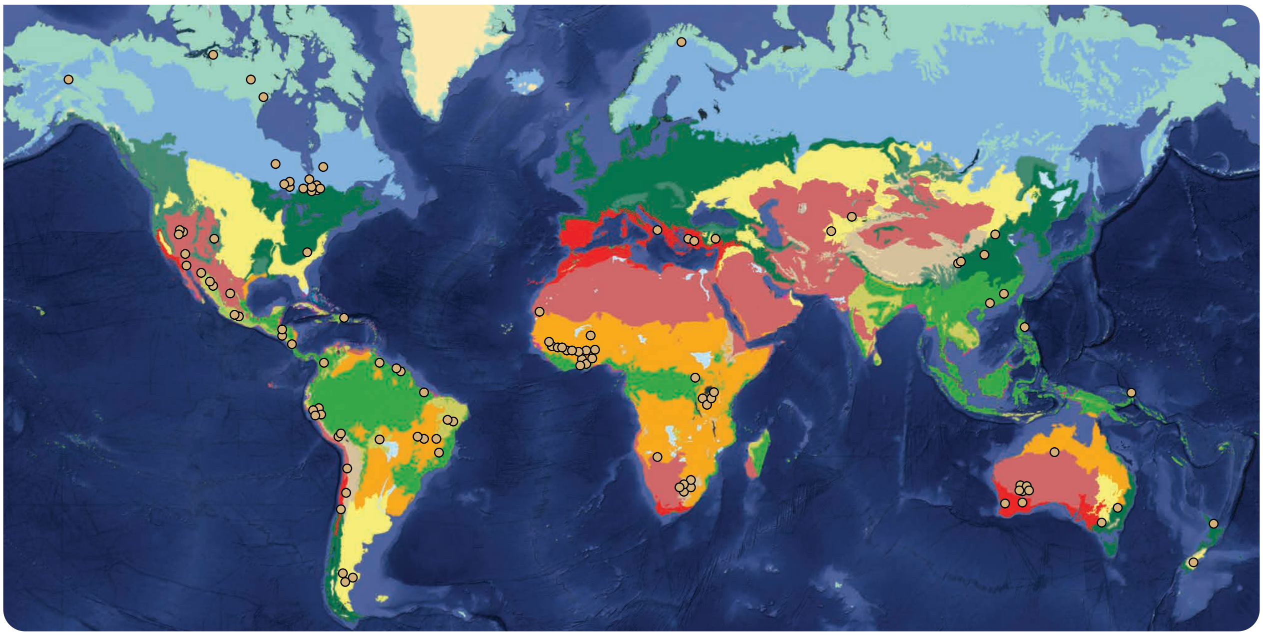


Figure 4. Biomes of the world (following Olson et al., 2001)[61] with sample gold mines mapped

57. Following the classification described in: *An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm* (2017), Dinerstein et al., *Bioscience*, Vol. 67 Issue 6
58. While there are 15 biomes total, two biomes are not referred to in this study as no sample mines are located there.
59. See https://ecoregions.appspot.com/ for an interactive summary of all ecoregions
60. For example, both the ecoregions 'Central China Loess Plateau Mixed Forests' and the 'Eastern Canadian Forest-Boreal Transition' are part of the biome 'Temperate Broadleaf & Mixed Forests'.
61. *Terrestrial Ecoregions of the World: A New Map of Life on Earth* (2001), Olson et al., *BioScience*, Vol. 51 No. 11

4.2. Nature-Related Impacts of Gold Mining

Overall Impact of Gold Mines

To normalise our measurement of nature-related and biodiversity impacts, we apply the '*Impact Ratio'* metric across all mines. As described previously, the 'Impact Ratio' is calculated combining measures of the 'Ecosystem Degradation' of the land, and the 'Ecological Significance' of that land. A high level of degradation on a plot of land that has high 'Ecological Significance' leads to a high 'Impact Ratio'. The thresholds of the individual categories, which vary from 'Very Low' to 'Very High', reflect statistical ranges that have been established (via the S&P Global Sustainable1 data) through a combination of data analysis and expert judgment.[62] More specifically, impact classification thresholds are defined as: 'Very Low' at <10%; 'Low' at 10-15%; 'Moderate' at 15-20%; 'High' at 20-25%; 'Very High' at >25%.

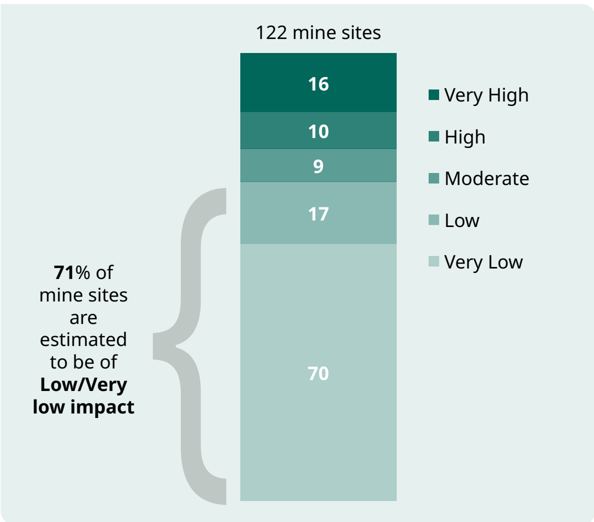


Figure 5. Breakdown of mining assets by negative nature and biodiversity impacts

The overall data shows that the majority of gold mine sites (in our sample) have a relatively low impact on nature and biodiversity. Of 122 gold mines, 87 - that is, 71% - of mines are classified as being in or below the 'Low' impact category. **This suggests that, as a sector, gold mining may be less impactful on global ecosystems than is often assumed.**

At the other end of the spectrum, however, there are 26 assets with 'High' impact or more challenging, potentially problematic profiles. 16 assets (13%) are classified as 'Very High' impact, which might be taken as signalling a call for deeper investigation of the conditions at or around these mines. Although these higher impact sites may not be representative of the wider sector, a closer consideration of their status and the industry's responses to these significant risks and impacts may offer learnings of relevance elsewhere. (This is the rationale for focusing in more detail on many of the mines featured in our *Case Studies*, profiled in *Appendix 2).*[63]

Mine Sites with 'Very High' Impact

To better understand assets with 'Very High' impact, we can break down the 'Impact Ratio' into its component parts: the **'Ecosystem Degradation'** and the **'Significance of Location'**. Applying equivalent thresholds as for the 'Impact Ratio', we can classify the level of 'Ecosystem Degradation' and 'Significance of Location' from 'Very Low' to 'Very High'. The cross-tabulation shows the results.

Of the 16 assets with 'Very High' impact, the majority of them (10) are in both an area of very high significance and of 'Ecosystem Degradation'. This highlights the need for responsibly managed mining operations with awareness of the ecological context, as negative impacts in sensitive areas are particularly problematic. It should be noted, however, that 'Ecosystem Degradation' is indirectly assessed at a granularity of 1x1 kilometres. Any human modification or pressure on the area is likely factored in, including activities unrelated to gold mining. **This makes issues of impact attribution and causality a further challenge.**

In a smaller number of cases either the significance of the land is the main driver for the negative impact (at 2 sites), *or* the ecosystem degradation accounts for the negative score (at 4 sites).

Mine Sites with 'Very High' Impact

		'Very High' Significance of Location	
		No	Yes
'Very High' Ecosystem Degradation	No	-	2
	Yes	4	10

62. The statistical differences and distribution of environmental impact classification scores can vary based on the specific methodology, data set and indicators used, although a combination of quantitative and qualitative analyses is often required to produce a robust composite score for a specific factor or activity.
63. Other mines were profiled and selected for closer examination due to specific risk factors or responses, such as a particular approach to water stewardship or community engagement.

Biomes and Ecosystem Impacts across the Globe

To further understand the impacts of gold mining, we provide a breakdown by biome. *Figure 6* shows the average 'Impact Ratio' of all studied mines per biome, as well as the component factors of the *'Ecosystem Degradation'* and *significance* of the land.

The **highest impact can be found in *Montane Grasslands & Shrublands* which, on an aggregate level**, would pass the 'Very High' threshold (>0.25) within the methodology. The 10 mines in this biome can be found in Peru, South Africa, and Argentina, with the Peruvian and Argentinian assets being those of highest impact intensity.

Further biomes with elevated impacts are *Tropical & Subtropical Moist Broadleaf Forests* as well as *Tropical & Subtropical Dry Broadleaf Forests*, both of which would be classified as having a 'Moderate' 'Impact Ratio' (between 0.15 and 0.20). The 25 mines in these biomes span a wide range of countries across Latin America, Africa, and Asia-Pacific.[64]

As is evident from *Figure 6*, impact scores can be driven both by 'Ecosystem Degradation' and 'Ecological Significance' factors. The ***Nature Risk Profile*** **methodology does not allow for causal statements about the sources of 'Ecosystem Degradation'**. Negative (or positive) developments over time such as, for example, the potential impacts of local artisanal mining (and non-mining economic) activities, cannot be understood without local 'on-the-ground' intelligence and, in many cases, a historical perspective.

Measures of 'Significance of Location', however, may offer a useful or 'sensitive' metric, providing a high-level indication of risks and vulnerabilities which should be taken into consideration alongside the entire lifecycle of a mine and reflected in developing responsive plans and precautions. As several of our *Case Studies* indicate, local site-based analysis can produce data and insights which may feed back into a re-evaluation of certain metrics, such as estimated levels of *'Species Significance'*.

Biome	Impact ratio	Ecosystem degradation	Significance of location
Tundra (3)	0.01	0.15	0.05
Montane Grasslands & Shrublands (10)	0.26	0.51	0.45
Boreal Forests/Taiga (15)	0.09	0.40	0.22
Temperate Broadleaf & Mixed Forests (10)	0.14	0.39	0.42
Temperate Conifer Forests (1)	0.06	0.42	0.15
Temperate Grasslands, Savannas & Shrublands (7)	0.06	0.26	0.20
Tropical & Subtropical Coniferous Forests (7)	0.09	0.33	0.24
Tropical & Subtropical Dry Broadleaf Forests (5)	0.16	0.37	0.41
Tropical & Subtropical Moist Broadleaf Forests (20)	0.15	0.49	0.39
Tropical & Subtropical Grasslands, Savannas & Shrublands (21)	0.12	0.45	0.27
Mediterranean Forests, Woodlands & Scrub (7)	0.12	0.35	0.27
Deserts & Xeric Shrublands (15)	0.03	0.25	0.10
Mangroves (1)	0.05	0.20	0.25

Figure 6. Breakdown of Nature-related Impacts by Biome

64. Countries with mines in the *Tropical & Subtropical Moist Broadleaf Forests* biome: Brazil, China, Colombia, Dominican Republic, Ghana, Guyana, Ivory Coast, Papua New Guinea, Peru, Philippines, Suriname. Countries with mines in *the Tropical & Subtropical Dry Broadleaf Forests*: Brazil, Mexico, Nicaragua.

Areas with High Ecological Significance

Aside from operating within areas designated as of high 'Ecological Significance' of sensitivity (see the comments on ***Overlap with Sensitive Areas***, below), there are a number of factors that play a role in identifying the significance of a location. We classify these via scores for:

- the importance to species measured by the *STAR (Species Threat Abatement and Restoration)* metrics[65]
- the importance to people and society measured by the *NCP (Nature's Contributions to People)* metrics[66]

The associated scores for the 122 mine sites in our sample are normalised (to a score between 0 and 1) and summarised in *Figure 7*. Focusing on the biomes in which these mines are located within highly significant ecological areas, we can further consider the significance profile of these biomes, in terms of their relevance to species and people.

Biome	Ecological significance	Species significance	Ecosystem contribution
Tundra (3)	0.05	0.00	0.05
Montane Grasslands & Shrublands (10)	0.45	0.17	0.37
Boreal Forests/Taiga (15)	0.22	0.00	0.22
Temperate Broadleaf & Mixed Forests (10)	0.42	0.06	0.37
Temperate Conifer Forests (1)	0.15	0.00	0.16
Temperate Grasslands, Savannas & Shrublands (7)	0.20	0.01	0.20
Tropical & Subtropical Coniferous Forests (7)	0.24	0.09	0.21
Tropical & Subtropical Dry Broadleaf Forests (5)	0.41	0.04	0.41
Tropical & Subtropical Moist Broadleaf Forests (20)	0.39	0.16	0.32
Tropical & Subtropical Grasslands, Savannas & Shrublands (21)	0.27	0.01	0.27
Mediterranean Forests, Woodlands & Scrub (7)	0.27	0.02	0.27
Deserts & Xeric Shrublands (15)	0.10	0.00	0.10
Mangroves (1)	0.25	0.06	0.24

Figure 7. Breakdown of Ecological Significance by Biome

The above breakdown of ecological significance in relation to its importance to species and people is further detailed in the following section.

Rehabilitation planning, Tanzania

65. *STAR: Species Threat Abatement and Restoration - see A metric for spatially explicit contributions to science-based species targets* (2021), Mair, L., Bennun, L.A., Brooks, T.M. et al., *Nature Ecology & Evolution*, Vol. 5. Also, https://app.ibat-alliance.org/pdf/star-industry-briefing-note.pdf. See also *Appendix 1 - Indicators, Metrics, and Definitions*
66. *NCP: Nature's Contributions to People* - see *Global modeling of nature's contributions to people* (2019), Chaplin-Kramer et al., *Science*, Vol. 366

The Challenge of Identifying the Drivers of High Ecological Significance

MINE #3, MEXICO

In this report, we have repeatedly commented that to define practical plans and protective or precautionary solutions we need to look beyond or beneath the 'Ecosystem Degradation' and *significance of location* metrics to identify the key drivers of specific threats and vulnerabilities.

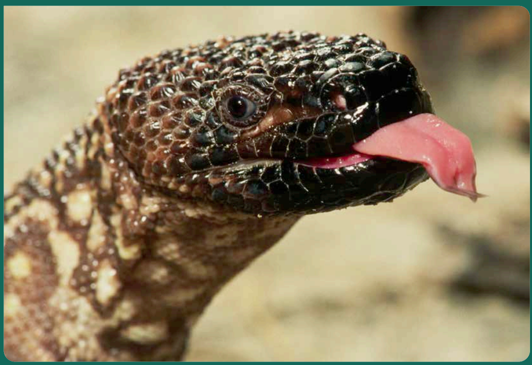
Looking at **Mine #3** in Mexico, for example, we note that it overlaps with a Key Biodiversity Area (KBA). Examining the database of Key Biodiversity Areas in more detail, we can determine which biodiversity elements trigger the area's designation as being of high significance. In the case of this site, it is the presence of *Peniocereus zopilotensis*, a critically endangered plant of the *Cactaceae* family. This level of data and insight is therefore needed to understand how the local mine site might respond to this particular vulnerability, although (without further analysis) it would again be wrong to assume a direct / causal link between the site and any heightened threat to the endangered species.

However, when exploring the main component of the 'species significance' score, we note that 'mammals' feature as the primary driver of that score, but when we examine the mine site's biodiversity plan, we can see a more granular view.

In 2021, biodiversity baseline studies were carried out as part of the permitting process for a project within the concession. These studies identified two at-risk fauna species: the *margay* (a small wild cat) and the *military macaw* (a medium-sized parrot) both native to the Americas. In response, the mining company implemented special conservation and monitoring programs for these species, as well as for the lesser long-nosed bat.

In 2022, the company also received authorisation to operate an Environmental Management Unit for Wildlife Conservation on its land. This unit (named 'UMA Bioluna') aims to breed and release Mexican Beaded Lizards (*Heloderma horridum*), which are protected under Mexican law as a Category A (*Threatened*) species. The unit's goal is to repopulate the Beaded Lizard within its natural geographical range and provide environmental education to local communities about the importance of preserving this threatened reptile, which is often the subject of myth and folklore, facing threats from superstition in addition to illegal poaching for the exotic animal trade.

Awareness of species sensitivities overlaps with the site operator's awareness of ecosystem contribution to people, with plans to complement conservation activities with additional exploration of how the distribution of bird and mammal species might impact local flora and crops (specifically, agave). These plans explicitly acknowledge the wider *ecosystem services* provided by the local environment and seek to contribute to a measured balance between conservation and local livelihoods well beyond the mine.



Mexican Beaded Lizard *(Heloderma horridum)*

Local Significance Metrics and Historical Impacts

MINE #4, TANZANIA

Mine #4 is a site designated by the *Nature Risk Profile* methodology as being of high significance to both people and local ecosystem factors. It is also located in a forest reserve, typically dominated by Miombo woodland with a minor area of grasses and shrubs. However, the 'reserve' designation may be a little ambiguous in its implications in this instance given, historically at least, the goal of environmental protection may have been compromised by other activities in the forest, both licensed and unregulated. Analysis suggests that the substantial levels of degradation identified in the reserve are mostly unrelated to recent formal gold mining operations, and more reflective of past impacts and extensive unauthorised activities such as timber and charcoal making, and illegal mining activities.

The substantial levels of degradation identified in the reserve are mostly unrelated to recent formal gold mining operations, and more reflective of historical impacts and extensive unauthorised activities such as timber and charcoal making, and illegal mining activities.

However, regardless of the company's limited direct impacts on the forest, it acknowledges it needs to act in a responsive manner, sensitive to the wider context and local history.

In this instance, the mine has had to recognise the consequences of the persistent presence of local Artisanal and Small-scale Mining (ASM) operations on the local environment, particularly in the deforestation that has scarred the forest reserve, alongside substantial social problems and challenges. This has led to a programme of multi-stakeholder engagement, striving to encourage ASM participants to consider conservation measures and other key aspects of the company's (post-closure) rehabilitation strategy – particularly, its plans focused on acid mine drainage and the treatment of old tailings storage facilities.

The site team also operate community-based policing efforts to support management of the forest reserve overlapping with their Special Mining License. The team report there is demonstrable evidence of the benefits of their interventions, reasserting the importance of multi-stakeholder management, with the areas outside of their control being in a more obviously degraded state.

Beyond direct environmental impact considerations, the company has also sought to support alternative livelihoods that might, indirectly, reduce community pressures on the local ecosystem.

Ghost Bats, Australia

Significance of location - Species and People

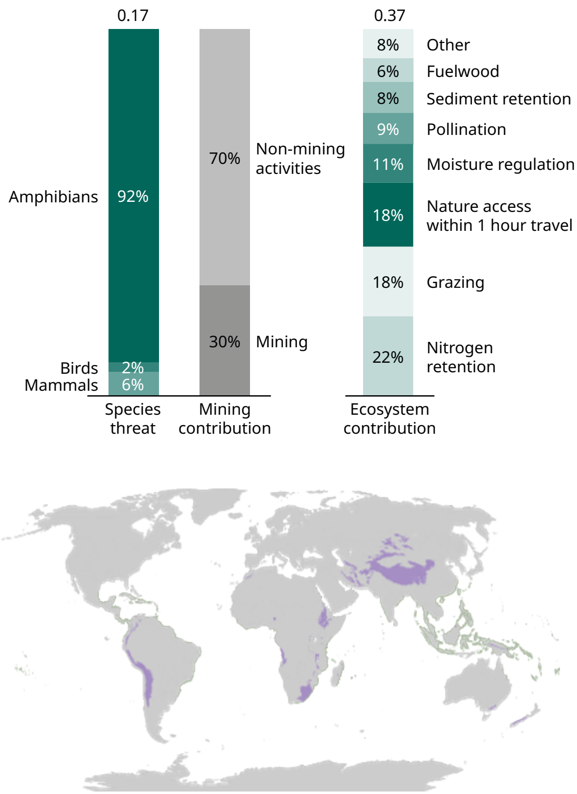


Figure 8. Montane Grasslands & Shrublands

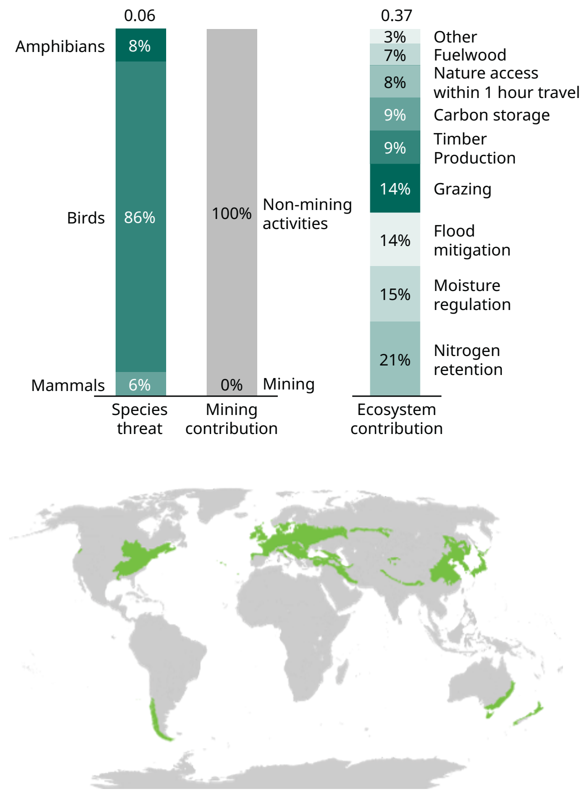


Figure 9. Temperate Broadleaf & Mixed Forests

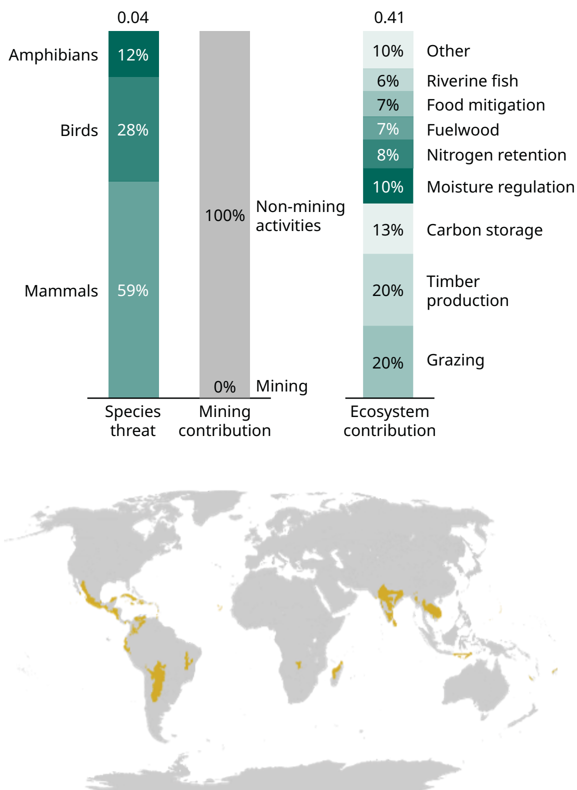


Figure 10. Tropical & Subtropical Dry Broadleaf Forests

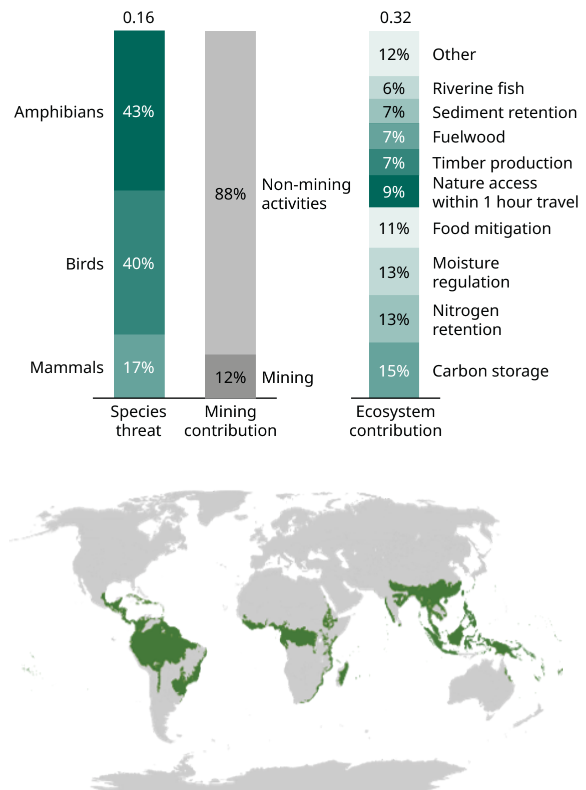


Figure 11. Tropical & Subtropical Moist Broadleaf Forests

Figures 8-11, above, present snapshots of mining locations with significance of location in the context of the biomes in which they are located. They show ***species threat*** scores, normalised from 0 to 1, and a breakdown into species types (amphibians, birds, mammals) that contribute to the threat score. In addition, the relative attribution to mining activities as a percent of the overall threat score is displayed.[67] For ***'Ecosystem Contribution to People'***, we show the overall score (again, normalised from 0 to 1) and the contributing critical factors (or 'natural assets') – that is, the specific ecosystem services of benefit to people.[68] Of the 14 critical factors, 'Climate regulation' and 'Moisture regulation' are global contributions, the remaining 12 are local contributors.

The analysis (in *Figure 8*) shows a heightened species threat in *Montane Grasslands & Shrublands*, mostly

Local Insights Enhancing Species Awareness

MINE #5, DOMINICAN REPUBLIC

This mine, in the sparsely populated central area of the Dominican Republic, has a local ecosystem of notable significance to both species and to people in the *Nature Risk Profile* methodology. Whilst mining is estimated as exerting pressure (at a level of 8%) on local species (particularly amphibians), other activities, including agriculture (32%), logging (15%), introduction of invasive species (15%), and hunting (9%), are more impactful.

An Environmental Impact Assessment during the site's construction identified a fairly wide range of flora and fauna which informed the site's formation of its 'no net loss' biodiversity targets.

Significantly, within the mine boundary, a small gecko species, *Sphaerodactylus samanensis*, was found in limestone caves. This gecko had been considered 'Critically Endangered', and its range was thought to be limited to a specific location (Los Haitises National Park). The mine conducted extensive studies and fieldwork, discovering that the gecko's habitat and population size were larger than previously known.

To protect the gecko, the site paused mining in part of the quarry for three years and relocated geckos from disturbed areas to nearby habitats. Successful trials also showed that the geckos could adapt to recreated karst habitats. The research, of potential value to future conservation efforts, was shared with the IUCN for further consideration and scientific purposes. The finding that the gecko population was larger and perhaps more resilient than had previously been estimated resulted in it being no longer classified as 'Critically Endangered', according to IUCN criteria. It is now identified as 'Near Threatened', but this reclassification does not mean the site is relaxing or reducing its conservation efforts.

Another feature of the same site is its location in a region that had already been negatively impacted by previous, less responsible mining activity. Specifically, there were substantial challenges regarding the condition of the local watershed, and the water quality of the local river, which flowed into the neighboring reservoir. When the mine commenced operations, it committed to treating water and discharging the treated water into the river, along with additional rehabilitation initiatives to address other historical 'legacy' impacts. Since 2012, this has led to significant improvements in the water quality of the river and reservoir, and the species they support, consequently improving ecosystem services and facilitating additional livelihoods via aquaculture opportunities.

Samana Least Gecko
(*Sphaerodactylus samanensis*)
Source: Marcos Rodríguez Bobadilla, licensed under CC BY-SA 4.0

67. Attribution to individual threats, including mining, is done following the approach outlined by Mair et al., 2021 (p. 842): "*The relative contribution of each threat to the species' extinction risk was calculated as the percentage population decline from that threat [...] divided by the sum of percentage population declines from all threats to that species*"
68. The aggregation to produce a summary score uses the weighted average of mine asset scores – the weights aim to reflect those mines that appear of more relevance to the factor under consideration. For example, to account for the fact that ecosystem contribution to people is more important for some mines than others, the mine-level contributions have been weighted by their NCP score before aggregating to the biome-level. Similarly, for aggregating species-related characteristics to biome-level (i.e., species type, and estimated level of impact attributed to the mining sector), the mine-level scores were weighted by their STAR scores.

Global 'Ecosystem Contribution' and Local Biodiversity Protection

MINE #6, FINLAND

Mine #6 is identified as being situated in a Boreal Forest/Taiga biome of global 'Significance to People' – primarily reflecting its substantial role as a carbon sink and in the regulation of water cycles. However, a closer examination of the site highlights that the mine is located in close proximity to a small (8 hectare) area of land that is protected under national law due to its significant biodiversity profile.

We highlight this here because it again suggests that high-level metrics need to be complemented by more granular, localised data to capture the impacts and vulnerabilities to which mine site operators may need to respond.

Examining company disclosures referencing the mine site, we note, for example, an awareness by the operating company of the significance of local peatland (beyond its potential for carbon sequestration) in the neighbouring ecosystem. To protect this land from damaging water infiltration, whilst enhancing local biodiversity prospects, a programme of tree-planting has commenced.

More specifically, we see **the mine's response to a very particular vulnerability** – the potential threat to *Lapland Buttercups* that grow near the mine. While being a common plant in Lapland, this is a rare and endangered in other parts of Finland and Europe. In response, the mine has established a conservation project of replanting and ongoing monitoring to preserve this fragile species.

Lapland Buttercup
(*Ranunculus lapponicus*)
Source: Bjoertvedt, licensed under CC BY-SA 3.0

driven by the *Amphibian* taxon group. Here, the impact is (at least partially) attributed to mining, although the linkage or means of attribution is not direct. In the *Tropical & Subtropical Dry Broadleaf Forests* biome (*Figure 10*) we can also observe a heightened species threat, affecting all three classes of species, but with a very moderate contribution of mining activities to the threat score.

However, trying to determine the precise nature of a 'contribution' or 'threat' – in order, for example, to identify impact drivers that may need to be better managed or mitigated – is, again, not possible with the available data and methodology. For example, no distinction is made between artisanal mining and large-scale mining, although we know their approach to environmental risk assessment and impact reduction planning is vastly different. Indeed, in codifying the threats from economic activities, the IUCN threat classification scheme only includes a single item for '*Mining & Quarrying*' – which, it can be argued, is far too broad to support the development of practical responses and threat reduction strategies. It might also increase the risk of misclassification or the misattribution of impact drivers and threats. As noted repeatedly in this report, to arrive at meaningful conclusions regarding specific ecological vulnerabilities and potential responses, we need to look beyond the summary nature risk landscape to specific company and, importantly, site-level practices.

The scores for *'Ecosystem Contribution to People'* show a variety of contributing factors. 'Nitrogen retention' is relevant across the board, playing a significant role in water quality downstream. 'Carbon storage' is most relevant in *Tropical & Subtropical Moist Broadleaf Forests* (Figure 9), while this is also the only biome in which grazing does not play a major role (as a beneficial ecosystem service).

Metric	Total	WDPA Overlap	KBA overlap
Number of Mines	122	17	8
Footprint of operation (hectares)	140,233[69]	8,871	6,281

Overlap with Sensitive Areas

The classification of the ecological significance of an area presents one of the key factors to be considered in assessing the environmental impact of business operations (and, in this case, mining assets). Metrics to assess significance of location revolve around richness and diversity in species, and around ecosystem productivity. These may then feed into salient markers or classifications of significance of location via the official designation of land as a **Protected Area** (WDPA[70]) or a **Key Biodiversity Area** (KBA) by UNEP-WCMC.

Geospatial analysis allows for the identification of overlaps between mining operations and protected areas, including the area of overlap.

Of the 122 mining assets, 17 overlap with a Protected Area, and 8 overlap with a Key Biodiversity Area. (3 mines are located in an area in which WDPA and KBA classifications overlap). In terms of footprint, 8,871 hectares of gold mining operations are located in a WDPA area (6% of the total footprint of our sample), and 6,281 hectares are sited in KBA land (4% of the sample footprint).

Looking at the high-level implications for the wider gold mining sector, this data suggests that the **industry's overlap with designated sensitive areas is very small.**[71] As commented elsewhere in this report, if we wish to consider strategies for managing particular risks on protected or sensitive lands, we need to move to site-level insights. This need to balance the summary insights from the *Nature Risk Profile* approach with local data drawn from site-level and mine company disclosures is repeatedly highlighted in the selected ***Case Study*** examples cited in this report.

Biodiversity Action Plans

There are, however, relatively clear indications regarding site-level good practice for mines operating in identified Key Biodiversity Areas, typically triggering the development of a **Biodiversity Action Plan** to achieve defined site-specific biodiversity objectives.[72] Such plans represent a systematic approach to biodiversity management that can help companies contribute to nature positive goals via a structured process, aligned with the key frameworks (including those described above in the *Current Governing Bodies* and *Guidance Frameworks* section). The key steps and components of these action plans are described below:

Site 'Sensitivity' to Species Significance

MINE #7, PERU

This mine scored relatively highly (5th highest in our sample) with regards its level of 'Species Significance', which consequently raised its estimated level of 'Location Significance'. When we then seek to unpack the drivers of this score, we note it is almost wholly reflective of the importance (and vulnerability) of Amphibians in that ecosystem.

Viewing this issue from the local perspective, exploring the mine site's potential awareness of this threat, we identify a more detailed understanding of vulnerable species and habitats in locations that may be affected by site operations. The habitat integrity and species diversity are reviewed biannually by the mine operator to ensure a snapshot is taken both during the wet and dry season. The operating company's 'Biodiversity and Land Management' data identifies 19 species listed as 'Vulnerable', 'Endangered' or 'Critically Endangered' on the IUCN Red List and the National Conservation List in areas potentially affected by the mine.

While ensuring the 'mitigation hierarchy' (see above) is applied when reviewing any expansions to the mine, the company is developing its net nature positive strategy for the asset with these species of significance an important component. Where a disturbance cannot be avoided, the site works to minimise its impact by activating a relocation program of both flora and fauna. This has been required four times since 2014 due to expansions of tailings and waste rock storage facilities and a pit expansion, with successful relocations of reptiles, amphibians and mammals.

69. The total land use footprint of these mine sites is skewed by the presence in our sample of a relatively small number of large open-pit sites.
70. Source from *World Database of Protected Areas*
71. The estimated total area of protected areas covered by the World Database on Protected Areas (WDPA) is approximately 20 million square kilometres, equivalent to 2 billion hectares; excluding marine areas, terrestrial protected areas equate to roughly 1.5 billion hectares (*ouroworldindata.org*, based on UNEP/World Bank data).
72. See, for example, the case studies presented in *Engaging industry in conserving nature - Case studies of biodiversity actions on non-operational lands and seas of companies* (2023), IUCN (International Union for Conservation of Nature and Natural Resources); https://portals.iucn.org/library/sites/library/files/documents/2023-024-En.pdf

1. **Assessment of Biodiversity:** Understanding the local biodiversity context and identifying key species and habitats.

2. **Setting Objectives:** Defining clear, measurable goals for biodiversity conservation.

3. **Implementation Strategies:** Outlining actions to achieve the objectives, including habitat restoration, species protection, and community engagement.

4. **Monitoring and Reporting:** Establishing metrics to track progress and adapt strategies as needed.

These plans are essential tools for promoting positive local socio-environmental outcomes and, specifically, for ensuring that biodiversity is considered in planning and decision-making processes, setting the context for many of the *Case Studies* included in this report.

Impact by Mine Type

Another factor that plays a role is the type of mining operation. We classified assets into underground and open pit mines. The following table shows the average 'Impact Ratio' as well as the average ecosystem footprint, broken down by type of mine.

What the data shows is that the 'Impact Ratio' between mine types is similar. The 'Impact Ratio' can be read as a measure for the concentration of impact and allows a comparison of assets of different sizes. However, if the land use footprint is substantially larger for open pit mines, then the absolute impact will be larger for a given 'Impact Ratio'. This is also what we observe in the data. Open pit mines occupy, on average, about 4 to 5 times the terrestrial surface area of an underground mine. As a result, our measure for the ecosystem footprint is also larger by a similar magnitude.

Mine Type	Avg. Impact Ratio	Avg. Ecosystem Footprint (in HSA eq.)
Open pit	0.12	195
Underground	0.11	38

Complex Pressures and Multi-faceted Impacts

MINE #8, AUSTRALIA

Mine #8 is a substantial underground gold mine in Victoria, Australia and is scored as having a 'Moderate Impact', although it is associated with a notable level of *'Ecosystem Degradation'* (0.35/1.00) due in part to the 'structural' modifications of the land imposed by economic activities and physical infrastructure, and, more importantly, because the area is associated with a high contribution of ecosystem services. 'Structural' impact may not be surprising when we consider that gold mining has been undertaken in the area since the 1890s and several companies (and individuals) have operated mines over this period. Significantly, however, the pressure on local species is not identified (via the *Nature Risk Profile* methodology) as related to mining operations and is more associated with invasive species, problematic native species, and urbanisation.

While not covered by the *Nature Risk Profile* methodology's 'strict overlap' approach, an examination of the site indicates it is adjacent to a High Biodiversity Area (*Mount Sugarloaf Nature Conservation Reserve*) and the mining company has disclosed there are 511 IUCN 'Red List' or 'National Conservation List' species that it views as potentially affected by the mine.

Acknowledging this responsibility, the mining company commissioned surveys that revealed a larger than expected population of the endangered *Pink-tailed Worm-lizard*. The mine also identified a substantial population of *Ghost Bats* using old mine openings as habitats and its research on bat behaviour is now guiding new conservation techniques and mine closure practices to create safe havens for wildlife.

Mine #8 has operated for just over a decade and been owned by 3 different companies. It is now estimated to have under a decade of productive life remaining. Its current owners have therefore defined a Mine Closure plan, which reflects an awareness of the intersections between environmental and social objectives, with land rehabilitation and repurposing shaped by both biodiversity and social considerations.

Local restoration projects include, for example, the mining company's collaboration with community groups and landowners to rehabilitate and protect an extensive stretch of a nearby creek. This is expected to encourage the native fish population and the return of indigenous creatures, such as the platypus.

4.3. Ecosystem Dependencies of Gold Mines

Gold mining, and mining in general, depends on a number of ecosystem services. We refer here to the ENCORE tool[73], which provides insights into which ecosystem services are material for specific industries (and 'sub-industries'). For our purposes, there are 5 material ecosystem services that will be considered (out of 21 ecosystem services in total[74]) and, for the sake of simplicity, this is reduced to 4, given that the results for the ecosystem service 'Ground Water' are the same as for 'Surface Water'. Mining is a process that typically requires substantial volumes of water as a direct physical input, but the source of the water is less relevant (from a dependency perspective). We will therefore use 'Ground Water' as the representative ecosystem service.

The 4 key ecosystem services on which gold mining operations are, to some degree, dependent are identified as the following:

- **Mass Stabilisation and Erosion Control:** This service is provided by natural vegetation and landscapes. Vegetation cover stabilises terrestrial, coastal, and marine ecosystems, reducing damage and helping maintain soil and sediment stability.

- **Climate Regulation:** Global climate regulation is provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass, and the oceans. At a regional level, the climate is regulated by ocean currents and winds while, at local and micro-levels, vegetation can modify temperatures, humidity, and wind speeds.

- **Ground Water:** Ground water is water stored underground in aquifers made of permeable rocks, soil and sand. The water that contributes to groundwater sources originates from rainfall, snow melts and water flow from natural freshwater resources.[75]

- **Water Flow Maintenance:** The hydrological cycle (or hydrologic cycle), also called the water cycle, is the system that enables circulation of water through the Earth's atmosphere, land, and oceans. The hydrological cycle is responsible for the recharge of groundwater sources (i.e. aquifers) and maintenance of surface water flows.

Dependency can be aggregated to a singular composite score for an asset by combining reliance and resilience per ecosystem service and then aggregating the composite scores of all material ecosystem services. For the present study, we show the disaggregated values to give insights into the drivers of overall dependency.

Reliance on Ecosystem Services

Identifying the level of dependency or reliance on an ecosystem service is primarily driven by the estimated level of materiality. ENCORE assigns the following materiality rating to the ecosystem services for the mining industry:

Ecosystem service	Materiality
Mass Stabilization and Erosion Control	Medium
Climate Regulation	High
Ground Water[76]	High
Water Flow Maintenance	High

For certain ecosystem services, we also adjust the 'Materiality' score for 'Relevance' to arrive at a 'Reliance' ('Dependency') score. Some ecosystem services are global in their consequences and whilst the specified biomes will contribute differently to the provision of those services, **all industries and sites are dependent on those services – specifically, climate regulation/moderation and the maintenance of natural water cycles**. However, the benefits to be gained from many 'regulating' services are unevenly distributed spatially and depends on the degree to which a given location is at risk from disruptions. We see in the analysis that for 'Mass Stabilisation and Erosion Control', the reliance score (a function of materiality and relevance) is substantially different for mines across different biomes.

Considering these adjustments, the reliance scores for the ecosystem services across biomes are as follows:

Applying ENCORE materiality alone for 'Mass Stabilisation and Erosion Control', which for mining is rated as 'Medium', would translate into a blanket materiality score of 0.60 for all mines globally. The consideration of biome characteristics, however, allows for a more nuanced picture. For example, this results in mining's reliance on 'Mass Stabilisation and Erosion Control' services being scored as 0.07 for mines in a Boreal Forests/Taiga biome, compared with a score of 0.77 for sites in a Mangroves biome.[77]

73. *ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure* – see https://encorenature.org/en
74. The full 21 Ecosystem Services are listed in *Appendix 1*.
75. As noted above, these comments can be taken as representative of the ecosystem services 'Ground Water' *and* 'Surface Water' (surface water is provided through freshwater resources from collected precipitation and water flow from natural sources).
76. While these are global, industry-specific scores, the 'Ground Water' rating has been adjusted based on available company-specific information from S&P Global's *Trucost* database. This environmental register contains disclosed and modelled water withdrawal quantities (which are translated into water intensities by normalisng for company revenue).
77. Albeit there is only one such mine – identified as operating in a Mangrove biome - in our sample.

Gold Mining Asset Reliance on Ecosystem Services by Biome

Biome	Climate Regulation	Mass Stabilisation and Erosion Control	Ground Water	Water Flow Maintenance
Tundra	0.80	0.30	0.07	0.80
Montane Grasslands & Shrublands		0.59	0.15	
Boreal Forests/Taiga		0.07	0.22	
Temperate Broadleaf & Mixed Forests		0.28	0.11	
Temperate Conifer Forests		0.11	0.21	
Temperate Grasslands, Savannas & Shrublands		0.25	0.20	
Tropical & Subtropical Coniferous Forests		0.38	0.14	
Tropical & Subtropical Dry Broadleaf Forests		0.30	0.12	
Tropical & Subtropical Moist Broadleaf Forests		0.21	0.32	
Tropical & Subtropical Grasslands, Savannas & Shrublands		0.35	0.29	
Mediterranean Forests, Woodlands & Scrub		0.24	0.05	
Deserts & Xeric Shrublands		0.29	0.25	
Mangroves		0.77	0.08	

Figure 12. Gold Mine Site Reliance on Ecosystem Services by Biome

Resilience of Ecosystem Services

The ability for industries (and people) to depend on ecosystems to contribute to risk mitigation depends on the enduring capacity of those ecosystems to continue to provide the necessary beneficial services. Declines in the state of Nature, as evidenced by biodiversity loss, will likely reduce the resilience of ecosystems and therefore their capacity to provide key services which then raises risk levels. For direct resource use, the resilience of provisioning ecosystem services will relate directly to the continued availability of that resource within the area where operations are taking place. For example, water scarcity risk is a measure for the resilience of 'Ground Water' (or '*Surface Water*'). For regulating and maintenance services, the measurement is more complex as they depend on the complex interactions and the functioning of the entire ecosystem. A proxy measure of resilience is the '*Ecosystem Integrity Index*' (EII), discussed above, which can be combined with further data layers relevant for particular ecosystem services.[78] The following table shows the average resilience scores for mines across biomes per ecosystems service (normalized from 0 to 1, with higher scores indicating higher risk).

The overview of resilience scores allows us to pinpoint areas of heightened risks, and how they differ between different locations. For example, 'Ground Water' may be an area of concern for *Deserts & Xeric Shrublands*, but not for *Mangroves*, while for 'Mass Stabilisation and Erosion Control' we observe the opposite relationship.

Ecosystem Service Resilience and Risk by Biome[79]

Biome	Climate Regulation	Mass Stabilisation and Erosion Control	Ground Water	Water Flow Maintenance
Tundra	0.31	0.20	0.13	0.20
Montane Grasslands & Shrublands	0.52	0.37	0.38	0.37
Boreal Forests/Taiga	0.41	0.13	0.05	0.13
Temperate Broadleaf & Mixed Forests	0.42	0.35	0.35	0.35
Temperate Conifer Forests	0.34	0.14	0.60	0.14
Temperate Grasslands, Savannas & Shrublands	0.25	0.21	0.35	0.21
Tropical & Subtropical Coniferous Forests	0.31	0.25	0.36	0.25
Tropical & Subtropical Dry Broadleaf Forests	0.34	0.30	0.19	0.30
Tropical & Subtropical Moist Broadleaf Forests	0.49	0.40	0.09	0.40
Tropical & Subtropical Grasslands, Savannas & Shrublands	0.43	0.33	0.20	0.33
Mediterranean Forests, Woodlands & Scrub	0.40	0.38	0.78	0.38
Deserts & Xeric Shrublands	0.23	0.10	0.70	0.10
Mangroves	0.39	0.44	0.05	0.44

Figure 13. Ecosystem Service Resilience and Risk by Biome

78. Data sources used: S&P Global Sustainable1 Physical Risk dataset (Water Stress), UNEP-WCMC, HydroSHEDS, ISRIC, GLOSIS
79. A colour-coded conditional scale was used for Figure 13, with pale yellow meaning closest to 0 (high resilience; low risk) and dark red meaning closest to 1 (low resilience; high risk).

Water Stewardship and Community Collaboration

MINE #9, MEXICO

Mine #9 is a large open pit mine (the fourth largest in our sample with regards to land use), spreading over 5,000 hectares. The mine is rated as having a 'Very Low' *'Impact Ratio'*, ranking 82/122. However, the operating company (using the World Resources Institute's Water Risk Aqueduct Tool) identified the site as having a high level of 'baseline water stress'. Its response also reflected its ongoing interaction with 25 neighbouring communities, and an awareness of the significance of water services to those communities.

In addition to a collaborative approach to water monitoring responsibilities, built on direct engagement with four key stakeholder communities, the company entered a long-term (30-year) agreement with another local community to provide infrastructure which will secure sustainable water supplies for local domestic and agricultural needs. The new and enhanced facilities and public water distribution network built by the mining company will, ultimately, be owned by the local municipality.

In 2023, the mine obtained 68% of its water from recycled or reused sources.

The same mining company, operating in a very different location - in Ontario, Canada - had already demonstrated its recognition of the benefits of dialogue and informational exchange between companies (at the mine site level) and Indigenous peoples with regards local water management processes. At this site, local members of First Nations communities were trained on collecting water and air samples, whilst leveraging their local knowledge of natural resources to conduct environmental compliance monitoring, with the findings shared by both the mine site and its neighbouring communities.

Water Stewardship and Good Practice Frameworks

Water stewardship is now widely recognised as a critical aspect of responsible mining and good water stewardship practices are accepted as essential to mitigate the negative impacts and ensure water resources are used sustainably, minimising the stress on ecosystems and those dependent upon them. This is reflected in the range of industry reference points and guidance detailing the principles and criteria for effective water stewardship. This includes the Alliance for Water Stewardship's *International Water Stewardship Standard*, a widely applicable framework for major water users to better understand their water use and impacts[80], and the ICMM's *Water Stewardship Maturity Framework*[81], a practical tool designed to help mining companies enhance their management of shared water resources in ways that are environmentally sustainable, socially equitable, and economically beneficial.

Although there is always scope for improvements, we have seen quite significant advances in the acceptance by mining companies of their level of responsibility for better management of water resources. This not only relates to mine site water consumption and discharges but also reflects a greater sensitivity of mine operators to local water availability and quality as it may affect local communities and landscapes. Good practice has moved from mine operators primarily focusing on water management within the operational 'fence line' of a site to a broader stewardship approach that considers the entire water catchment area. This expanded perspective was a key recommendation of the UN's CEO *Water Mandate* in 2019[82] but, prior to this, was already becoming a cornerstone of industry practice a decade or so ago.[83]

That said, in order to build greater resilience and develop future solutions, it is important to acknowledge the previous failures of the mining industry and its negative impacts on local water resources, often leading to depletion and contamination. The South African example of the acid mine water drainage crisis of a few decades ago[84] is a challenging example of what can happen when companies abandon mines in an unrehabilitated fashion and without sufficient consideration of water impacts. Specifically, unmitigated seepage from old mine sites flowed into local streams, dams and sources of groundwater, proving a danger to people's health, as well as that of plants, animals, and aquatic life.

There is certainly still room for further improvement, but substantial progress has been made over the last decade. We have seen the benefits of the industry's greater sensitivity to local water resources, for example, in the recent enhancements to water stewardship policies as reflected in the management of mining tailings[85].

80. The AWS Standard 2.0 (2019); https://a4ws.org/the-aws-standard-2-0/
81. https://www.icmm.com/en-gb/guidance/environmental-stewardship/2023/water-stewardship-maturity-framework
82. *From Water Management to Water Stewardship—A Policy Maker's Opinion on the Progress of the Mining Sector* (2019); https://www.mdpi.com/2073-4441/11/3/438
83. As articulated in the ICMM's *A practical guide to catchment-based water management for the mining and metals industry* (2015)
84. *Water Pollution and Contamination from Gold Mines: Acid Mine Drainage in Gauteng Province, South Africa* (2020), Anthony Minnaar, in *Water, Governance, and Crime Issues* (2020), Eman, K., Meško, G., Segato, L., Migliorini, M. (eds)
85. *Water stewardship: A golden thread through GISTM* (2025), Mining Review Africa

More generally, a survey of the current status of mining company awareness and plans suggests that water resources as an environmental risk and ecosystem service are increasingly well understood, and robust water stewardship is now a key priority for the global mining industry, including the gold sector.

Indeed, the depth and range of industry knowledge and responses on this matter mean a full exploration of gold mining's water-related impacts and plans, aligned with wider industry good practice, is beyond the scope of this paper, although clearly worthy of further examination.

Water Stewardship, Ecosystem Services, and Legacy Impacts

MINE #10, USA

Mine #10 is an open pit mine in Alaska, USA, that is rated 'very low' in its 'Impact Ratio', ranked at 109 out of our sample of 122 gold mines, and its low level of impact is reflected across most key indicators.

However, the mine is situated in a region that has been home to gold mines since the early 1900's and it has been operational for at least three decades.

Acknowledging that historical hydraulic placer mining in the area had impacted local waterways both near the mine and across Alaska, the mine implemented reclamation and habitat restoration through working with local and state partners. (As the *Nature Risk Profile* data does not yet cover freshwater species, we would not expect these impacts to be reflected in the risk metrics in the main body of our analysis.)

The mine and the Alaska department of Fish and Game worked together to restore Fish Creek in the area downstream from the mine. Fish monitoring, including population assessments, has been performed annually since 1992. Water quality sampling began in 1997, with winter sampling starting in 1998, indicating a sustained commitment to understanding and managing the environmental impacts of mining activities (including those that preceded the current operation).

In spring 2023, there was an estimated population of 4,767 fish longer than 200 mm—slightly more than the 4,594 counted in 2022. Both numbers are well above the target range of 800 to 1,600 fish after mining. Also, levels of metallic elements found in samples of Arctic grayling fish were lower in 2024 compared to 1993. The comprehensive data gathered over these years supports informed decision-making for conservation and resource management in the area.

Elsewhere in Alaska, the mine's partnership with Trout Unlimited on the Alaska Abandoned Mine Restoration Initiative continued in 2024. The first project of this initiative was to restore more than two miles of Resurrection Creek, which is an important and popular salmon stream that was also significantly impacted by hydraulic placer mining in the early 1900s. Additional partners include the U.S. Forest Service, the National Oceanic and Atmospheric Administration, the National Forest Foundation, the Alaska Department of Fish and Game, and Hope Mining Company, which conducts small-scale mining operations under leases to adjacent lands. Construction at the project site began in 2023 and will continue through 2026. Activities in 2024 included rebuilding and recontouring the stream channel, hauling in new topsoil, and planting willows and new riparian vegetation. These efforts have produced immediate benefits and, within days, h coho, pink and chum salmon were seen spawning in the newly-constructed stream channel.

Trout Unlimited is working with the University of Alaska to map more than 1,000 historic mine sites in Alaska, to help guide future restoration efforts. The mining company and Trout Unlimited continue to explore further collaboration opportunities.

Chum Salmon, Alaska

5. Gold Mining and Sectoral Responses to Nature-related Risks

The above sections aim to provide an overview of the global nature-risk landscape as it applies to gold mining, alongside examples of localised nature-focused plans and actions at a selection of gold mines. In this section, we offer a summary of the status of the gold mining sector's level of awareness and preparedness in relation to nature-related risks, particularly as perceived by key stakeholders and in the context of key drivers. We look, for example, at the state of current environmental and nature-related disclosures from those companies that operate the mines we profile (using the *Nature Risk Profile* methodology), while considering how these are evaluated by the mining analyst community. We also consider how mining impacts will be shaped by the stage of a mine's development across its lifecycle, and the significance of mine closure and post-closure plans and their potentially enduring legacy impacts on local environments.

These considerations allow us to arrive at a more detailed assessment of what constitutes 'good practice' in the nature-focused strategies and actions of gold mining companies at both the corporate and mine-site level.

As we have noted above, high-level environmental metrics and ecosystem scores may be useful in offering an overview of current nature-related impacts and dependencies to facilitate the setting of parameters and boundaries for risk management purposes. In the language of TNFD, they contribute to the initial ***L***ocate phase of the LEAP approach by directing attention to the relative key vulnerabilities and threats,[86] but they are not wholly sufficient to facilitate adequately detailed and locally 'sensitive' solutions. Whist the risk profile analysis offers mining companies and other stakeholders a means to signal and ***E***valuate key impacts and dependencies, this needs to be complemented by local knowledge. If we wish to understand how specific gold mines translate those signals into more practical steps to ***A***ssess their local risks and ***P***repare their responses, we are still dependent on granular site-level insights. Typically, our understanding of these risks and responses will also depend on how they are reported via associated corporate disclosures.

5.1. Corporate Plans and Disclosures

To define the scope of our site level analysis, we selected a subset of the companies that operate the mine sites to which we applied the *Nature Risk Profile* approach **(see Appendix II)** and from which we then compiled the *Case Studies*. Although we did not establish a methodological basis to confirm these companies are representative of the diverse nature of gold mining companies across the wider industry, we are pleased that they represent a substantial range of companies of different scale with varied assets in dispersed locations (and different ecosystems). We then examined their disclosed plans and responses at both the corporate and site level, as summarised under a number of key categories.

The disclosure can be broadly classified as 'negative' and 'positive' risk strategies – that is, plans seeking to avoid destructive actions and minimise net harm compared with those seeking to contribute to enhanced nature-focused outcomes and improved ecosystem performance. Whilst, in practice, the two strategies will be closely related and may in many cases overlap, we have made an assumption here that responsible mining is based upon foundational principles of 'harm avoidance'[87], and therefore focused most of our attention (in our *Case Study* examples) on positive company and site responses – those actions, for example, seeking to contribute to the enhanced resilience of local species and people.

That said, our research included consultations with a number of mining industry specialists and analysts, from which we noted a tendency to focus far more on the harm avoidance aspects at mining operations, with limited expectations that operators might also seek to proactively contribute to net 'nature positivity'. This might be reflective of the priorities defined by

86. This can be perceived as also aligned to foundational stage (Step 1) in the ICCM's guide on *Achieving No Net Loss or Net Gain of Biodiversity* – that is, establishing a biodiversity *Area of Analysis* (AoA).
87. Perspectives on the prioritisation of 'harm avoidance', balanced against considerations of the other social (namely, socio-economic development) impacts and benefits of mining are discussed in *An essay on mining and the moral obligation not to harm others* (2024), David Brereton, Sharon Flynn, Deanna Kemp, *Resources Policy*, Vol. 98

established *environmental impact assessment* procedures and reporting[88], which are a core component of the early development process of a mine asset. In turn, these assessments – or the elements of them that have previously attracted most attention - are also reflected in the established and broadly applied concept of a '**mitigation hierarchy**'. This is a broadly applicable framework of four iterative steps which initially focuses on:

i. **avoidance**, and

ii. **mitigation of negative impacts**, before considering

iii. **restoration and rehabilitation**, and

iv. **remediation** (and offsetting of residual impacts).

It should also be noted that the momentum behind climate-related reporting has probably been the primary driver of extended industry perspectives on environmental impacts, and this has led to what is sometimes referred to as 'carbon tunnel vision' – the prioritisation of decarbonisation above other environmental and social objectives. Although our analysis indicates that gold mining leaders are increasingly mindful of external pressures and expectations on nature- and biodiversity-focused actions and disclosures (as described above in *Current Governing Bodies and Frameworks*), our discussions with other industry participants and commentators suggest they may not yet fully comprehend or embrace these frameworks. This has implications for how the disclosure of risks and impacts is evaluated by analysts, investors and stakeholders.

Preparing for Closure with Innovative Soil Regeneration Techniques

MINE #11, MEXICO

Mine #11 is an open pit mine which scores 'High' for *'Ecosystem Degradation'* but, overall, is rated as having a 'Low' *'Impact Ratio'* (64th from our sample of 122 mines). Significantly, the mine is identified as nearing the end of its productive life, with three or so years currently remaining. Whilst its decommissioning and post-closure reclamation programme has yet to be activated, the mine operators are already undertaking activities to progressively restore the land. Specifically, the site is utilising an innovative 'Ultra-High-Density Cattle Grazing' technique to generate topsoil for revegetation activities. This approach was described by the Mining Association of Canada, in awarding the project its Towards Sustainable Mining Excellence Award in 2020, as mimicking "*…the effect of large herds of grazing herbivores that group together and move constantly as a result of the presence of predators, trampling the ground and plants. In this way, the program replicates nature's way of regenerating the soil*". This natural and sustainable restoration process achieved positive regeneration results faster than established methods without using synthetic or 'imported' materials.

At a neighbouring rock storage facility at the mine site, the mining company uses hens instead of cattle, employing the poultry to generate topsoil in a similar fashion.

These efforts have been complemented by introducing beehives at the site to encourage pollination of flora and an extensive programme of reforestation.

Ulltra-High-Density Cattle Grazing, Mexico

88. *Environmental Impact Assessments* (EIAs) are crucial in the mining industry and most countries require an EIA to be formally approved before allowing a mining project to be developed. EIAs are currently described by some industry participants as a pivotal tool in balancing development opportunities and environmental protection and in recent regulations are assigned a fairly broad scope/purpose. However, it can be argued that, traditionally, EIAs have been primarily focused on risk avoidance – that is to avoid or reduce mining's potential adverse impacts.

'Good Practice' Disclosures and Stakeholder Expectations

Drawing from our survey of different disclosures and engagement with the mining analyst community regarding their interpretation of company reports and data, we were able to identify some key characteristics that industry analysts and stakeholder groups associate with (or expect from) **good practice in corporate disclosures on nature-related risks**. These can be summarised as follows:

- **Identification:** Does the disclosure identify, with adequate specificity, that mining activity is having direct nature-related impacts or might contribute to increased future risks/benefits to either species or people?
- **Qualification:** Does the disclosure include factual figures that quantify the activity that impacts species or people and/or quantify the nature and scale of the impact?
- **Remediation:** Does the disclosure reference remediation efforts that are actioned to reduce risk, or actions taken to improve the impact on species or people?
- **Assurance:** Does the disclosure reference collaborations and partnerships with external stakeholders to ensure remediation efforts and nature-focused actions are appropriate and validated as likely to achieve the desired outcomes?

On this basis, we evaluated the corporate disclosures of the member companies that operate the mines (identified under ***Appendix: Site-Level Metrics***), viewed in the context of the direct impacts the companies identified and described as being of a positive or negative risk to local species or people. We noted a broadly shared level of awareness of risks and impacts among most companies, coupled with responsive actions, although these were articulated through diverse perspectives, using varying metrics and levels of detail.

Disclosing Negative Impacts

Although this report seeks to arrive at a better understanding of gold mining's awareness of expanding societal and regulatory expectations on nature and biodiversity, as framed by global risk perspectives and key reporting frameworks (described in ***Section 1***), it is important to acknowledge the foundational nature of industry disclosures focusing on **negative impacts and harm avoidance.**

A survey of company reports[89] highlighted the following key areas of focus:

- **Contamination**
- **Operational Emissions and Waste Management**
- **Consumption**

Contamination

Disclosures addressing potential destructive impacts to local land, water and air from operational outputs and emissions – planned or accidental – and the steps taken to avoid or minimise their environmental consequences. Tailings management and acid rock drainage were noted as significant risks in this context. In the case of specific **problematic incidents** (toxic spillages, tailings breaches, excessive effluent discharges, etc.), it is expected that companies are clear and appropriately detailed in describing both the problem and the path to resolution or restoration.

Operational Emissions and Waste Management

Closely related to the above, but with a focus on *known* operational outputs, these disclosures are mainly focused on known waste management issues – hazardous and non-hazardous – and emissions (water, dust, diesel particulate matter, etc.) associated with mining operations. This category also includes water management and stewardship issues. This is an area that the mining industry has spent considerable time on, to ensure water is acknowledged as a critical resource for industrial, social and environmental purposes. Given the range and depth of industry guidance on this issue, we have chosen not to address it in detail here but acknowledge that efforts to protect or enhance the integrity and resilience of water systems is of pivotal importance. (See also *Consumption* below.)

Although greenhouse gases (GHGs)[90] are the emissions that are most obviously analysed and disclosed by most companies, with the expectation of associated emission reduction plans and actions, there is a very substantial body of work and extensive data on the industry's climate-related impacts. Whilst we acknowledge that there are likely significant benefits in moving towards a more integrated approach combining perspectives and plans on both climate- and nature-related issues, at this early 'mapping' stage, we have chosen to deliberately limit the focus of our analysis here. However, we expect convergent analytical and reporting frameworks to emerge in the near future, and this should form a fruitful area for the development of new research and strategies in coming years.

89. A range of sources was examined – for example, GRI tables, and sustainability and climate-focused reports published by the mining companies.
90. Including but not limited to CO_2.

Corporate Commitments and Local Action Plans

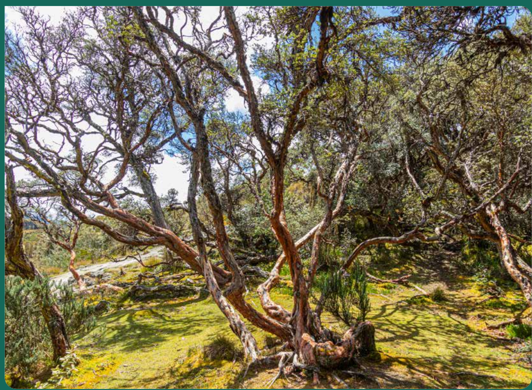
MINE #12, PERU

Mine #12, in Peru, ranks highly (11th in our sample of 122 gold mines) in terms of '*Ecosystem Degradation*', reflecting substantial accumulated impacts on the land's 'Structure'. The mining company which owns the site has a corporate commitment to conduct biodiversity and ecosystem impact assessments across all its operations, including this one.

In this case, recognising the severely degraded state of local land, they have supported the substantial (and award-winning) *Huella Verde* reforestation project in Cajamarca, aiming to plant one million trees by 2025. By the end of 2023, over 570,000 trees had been planted across 518 hectares. This is also estimated to have additionally benefited more than 380 families.

As part of its Biodiversity Action Plan (BAP) for Mine #12, the company has prioritised planting *Polylepis racemosa* in reclamation areas, and its 2023 disclosure indicates it has substantially exceeded its target of establishing 2,250 specimens.

Further specific actions to ensure no further net loss of nature include improving habitats for *Pristimantis simonsii*, prioritising planting of *Polylepis racemosa*, using Andean grassland in reclamation areas, and prohibiting disturbance of lagoons and bogs.



Queñua Tree *(Polylepis racemosa)*

Consumption

Although, conceptually, this might concern gold mining's use of any ecosystem service, we note above (see *Ecosystem Dependencies of Gold Mines*) that of the four services identified as key to mining operations, two relate to water (that is, 'Ground Water' or 'Surface Water' and 'Water Flow Management'). Disclosures relating to this aspect of water stewardship are not focused on mining impacts that may contaminate or compromise the quality of local water sources, but on reporting how operations might consume the water that others (communities and/or species) might also require.

Of course, in practice, sustainable water stewardship strategies will likely include a holistic approach that seeks to identify and mitigate any risk associated (directly or indirectly) with mining operations that might adversely affect water quantity and quality. Increasingly, those strategies will also need to account for the greater stress on water systems imposed by physical climate change impacts, although this is an area which still needs considerably more study: "*Climate change and extreme weather events (such as droughts, heatwaves, rainstorms and floods) pose serious challenges for water management, in terms of both water resources availability and water quality. However, the responses and mechanisms of river water quality under more frequent and intense hydroclimatic extremes are not well understood.*"[91]

As noted above, however (see *Water Stewardship and Good Practice Frameworks*), the mining industry has over the last decade or so developed fairly rigorous and robust frameworks to better manage its impacts and dependencies on local water systems. We might therefore expect responsible miners to exhibit further and continuous improvements in their water stewardship practices.

Disclosing Positive Plans and Actions

- ***Protection***
- ***Rehabilitation***
- ***Community***

Protection

Mining is generally understood to have inevitably disruptive or destructive impacts on ecosystems: "*Mining has long been recognized as a threat to protected areas and biodiversity in general, both directly due to habitat loss and degradation, and indirectly through supporting industries and increased access to biodiversity rich areas as a result of mining operations*".[92] This assertion may not entirely be supported by the

91. *Global river water quality under climate change and hydroclimatic extremes* (2023), M.T.H. van Vliet, J. Thorslund, M. Strokal, et al., *Nature Reviews Earth & Environment*, Vol. 4
92. *Mining, Biodiversity, and Protected Areas* (2023), IUCN

A Proactive Approach to Species and Ecosystem Protection

MINE #13, SENEGAL

Mine #13 is an open pit mine in Senegal that rates 'Very Low' in its *'Impact Ratio'*, although it scores higher in relation to the importance of '*Species Significance*'.

Whilst the *Nature Risk Profile* analysis attributes no responsibility to mining activity exerting pressures on key local species, the mine's operators have acted to proactively support biodiversity in and beyond the mine site by implementing a protection strategy for the surrounding area. Specifically, they have established a 1,500-hectare '*No Go Zone*' on land that falls within their concession to protect the West African chimpanzee (a critically endangered species). 5-7% of the Senegalese chimpanzee population live on this land.

This conservation project in Senegal focuses on protecting a designated zone through various measures such as providing water sources for wildlife, restoring pits, preventing bush fires, building protective barriers, and re-vegetating disturbed areas. Collaboration with local communities is essential, as they help shape the conservation strategy. By combining scientific methods with traditional knowledge, the mining company and its partners (including government authorities and environmental groups) enhance ecosystem management and environmental assessment. Additionally, the project is fostering sustainable economic activities like agriculture and beekeeping to support local communities.

In addition, the company is also undertaking a reforestation programme that has already reforested 390 hectares. In partnership with the *Senegalese Agency for Reforestation* and as part of the ambitious *Great Green Wall* initiative, its programme will also focus on the improvement of an irrigation system for the market gardening of four women's agricultural cooperatives in a neighbouring village.

Great Green Wall, Senegal
https://thegreatgreenwall.org/

findings of our analysis and might also be interpreted as reflecting assumptions and perceptions that may be rooted in mining's problematic history and legacy reputation rather than in current 'good practice'. Nonetheless, it is impossible to deny that some level of physical disruption and initially destructive impact is an intrinsic part of the development of mining assets – that is, a process that always results in an altered landscape with potential ecological consequences.

Much of the consideration given to mining's positive nature-focused actions has, until recently, centred on restoration and rehabilitation plans and actions, particularly near or after the mine's closure, to repair or reverse physical impacts and environmental damage (see below). However, there is increased attention now paid to biodiversity conservation and the ongoing monitoring and protection of local ecosystem integrity across the mine development cycle.

This can also make good business sense, reducing the risks and potential costs that might otherwise be associated with cumulative impacts that have not been mediated or mitigated over time.

Many of the *Case Studies* detailed herein suggest an industry that is increasingly prepared to accept responsibility for implementing protective actions reflective of a wider understanding of ecosystem vulnerabilities and dependencies.

Rehabilitation

Research[93] has suggested that the academic literature assessing mining's impact on ecosystems identifies the industry's main positive ecosystem impacts as mostly related to its site restoration activities. This can be defined as "*the restoration of biodiversity as well as ecosystem structure, functioning and services*"[94] through the repair and revegetation of areas degraded by

93. *Understanding the impacts of mining on ecosystem services through a systematic review* (2021), Boldy et al, *The Extractive Industries and Society*, Vol. 8, Issue 1
94. *Mine land rehabilitation: Modern ecological approaches for more sustainable mining* (2018), M. Gastauer et al, *Journal of Cleaner Production*, Vol. 172

Considering Infrastructure Impacts

MINE #14, TÜRKIYE

Mine #14 reports that its powerlines cross through a local National Park and a mountain Key Biodiversity Area. These powerlines are located at the intersection of major bird migration routes across Europe, Asia, and Africa, and consequently, to minimize their impact, bird flight diverters have been installed on the powerlines. The company's Environmental Team regularly monitors the area, alongside expert ornithologists, during migration seasons.

More broadly, the company has developed a Biodiversity Management Plan aligned with established policy frameworks - specifically, guidance from the European Bank for Reconstruction and Development (EBRD) - addressing habitat loss, invasive species, and wildlife risks from traffic. The company aims to achieve net gains for critical habitats and prevent biodiversity loss.

Additionally, a complementary Biodiversity Offset Management Plan includes efforts to reinforce the local oak population by collecting and planting acorns in designated areas. It also focuses on identifying and protecting endemic species at the mine, such as *Astragalus öksütdaghensis*, an endemic plant species.

mining activities and species restoration (*ecosystem reconstruction*[95]) activities.

The sites we have identified (via the *Nature Risk Profile* analysis) as scoring high in terms of levels of degradation are therefore those at which we might expect to see a more concerted and robust approach to rehabilitation. The significance of post-closure rehabilitation plans is also considered below (in the comments on *Mine Closure and Post-Closure 'Legacy' Actions*).

However, as we note above, there is a challenge when current methodologies offer little insight regarding causation and attribution. At locations where degradation has been an enduring feature of the landscape for a prolonged period, it may be difficult to define a meaningful benchmark or target state for rehabilitation. In many instances, mining companies are likely to be undertaking projects to restore ecosystems to a 'baseline state' that predates their presence or operational impacts by many years or decades. This suggests a wider set of reference points and more ambitious targets may be needed that extend well beyond the concept of 'no net loss'.[96] That said, this may need to be balanced with a set of rational expectations and collaborative commitments agreed by a broad set of local stakeholders, given that securing enduring biodiversity gains (for land degraded over a prolonged period) may be beyond the capacity or reach of any one company or site.

Fortunately, mining companies, their stakeholders, and the regulatory authorities in key mining jurisdictions, now recognise the significance of successful rehabilitation plans as key components of mine-site sustainability strategies and how local environmental impact performance is evaluated. They also acknowledge that rehabilitation commitments and actions are increasingly pivotal in ensuring mining companies are granted access to land and therefore have become an integral part of maintaining the credibility and long-term prospects of the industry.

The range of guidance on mine-site rehabilitation is now extensive, and summarising it in any level of detail or granularity is beyond the scope of this report. However, the core elements of good practice on rehabilitation (once the business case has been made and accepted), can be summarised as follows:

- Defining goals, benchmarks, and success measures for rehabilitation.
- Developing rehabilitation strategies by collaborating with stakeholders, setting objectives and completion criteria, and determining baseline conditions.
- Integrating and executing rehabilitation plans throughout the operational lifespan.
- Monitoring and documenting the progress of mine-site rehabilitation.

95. *Post-mining ecosystem reconstruction* (2024), M. Tibbett, *Current Biology*, Vol. 34, Issue 9
96. For example, for long-term degraded locations, the reference in Commitment 1.3 of the ICMM's 2025 Position Statement on Nature requiring companies to achieve '*no net loss or net gain of biodiversity by closure for all existing mining operations from a 2020 baseline or earlier*' will likely require further clarification regarding what '*net gains*' might be targeted against an '*earlier*' baseline.

While leading practice may imply an ongoing process across the mine lifecycle, typically, rehabilitation is viewed from a post-operational perspective.

In many countries, implementing these steps is not a question of choice or prioritisation; in many locations, mine-site rehabilitation is simply a legal obligation for all mining projects. This is true in several countries that host substantial gold mining operations, including Australia, Canada, the United States, and South Africa. Many of these regulations impose legal obligations on mining firms to not only ensure responsible closure and environmental recovery, but also to set aside funds for rehabilitation activities across the lifecycle of the mine. This can then reinforce the business case for more pro-active *protection* measures (as discussed above) to reduce the scale of eventual reparatory measures.

Rehabilitation or Restoration?

It should be noted that there is a case for differentiating between the concepts of *rehabilitation* and *restoration*, as they may imply a different set of ecological outcomes. Although both may seek to reverse or repair the decline in the 'structural' or functional complexity of ecosystems associated with a mine's negative impacts, **rehabilitation** efforts are often focused on restoring the functionality and productivity of the local land and ecosystem. Depending on the expectations and needs of stakeholders, including local communities, the resulting ecosystem may have a different land-use and species composition compared to its perceived 'original' state.

On the other hand, **restoration** has a more ambitious goal of re-establishing the ecosystem's structure and function to resemble its state before disturbance (or to replicate a desired reference ecosystem[97]). Restoration aims to create an ecosystem that follows a successional pathway, developing a structure, function, and composition similar - although not necessarily identical - to the original.

Communities

It is somewhat telling – and perhaps reflective of mining's problematic history - that analysts' views on the nature-related aspects of community relations often focus on disputes and conflicts, frequently related to competitive or disruptive use of local ecosystem resources, particularly water, and threats to ecosystem supply and delivery. Considerable tensions may also arise from shifts in local land-use and from relocations, which may have significant implications for communities when moved to sites with different ecosystem features and capacities. However, it should also be acknowledged that in our examination of gold mining companies' nature-related plans and site-level solutions (as described here in the selected ***Case Studies***), we encountered clear evidence of an awareness of the vulnerabilities and potential interdependencies linking mine sites and their host and neighbouring communities in relation to local environmental risks and ecosystem services.

We have noted in previous research published by the WGC, focused on gold mining responses to physical climate risks and impacts[98], that mutual benefits can flow from a programme of engagement and co-operation between different local stakeholders. Specifically, substantial improvements can be made when defining and implementing local adaptation and resilience strategies by shaping these as collaborative endeavours, with local communities and Indigenous peoples engaged in an ongoing dialogue and informational exchange with mine site operators. This is also highly relevant when considering the development of integrated planning to better manage wider local environmental risks and contribute to ecosystem and biodiversity resilience.[99]

Several of the *Case Studies* included here strongly suggest that gold mine owners and operators are increasingly aware of the significant benefits of adopting a collaborative approach to environmental stewardship which is shaped by community engagement and longer-term perspectives on ecological and social sustainability.

Looking at the lessons that can be drawn from projects that have empowered local communities to help deliver reforestation projects (often as part of nature-based climate mitigation programmes), we can summarise the benefits as follows:

- **Empowerment and Ownership:** Involving local communities fosters a sense of responsibility and pride, encouraging active participation in conservation efforts and sustainable practices.
- **Relevance and Context:** Tailoring projects to address the unique environmental challenges and needs of each community increases their relevance and chances of success.
- **Collaboration:** Engaging local communities facilitates partnerships with various stakeholders, pooling resources and expertise for greater impact.
- **Local Expertise:** Communities possess valuable knowledge about their environment, helping to identify sustainable solutions and traditional practices.

97. A *reference ecosystem* – or *ecological reference* - is a real or notional community of organisms that can act as a model or benchmark for restoration – for further details: https://docs.ers.org/standard1.0/reference-ecosystem-guidelines.pdf
98. https://www.gold.org/goldhub/research/gold-and-climate-change-adaption-and-resilience
99. See also the recommendations in the ICMM's Good Practice Guide on *Achieving No Net Loss or Net Gain of Biodiversity* (2025). For example, its advice on stakeholder consultation suggests, "*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.*"

- **Education:** Environmental projects educate communities about conservation and sustainable practices, leading to behavioral changes and long-term development.

- **Social and Economic Benefits:** Involving communities can generate employment, support local businesses, and improve livelihoods, fostering social cohesion and economic resilience.

- **Sustainability:** Active community involvement in decision-making and implementation ensures the longevity and effectiveness of projects, even after external support ends.

This perspective is also reinforced by recent academic research, which concludes:

> "*Our findings suggest that equitable conservation, which empowers and supports the environmental stewardship of Indigenous peoples and local communities represents the primary pathway to effective long-term conservation of biodiversity, particularly when upheld in wider law and policy. Whether for protected areas in biodiversity hotspots or restoration of highly modified ecosystems, whether involving highly traditional or diverse and dynamic local communities, conservation can become more effective through an increased focus on governance type and quality, and fostering solutions that reinforce the role, capacity, and rights of Indigenous peoples and local communities*."[100]

Overall, engaging local communities in nature-focused projects and conservation actions not only acknowledges their perspectives and empowers them to take action, it improves the likely success and resilience of such projects over time. It can also foster further collaborations between mines and local communities and be pivotal in helping cement a mine's social license to operate.

Mine Lifecycle Impacts

Many measures of mine site impacts focus on a comparison of the state of local ecosystems compared against a baseline state or set of conditions that strive to capture a location's undisturbed or 'pristine' state. Identifying how to capture that state is not a simple matter, not least given the limited data we have on the natural history of many locations.

But 'snapshot' measures of impacts also frequently fail to capture the shifting dynamics of industrial enterprises – in this case, they may fail to consider that site-level impacts will vary considerably depending on where a particular gold mine is in its 'lifecycle'.

Recent research considering mine lifecycle implications for climate actions suggests a combinational approach which synthesises a site's operational and economic implications – drawing overlapping insights from analysis of both the mine lifecycle and the mining value chain - can be productive in highlighting *specific climate-related challenges and opportunities at every juncture, underscoring the importance of strategic mine planning with climate objectives*".[101] There is a strong case for applying a similar approach when devising nature-focused strategies and mapping out local pathways towards enhanced environmental sustainability.

The majority of **the mines we have analysed in this study are operational, *producing* mines** (engaged in extraction and processing), and while it is highly likely that the most substantial impacts will occur during this phase of a mine's life, we should acknowledge that the process of developing a mine unfolds in several distinct stages, each with varying degrees of impact on local ecosystems and biodiversity. Specifically, prior to the physical extraction of ore, we should also consider the following stages and the associated nature-related risks.

1. Exploration

Before a mine is developed, companies conduct geological surveys and exploratory drilling to determine where gold deposits are located. This stage may result in some level of habitat disruption due to land clearing and increased human activity, disrupting local wildlife.

2. Development and Construction

Once a viable gold deposit is found, infrastructure such as roads, processing plants, and housing is often built. Gold mining sites differ from the mining of other metals in their infrastructure requirements due to their relative independence in being able to operate in isolated areas without much infrastructure support. Nonetheless, this phase may lead to further ecosystem disruption, such as further land clearance, deforestation, soil erosion, and water impacts.

100. *The role of Indigenous peoples and local communities in effective and equitable conservation* (2021), Dawson et al, *Ecology and Society* 26. This article presents a systematic review of 169 publications investigating how different forms of governance influence conservation outcomes, paying particular attention to the role played by Indigenous peoples and local communities.
101. *Knowledge synthesis on the mine life cycle and the mining value chain to address climate change* (2024), Alireza Gholami, Batur Tokac, Qian Zhan, *Resources Policy*, Vol. 95

However, prior to the latter activity - mine development - and applicable in almost all jurisdictions, mining companies are required to conduct **environmental impact assessments** (EIA) or environmental and social impact assessments (ESIA). In some locations, such assessments are also required prior to the earlier exploration activities. These (particularly ESIAs) enable local authorities, regulators, and stakeholders to participate in the identification and review of predicted impacts and to evaluate the proposed mitigation measures for a mine before plans are finalised or approved. When developing such mitigation strategies, mining companies generally use a *mitigation hierarchy* to avoid negative impacts or, where avoidance is not possible, to minimise or compensate for those impacts via explicit environmental risk management measures. However, in our examination of different methodologies for identifying and categorising locational biodiversity risk (including the *Nature Risk Profile* approach we applied in our mine site analysis), there was no clear way to acknowledge the different impacts related to lifecycle stages or to capture the possible consequences, over time, of site-level risk mitigation plans.

That said, and as noted above, the crucial milestone and comparison point for evaluating the long-term impacts of mining operations on the local environment is typically taken to be what can be observed at the point of a mine's closure and at a point (or points) after rehabilitation actions have been implemented. There is a potential case to be made here for applying the *Nature Risk Profile* approach in this context. That is, to define a 'baseline', either before or at the point of closure or rehabilitation, enabling the site to track the subsequent development of the local ecosystem over time.

In *Commitment 1.3* of its *Position Statement on Nature*[102], the ICMM describe that compliance "*…requires achieving **no net loss or net gain of biodiversity by closure** for all existing mining operations from a 2020 baseline or earlier, and for all new operations and significant expansions against a pre-operation or pre-expansion baseline, respectively*."

While the definition of a practical 'baseline' - from which impacts and progress can be measured - may be challenging, there is little doubt regarding the significance of the plans leading up to and in the wake of mine closure.

Mine Closure and Post-Closure 'Legacy' Actions

It has been understood for some time that responsible mine closures are key to ensuring sustainable outcomes of benefit to both the local environment and the socio-economic prospects of neighbouring communities.

Mine closure planning will likely begin long before the end of operations and is increasingly an integral component of the initial mine design and pre-operational approval process. It will also include considerations beyond current and future environmental commitments and obligations, including, for example, workforce, socio-economic and community transition plans.[103] But given the accepted importance of the closure and post-closure phases of the mine lifecycle, there is now a fairly deep pool of guidance and knowledge that should increasingly lead to convergent industry understanding and actions which move the whole sector, including gold mining, towards prioritising the achievement of positive legacy impacts – including a shift to net gains in biodiversity.

It is hoped this will counter the deficiencies that still exist in both regulations and some company practices, often resulting from ineffective or inadequate closure/post-closure plans and insufficient financial resources to ensure their effective implementation.

As noted above, mine closure and post-closure plans and actions have become a key milestone in evaluating the progress and success of mine site rehabilitation strategies; "*Completion (or closure) criteria are defined as rehabilitation performance objectives that provide an indication of mine rehabilitation success and the likelihood that the site has reached its agreed closure state (i.e. rehabilitation objective).*"[104]

102. https://www.icmm.com/en-gb/our-principles/position-statements/nature
103. To guide these plans, the ICMM have recently published a *Handbook on Multistakeholder Approaches to Socio-Economic Transitions in Mining* (2025); https://www.icmm.com/en-gb/guidance/social-performance/2025/multistakeholder-approaches-socio-economic-transitions
104. *Mine Rehabilitation - The Leading Practice Sustainable Development Program for the Mining Industry* (2016); https://www.industry.gov.au/sites/default/files/2019-04/lpsdp-mine-rehabilitation-handbook-english.pdf

Community Engagement and Water Management

MINE #15, PERU

Mine #15, an open pit mine in Peru, is rated as relatively high in its overall *'Impact Ratio'*. This is driven in the first instance by its *'Species Significance'*, but the site is also has significance in terms of its *'Ecosystem Contribution'*, in particular, in ecosystem services linked to water quality such as sediment and nitrogen retention.

Reviewing site-level actions and plans, we have identified that the mine's current operators have prioritised those impacts previously flagged as being most problematic and likely to have wider consequences on both species and people – that is, specifically, the need for enhanced water stewardship whilst reducing potential negative impacts from local community and informal mining activities.

Since acquiring the mine in 2019, the company has made significant strides in improving water conditions and ecosystem services, with a clear awareness of community needs and dependencies, alongside consideration of historical impacts from previous mining-related activities. Exploration and mining activities have been conducted on these lands since 1945, and the mine recognises that to build environmental resilience it has also had to address previous industry failures whilst considering wider social needs.

Having established a Water Management Committee, the company invested over $2.5 million in surface water management improvements and more than $12 million in constructing a new wastewater treatment plant. To support nearby communities, the mine installed 23 chlorination systems to provide safe drinking water to over local 16,000 people, and initiated water collection and conduction system improvement projects, in collaboration with the local municipality, to the benefit of approximately 5,000 inhabitants from five neighbouring hamlets.

Meanwhile, to reduce the mine's water consumption levels, the site team deployed innovative molasses-based additives, produced from a local sugar cane business, to reduce the amount of water used for dust control by 23%.

The beneficial impacts of these projects were recognised by the Peruvian National Water Authority which awarded the mine a Blue Certificate for company actions towards the efficient management and use of water.

The value of collaborative and inclusive environmental management processes is also reflected in the mine's initiation of participatory environmental monitoring sessions, involving local authorities and village representatives in water, air, and noise quality sampling.

The mine is situated in a region where artisanal-scale gold mining (ASGM) is established as a traditional livelihood, and the company has sought to demonstrate a sensitivity to this activity and the communities it supports whilst addressing environmental challenges that arise from informal mining . Having identified 118 groups of informal miners adjacent to their mining concession, the company engaged in round table discussions with many of these miners to define and update environmental, social, and economic baselines by which different employment and sustainable solutions might offer local people alternative economic activities. Exploring a different path, in 2024, a Framework Agreement was signed with two informal mining groups to establish an area to facilitate their operations being undertaken in compliance with Peru's comprehensive mining formalisation process.

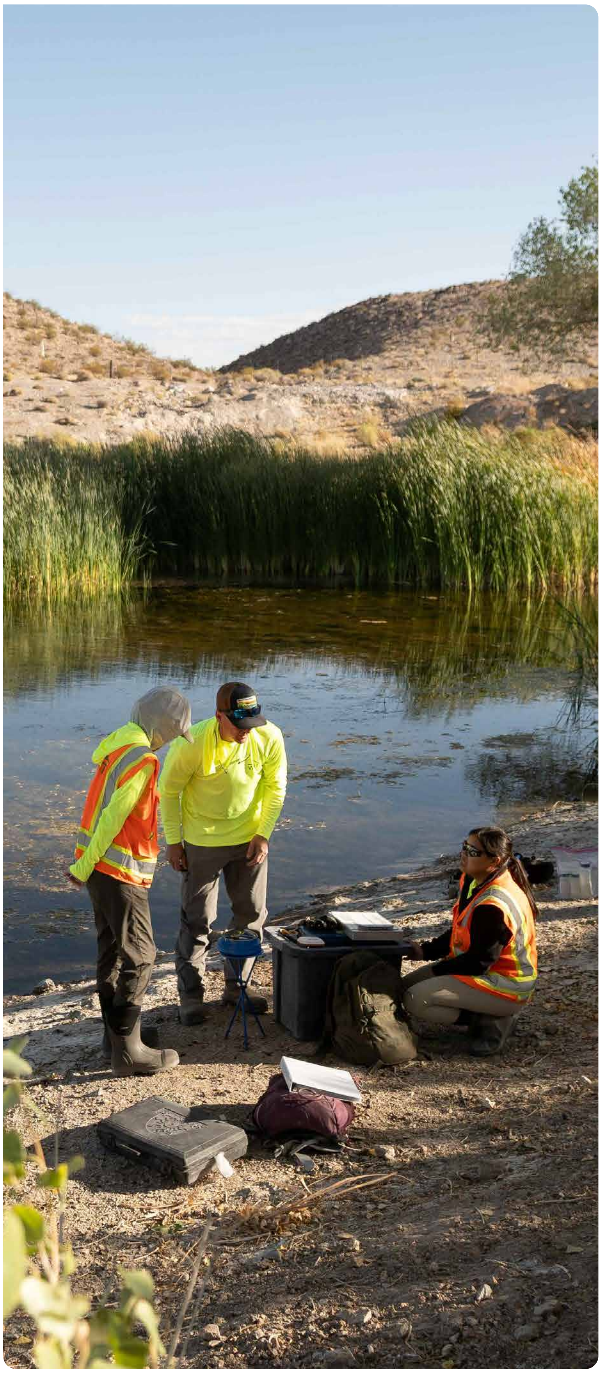
The mining company, aware of the need to balance community demands on ecosystem services with enduring livelihoods, has supported a range of sustainable agriculture projects, particularly focused on avocado production. In 2021, it launched an 8-year project to strengthen avocado production, aiming to create a robust income source for 500 local producers. Additionally, five seedling nurseries, managed by a local company and a women's group, have been established within the mine site. And the mine has also contributed to building greater resilience in local flood mitigation efforts, including planting bamboo to prevent soil erosion and protect agricultural areas.

Water flow regulator, Peru

6. Conclusion

The application of the *Nature Risk Profile* methodology to a sample of 122 gold mines produced some significant findings regarding the general pattern of nature-related risks and impacts associated with current gold mining operations. These include the following:

- The overall data shows that the majority of gold mine sites (in our sample) have a relatively low impact on nature and biodiversity. Of 122 gold mines, 71% of mines are classified as being in or below the '*Low*' impact category. This suggests that, as a sector, gold mining may be less impactful on global ecosystems than is often be assumed.
- Of the 122 sites examined, 17 overlap with a *Protected Area*, and 8 overlap with a *Key Biodiversity Area* (KBA). In terms of the sites' collective footprint in these sensitive areas, 6% was sited in a Protected Area and 4% in a Key Biodiversity Area. If we look at a global overview of these areas, our sample data suggests that the industry's overlap with such designated sensitive areas is very small.
- Of the 16 mine sites estimated to have a '*Very High*' impact, the majority of them are in an area of both very high *'Ecological Significance'* and of very high *'Ecosystem Degradation'*. However, it should be noted that there are severe limits to the degree of attribution or causation that can be drawn from these impact metrics, even where analysis suggests mining activity is associated with a particularly 'threat' level. A closer examination of many local sites suggests historic causes and/or other local economic activities may be associated with these negative impacts.
- That said, examining 15 mine sites in greater local detail - analysing corporate disclosures and site-level insights - indicated a welcome level of awareness of local historic and current drivers and conditions, with corresponding measures initiated by gold mine owners/operators seeking not only to rehabilitate degraded land but also protect flora and fauna. Mining company actions were frequently located well beyond operational sites, often reflecting an additional awareness of the importance of ecosystem services to local communities and wider environmental interdependencies.



Environmental assessment, USA

We believe that the approach used in this report, complementing high-level nature-related risk metrics with local insights and an analysis of mine site-level plans and responses, can be developed further to contribute to a greater understanding of the status of gold mining's impacts on nature and biodiversity.

In the language of the *Taskforce on Nature-related Financial Disclosures*, our analysis suggests this combinational approach should help clarify how nature-related risks are ***Located*** and ***Evaluated*** – via standardised metrics. An overlay of site-level insights can then help all stakeholders better ***Assess*** the local risks in practical detail, while companies and their partners can ***Prepare*** their responses and solutions.

More specifically, the indicators and metrics provided by the *Nature Risk Profile* approach, whilst still evolving and with known constraints, offer investors and gold mine operators and stakeholders a useful comparative framework by which very different sites can be evaluated. They also provide a foundation for the definition of baselines from which future progress can be measured. But detailed local site-level analysis is also required if practical solutions are to be defined and implemented. Our examination of a range of gold mines in very different locations and biomes reflect an industry that is increasingly aware of its impacts on local ecosystems and is already active in striving to shift from a position of 'no net harm' to strategies that might contribute to further ecosystem recovery and resilience.

Gold mine, Canada

Appendix 1

Indicators, Metrics, and Definitions

Ecological significance is defined in a number of frameworks with similar objectives but different emphasis depending on their purpose and intended audience.

Measuring the environmental aspects of that significance, we can use methods such as the following:

- **Ecosystem Services Valuation:** Assigning economic value to ecosystem services.
- **Biodiversity Indices:** Measuring species diversity and abundance.
- **Carbon Sequestration:** Quantifying carbon absorption by ecosystems.
- **Habitat Quality and Extent:** Monitoring the health and area of habitats.
- **Ecosystem Health Indicators:** Assessing metrics like water quality and soil fertility.

Acknowledging these measures, but focusing on investor understanding of the financial risks associated with biodiversity loss and ecosystem degradation, UNEP and S&P Global's *Nature Risk Profile* methodology references a number of key types of metrics:

- **Risk Exposure Metrics:** Quantifying a company's exposure to biodiversity-related risks.
- **Impact Metrics:** Measuring the impact of a company's operations on biodiversity and ecosystems.
- **Dependency Metrics:** Assessing how much a company relies on ecosystem services for its operations.
- **Scenario Analysis:** Evaluating potential future risks under different environmental scenarios.

The *Nature Risk Profile* indicators often build on established descriptors, data sets and reference points – some of which are summarised below. Detailed descriptions of the specific metrics that comprise the *Nature Risk Profile* are offered below (in the *Nature Risk Profile Definitions – Impacts and Dependency Metrics* section).

The Species Threat Abatement and Restoration (STAR) Metric

The STAR score (T) for a location (i) and threat (t) is calculated among all species as:

$$T_{t,i} = \sum_{s}^{N_s} P_{s,i} W_s C_{s,t}$$

P	current Area of Habitat (AoH)
s	species
i	location
t	threat
W	IUCN Red List category weight of species
C	is the relative contribution of threat t to the extinction risk of species
N	total number of species at location i

Source: https://www.nature.com/articles/s41559-021-01432-0.epdf

Ecosystem degradation refers to the deterioration of the natural environment due to the depletion of resources such as air, water, and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution. It encompasses any change or disturbance to the environment perceived to be harmful or undesirable.

Land Structure and Stressors: A key concept in the measurement of ecosystem degradation is that of the 'structure' of land which refers to the cumulative impact of human activities, which stress and modify the physical and biological characteristics of the land. The *stressors* identified in degradation metrics are:

Human Settlement
This includes population density and the development of built-up areas.

Agriculture
The conversion of natural landscapes into cropland and livestock areas is a major factor in land degradation.

Transportation
The construction of major and minor roads, two-tracks, and railroads alters the land structure by fragmenting habitats and increasing pollution.

Mining and Energy Production
Activities such as mining, industrial operations, and the installation of oil wells and wind turbines significantly modify the land.

Electrical Infrastructure
The presence of powerlines and night-time lights can impact wildlife and alter natural processes.

Understanding and managing these stressors is viewed as crucial for mitigating their adverse effects on ecosystems and promoting sustainable land use practices.

The **baseline** for measuring ecological degradation typically involves assessing the state of ecosystems and biodiversity at a specific point in time – theoretically, before significant human impact. This baseline can include various indicators such as:

- *Biodiversity Levels:* The variety and abundance of species in an ecosystem.
- *Ecosystem Health:* Indicators like soil quality, water purity, and air quality.
- *Habitat Extent and Condition:* The area and quality of natural habitats.

Ecosystem Services: The benefits provided by ecosystems, such as pollination, water filtration, and carbon sequestration. (See the ENCORE classifications below)

These baselines are often established through a combination of historical data, scientific analysis, and long-term monitoring. By comparing current and changing conditions (to the conceptual baselines), we can quantify the extent of ecological degradation over time.

ENCORE Classification of Ecosystem Services

The ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) tool categorises ecosystem services - the benefits that humans receive from the natural environment - as follows:

1. **Provisioning Services:**
    - Crops
    - Livestock
    - Capture fisheries
    - Aquaculture
    - Wild foods
    - Timber
    - Fiber
    - Biomass-based energy
    - Freshwater
2. **Regulating Services:**
    - Air quality regulation
    - Climate regulation
    - Water flow regulation
    - Water purification
    - Erosion control
    - Pollination
    - Pest control
    - Disease control
3. **Cultural Services:**
    - Recreation and tourism
    - Aesthetic value
    - Spiritual and religious value
    - Educational value
4. **Supporting Services:**
    - Soil formation
    - Nutrient cycling
    - Primary production
    - Habitat provision
    - Biodiversity maintenance

These categories aim to capture the different ways ecosystems contribute to human well-being and economic activities.

Nature Risk Profile Definitions – Impacts and Dependency Metrics

The specific metrics that comprise the *Nature Risk Profile* approach are described below:

Nature-related Impacts:

Impact Ratio[105] – a conceptual and normalised metric that expresses nature-related impacts as the proportion of a mine site's total physical footprint that would be the most significant ecosystem and land that is fully degraded.

Calculation: $\frac{\text{Ecosystem Footprint (ha HSA eq)}}{\text{Land Use Footprint (ha)}}$

Unit: Highest Significant Area equivalent (HSA eq)

Impact on Nature – an indicator expressing nature-related impacts as an area equivalent to a mine site's total physical footprint perceived as fully degradaed if the impact took place in the most significant ecosystem.

Metric: Ecosystem Footprint (EF)

Calculation: Land use x Ecosystem Integrity Impact Index (EIII) x Ecosystem Significance Index (ESI)

Unit: Hectares of Highest Significant Area equivalent (ha HSA eq.)

Magnitude of impact – scale and size of nature-related impacts in a given location.

Metric: Ecosystem Integrity Footprint (EIF)

Calculation: Land use x Ecosystem Integrity Impact Index

Unit: Hectares equivalent (ha eq.)

Ecosystem Degradation[106] – the present ecosystem integrity of a given location compared to its 'natural' (or current potential) reference level. This state/condition constitutes three key components – structure, composition, and function – and takes a maximal value approach, whereby the highest (i.e. most degraded) scoring component reflects the overall land degradation, as an ecosystem's integrity cannot be higher than the lowest value of its three contributing layers.

Metric: Ecosystem Integrity Impact Index (EIII) (and its inverse, Ecosystem Integrity Index – EII)

Calculation (EIII): Max(1 - structure EII, 1 - composition EII, 1 - function EII)

Unit: 0 (lowest; pristine) – 1 (highest; fully degraded)

Structure – cumulative impact of human activities, which stress and modify the physical and biological characteristics of the land. The 12 stressors identified are: croplands, pasturelands, rangelands, plantations, built-up areas, human population density, roads, rails, quarries and mining, wind turbines, electrical infrastructure, and powerlines (see also the comments on Land Structure and Stressors above).

Composition – the change in the identity and variety of ecological communities in a given location in response to human pressures.

Function – the difference between current and potential natural net primary productivity within a given location.

Significance of Location / Ecosystem Significance – the ecological importance of a given location.

Metric: Ecosystem Significance Index (ESI)

Calculation: Max(species significance, ecosystem contribution)

Unit: 0 (lowest; least significant) – 1 (highest; most significant)

105. 'Impact Ratio', 'Impact on Nature', 'Magnitude of Impact', 'Significance of Location', and all 'Dependency on Nature' metrics are sourced from S&P Global and UNEP-WCMC, *Nature Risk Profile* (2022).
106. 'Ecosystem Degradation' (and its three component parts) are sourced from Hill et al., *The Ecosystem Integrity Index* (2022)

Species Significance[107] – the relative importance of a location for biodiversity conservation.

Metric: Normalised Species Threat Abatement and Restoration (STAR)

Unit: 0 (lowest; least significant) – 1 (highest; most significant)

Calculation: please review - Mair et al., *A metric for spatially explicit contributions to science-based species targets* (2021)

Ecosystem Contribution to People – the relative importance of a location for the provision of services to people and society.

Metric: Ecosystem Contribution Index (ECI)

Unit: 0 (lowest; least important) – 1 (highest; most important)

Calculation: please review - Chaplin-Kramer et al., *Mapping the planet's critical natural assets* (2022)

Asset-level flags – additional binary contextual flags, sourced from area-based data layers, as to the significance of a given location and the associated asset-level impacts.

Overlap with Protected Areas – whether a mine site is located within an area listed in the World Database of Protected Areas (WDPA) and how much of the site's area overlaps with the Protected Area(s).

Unit(s): Yes/No and Total Area (ha)

Overlap with Key Biodiversity Areas – whether a mine site is located within a Key Biodiversity Area (KBA) and how much of the site's area overlaps with the KBA(s).

Unit(s): Yes/No and Total Area (ha)

Nature-related dependencies:

Nature-related dependencies – the level of reliance a business has on 21 different ecosystem services.

Metric: Dependency score

Calculation 1 (dependency per ecosystem service):

$$Dependency\ score_i = \sqrt[n]{Reliance\ score_i * Resilience\ score_i}$$

Where
- i: Ecosystem service i
- n: Number of relevant score components for ecosystem service i
- All 3 materiality, reliance and resilience scores range from 0 to 1

Calculation 2 (dependencies per sector):

$$Composite\ score_j = f\left(\sum_{i=1}^{m} Dependency\ score_i\right)$$

Where
- i: Ecosystem service i
- j: Sector/process j
- m: Number of ecosystem services

Calculation 3 (dependencies per asset or company):

$$Aggregate\ score_k = \sum_{j=1}^{z} w_j * Composite\ score_j$$

Where
- j: Sector j
- wj: Weight of sector/asset j in company revenue
- m: Number of sectors/asset in company portfolio

Reliance on an ecosystem service – the extent to which company activities depend on ecosystem services, thus determining the level of risk exposure.

Metric: Reliance score

Calculation: $\sqrt[n]{Materiality\ score_i * Relevance\ score_i}$

Materiality score – sourced from the ENCORE knowledge base, it assesses the links between each sector of the global economy, the ecosystem services that support their production processes, and the natural capital assets that support those services.

Relevance score – adjusts each materiality score with a normalised value representing the potential benefits to be gained for each regulating service.

Resilience of an ecosystem service – the ability of ecosystems to reliably provide a service that a company relies on, thus determining the likelihood of risk.

Metric: Ecosystem Integrity Impact Index (EIII) (and its inverse, Ecosystem Integrity Index – EII)

Calculation (EIII): Max(1 - structure EII, 1 - composition EII, 1 - function EII)

Unit:0 (lowest; least relevant) – 1 (highest; most relevant).

107. 'Species significance', 'Overlap with protected areas' and 'Overlap with Key Biodiversity Areas' are all sourced from the Integrated Biodiversity Assessment Tool (IBAT).

Appendix 2

Gold Mine Site Profiles

We here provide a brief summary of the data for individual mine sites from our quantitative analysis. The sites were chosen to cover a range of biomes and geographic locations, with a **focus on those with an elevated level of ecological significance** or offering **examples of good practice**. We have anonymised the mine sites simply because we primarily want to direct attention to specific site characteristics, key biodiversity impacts, and company and site-level responses of potential relevance to the wider industry. The owning/operating companies of these mines are not specified here, but we have examined their corporate disclosures and plans to extract relevant insights regarding their associated strategies and plans.

Anonymised Mining Assets/Sites

Mine	Country	Driver(s) of Impact	Biome
Mine 1	Nicaragua	Species Significance and Ecosystem Contribution	Temperate Broadleaf & Mixed Forests
Mine 2	Canada	Ecosystem Degradation	Boreal Forests/Taiga
Mine 3	Mexico	Significance of Location	Tropical & Subtropical Dry Broadleaf Forests
Mine 4	Tanzania	Ecosystem Contribution	Tropical & Subtropical Grasslands, Savannas & Shrublands
Mine 5	Dominican Republic	Ecosystem Degradation and Species Significance	Tropical & Subtropical Moist Broadleaf Forests
Mine 6	Finland	Ecosystem Contribution	Boreal Forests/Taiga
Mine 7	Peru	Species Significance	Montane Grasslands & Shrublands
Mine 8	Australia	Ecosystem Degradation, Species Significance and Ecosystem Contribution	Temperate Broadleaf & Mixed Forests
Mine 9	Mexico	Water Stewardship	Tropical & Subtropical Coniferous Forests
Mine 10	USA	Water Stewardship	Boreal Forests/Taiga
Mine 11	Mexico	Ecosystem Degradation	Tropical & Subtropical Coniferous Forests
Mine 12	Peru	Ecosystem Degradation	Montane Grasslands & Shrublands
Mine 13	Senegal	Species significance	Tropical & Subtropical Grasslands, Savannas & Shrublands
Mine 14	Türkiye	Biodiversity Management	Temperate Broadleaf & Mixed Forests
Mine 15	Peru	Species Significance	Tropical & Subtropical Moist Broadleaf Forests

MINE #1, NICARAGUA

MINE #1 is located in the Nicaraguan Temperate Broadleaf & Mixed Forests. The 'Ecosystem Significance' around the asset is driven by 'Significance to People' but also has 'Significance to Species'.

Ecosystem Footprint (ha HSA eq.)	21
Impact Ratio (0-1)	0.19
Ecosystem Degradation (0-1)	0.36
Ecosystem Significance (0-1)	0.54
Species Significance (0-1)	0.05
Thereof amphibians (%)	47
Thereof birds (%)	47
Thereof mammals (%)	6
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.54
Nitrogen retention (%)	0
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	14
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	17
Fuelwood (%)	17
Flood mitigation (%)	17
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	17
Nature access within 1 hour travel (%)	17
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #2, CANADA

MINE #2 is located in the Canadian Boreal Forests/Taiga, next to a river and in close proximity to a town of 30,000 inhabitants. The 'Ecosystem Significance' around the asset is driven by its 'Significance to People', more so than to species.

Ecosystem Footprint (ha HSA eq.)	13
Impact Ratio (0-1)	0.37
Ecosystem Degradation (0-1)	1.00
Ecosystem Significance (0-1)	0.37
Species Significance (0-1)	0.01
Thereof amphibians (%)	NA
Thereof birds (%)	51
Thereof mammals (%)	49
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.37
Nitrogen retention (%)	0
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	25
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	0
Fuelwood (%)	25
Flood mitigation (%)	0
Riverine fish (%)	25
Marine fish (%)	0
Grazing (%)	0
Nature access within 1 hour travel (%)	25
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #3, MEXICO

MINE #3 is located in the Mexican Tropical & Subtropical Dry Broadleaf Forests. The site overlaps with a Key Biodiversity Area that has high significance due to the presence a critically endangered plant.

Ecosystem Footprint (ha HSA eq.)	135
Impact Ratio (0-1)	0.27
Ecosystem Degradation (0-1)	0.51
Ecosystem Significance (0-1)	0.53
Species Significance (0-1)	0.05
Thereof amphibians (%)	0
Thereof birds (%)	1
Thereof mammals (%)	99
Attribution to mining & quarrying (%)	1
Ecosystem Contribution (0-1)	0.53
Nitrogen retention (%)	22.2
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	11.1
Carbon storage (%)	0
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	22.2
Fuelwood (%)	0
Flood mitigation (%)	0
Riverine fish (%)	22.2
Marine fish (%)	0
Grazing (%)	22.2
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	242

MINE #4, TANZANIA

MINE #4 is located in the Tanzanian Tropical & Subtropical Grasslands, Savannas & Shrublands, next to a city of 300,000 inhabitants. The 'Ecosystem Significance' around the asset is driven primarily by its 'Significance to People'.

Ecosystem Footprint (ha HSA eq.)	1,156
Impact Ratio (0-1)	0.41
Ecosystem Degradation (0-1)	0.59
Ecosystem Significance (0-1)	0.69
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	93
Thereof mammals (%)	7
Attribution to mining & quarrying (%)	1
Ecosystem Contribution (0-1)	0.71
Nitrogen retention (%)	12
Pollination (%)	5
Reef tourism (%)	0
Sediment retention (%)	7
Carbon storage (%)	7
Moisture regulation (%)	12
Coastal risk reduction (%)	0
Timber production (%)	12
Fuelwood (%)	12
Flood mitigation (%)	12
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	12
Nature access within 1 hour travel (%)	12
Area Overlapping with Protected Areas (ha)	1,600
Area Overlapping with KBAs (ha)	0

MINE #5, DOMINICAN REPUBLIC

MINE #5 is located in the Tropical & Subtropical Moist Broadleaf Forests, in a less populated area in the centre of the Dominican Republic. The 'Ecosystem Significance' around the asset is driven both by 'Significance to Species' and to 'People'.

Ecosystem Footprint (ha HSA eq.)	277
Impact Ratio (0-1)	0.38
Ecosystem Degradation (0-1)	0.61
Ecosystem Significance (0-1)	0.62
Species Significance (0-1)	0.60
Thereof amphibians (%)	55
Thereof birds (%)	35
Thereof mammals (%)	10
Attribution to mining & quarrying (%)	8
Ecosystem Contribution (0-1)	0.32
Nitrogen retention (%)	0
Pollination (%)	2
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	15
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	15
Fuelwood (%)	14
Flood mitigation (%)	9
Riverine fish (%)	15
Marine fish (%)	0
Grazing (%)	15
Nature access within 1 hour travel (%)	14
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #6, FINLAND

MINE #6 is located in the Finnish Boreal Forests/Taiga, with no population centres in close proximity. The 'Ecosystem Significance' around the asset is driven by its 'Significance to People', more so than to 'Species'.

Ecosystem Footprint (ha HSA eq.)	57
Impact Ratio (0-1)	0.1
Ecosystem Degradation (0-1)	0.29
Ecosystem Significance (0-1)	0.33
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	83
Thereof mammals (%)	17
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.35
Nitrogen retention (%)	0
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	50
Moisture regulation (%)	50
Coastal risk reduction (%)	0
Timber production (%)	0
Fuelwood (%)	0
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	0
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #7, PERU

MINE #7 is located in the Peruvian Montane Grasslands & Shrublands, next to a town of 16,000 inhabitants. The 'Ecosystem Significance' around the asset is driven by its high 'Significance to Species' and moderate 'Significance to People'.

Ecosystem Footprint (ha HSA eq.)	303
Impact Ratio (0-1)	0.43
Ecosystem Degradation (0-1)	0.63
Ecosystem Significance (0-1)	0.69
Species Significance (0-1)	0.55
Thereof amphibians (%)	98
Thereof birds (%)	0
Thereof mammals (%)	2
Attribution to mining & quarrying (%)	32
Ecosystem Contribution (0-1)	0.29
Nitrogen retention (%)	16
Pollination (%)	16
Reef tourism (%)	0
Sediment retention (%)	16
Carbon storage (%)	1
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	0
Fuelwood (%)	16
Flood mitigation (%)	1
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	16
Nature access within 1 hour travel (%)	16
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #8, AUSTRALIA

MINE #8 is located in the South Eastern Australia's Temperate Broadleaf & Mixed Forests. The 'Ecosystem Significance' around the asset is driven by 'Significance to People', although it is also 'Significant to Species', particularly amphibians and birds.

Ecosystem Footprint (ha HSA eq.)	252
Impact Ratio (0-1)	0.17
Ecosystem Degradation (0-1)	0.35
Ecosystem Significance (0-1)	0.49
Species Significance (0-1)	0.04
Thereof amphibians (%)	59
Thereof birds (%)	34
Thereof mammals (%)	7
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.45
Nitrogen retention (%)	25
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	12.5
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	12.5
Fuelwood (%)	25
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	25
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	4
Area Overlapping with KBAs (ha)	195

MINE #9, MEXICO

MINE #9 is located in the Mexican Tropical & Subtropical Coniferous Forests. The mine's owners have identified the site has high baseline water stress as classified by the World Resources Institute (WRI) Water Risk Aqueduct Tool.

Ecosystem Footprint (ha HSA eq.)	211
Impact Ratio (0-1)	0.04
Ecosystem Degradation (0-1)	0.34
Ecosystem Significance (0-1)	0.12
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	71
Thereof mammals (%)	29
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.12
Nitrogen retention (%)	0
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	0
Moisture regulation (%)	50
Coastal risk reduction (%)	0
Timber production (%)	0
Fuelwood (%)	0
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	50
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #10, USA

MINE #10 is located in the U.S. Boreal Forests/Taiga. This area has experienced mining since the early 1900s.

Ecosystem Footprint (ha HSA eq.)	28
Impact Ratio (0-1)	0.01
Ecosystem Degradation (0-1)	0.26
Ecosystem Significance (0-1)	0.05
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	43
Thereof mammals (%)	57
Attribution to mining & quarrying (%)	2
Ecosystem Contribution (0-1)	0.05
Nitrogen retention (%)	7
Pollination (%)	7
Reef tourism (%)	7
Sediment retention (%)	7
Carbon storage (%)	7
Moisture regulation (%)	7
Coastal risk reduction (%)	7
Timber production (%)	7
Fuelwood (%)	7
Flood mitigation (%)	7
Riverine fish (%)	7
Marine fish (%)	7
Grazing (%)	7
Nature access within 1 hour travel (%)	7
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #11, MEXICO

MINE #11 is located in the Mexican Tropical & Subtropical Coniferous Forests. The 'Ecosystem Significance' around the asset is driven by its 'Significance to People', particularly for moisture regulation, nitrogen retention and timber production.

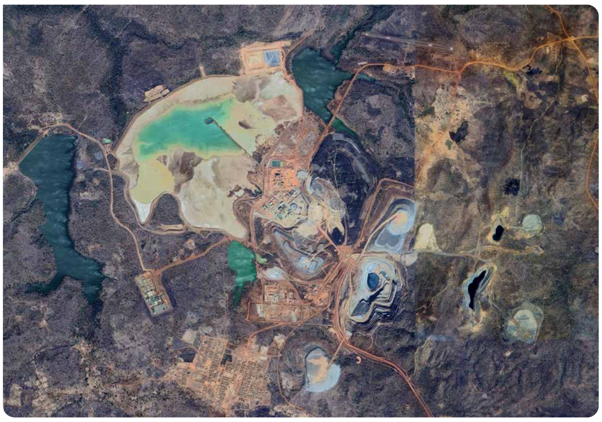
Ecosystem Footprint (ha HSA eq.)	26
Impact Ratio (0-1)	0.06
Ecosystem Degradation (0-1)	0.26
Ecosystem Significance (0-1)	0.25
Species Significance (0-1)	0.08
Thereof amphibians (%)	51
Thereof birds (%)	42
Thereof mammals (%)	6
Attribution to mining & quarrying (%)	1
Ecosystem Contribution (0-1)	0.25
Nitrogen retention (%)	33
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	0
Moisture regulation (%)	33
Coastal risk reduction (%)	0
Timber production (%)	33
Fuelwood (%)	0
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	0
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	248
Area Overlapping with KBAs (ha)	0

MINE #12, PERU

MINE #12 is located in the Peruvian Montane Grasslands & Shrublands, in a sparsely populated area. The 'Ecosystem Significance' around the asset is driven by a very high 'Significance to Species' and a high 'Significance to People'.

Ecosystem Footprint (ha HSA eq.)	4,398
Impact Ratio (0-1)	0.72
Ecosystem Degradation (0-1)	0.73
Ecosystem Significance (0-1)	0.99
Species Significance (0-1)	0.99
Thereof amphibians (%)	100
Thereof birds (%)	0
Thereof mammals (%)	0
Attribution to mining & quarrying (%)	32
Ecosystem Contribution (0-1)	0.50
Nitrogen retention (%)	20
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	12
Carbon storage (%)	0
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	12
Fuelwood (%)	20
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	20
Nature access within 1 hour travel (%)	16
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #13, SENEGAL



MINE #13 is located in the Senegalese Tropical & Subtropical Grasslands, Savannas & Shrublands. The 'Ecosystem Significance' around the asset is driven by 'Significance to People' and the site also has 'Significance to Species'.

Ecosystem Footprint (ha HSA eq.)	52
Impact Ratio (0-1)	0.05
Ecosystem Degradation (0-1)	0.35
Ecosystem Significance (0-1)	0.13
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	35
Thereof mammals (%)	65
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.13
Nitrogen retention (%)	25
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	25
Carbon storage (%)	0
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	25
Fuelwood (%)	25
Flood mitigation (%)	0
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	0
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #14, TÜRKIYE

MINE #14 is located in the Turkish Temperate Broadleaf & Mixed Forests. The 'Ecosystem Significance' around the asset is driven by 'Significance to People'.

Ecosystem Footprint (ha HSA eq.)	55
Impact Ratio (0-1)	0.23
Ecosystem Degradation (0-1)	0.3
Ecosystem Significance (0-1)	0.75
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	26
Thereof mammals (%)	74
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.75
Nitrogen retention (%)	25
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	0
Moisture regulation (%)	25
Coastal risk reduction (%)	0
Timber production (%)	0
Fuelwood (%)	0
Flood mitigation (%)	25
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	25
Nature access within 1 hour travel (%)	0
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

MINE #15, PERU

MINE #15 is located in the Peruvian Tropical & Subtropical Moist Broadleaf Forests. The 'Ecosystem Significance' around the asset is driven by 'Significance to Species' and to 'People'.

EcosystemFootprint (ha HSA eq.)	281
Impact Ratio (0-1)	0.15
Ecosystem Degradation (0-1)	0.21
Ecosystem Significance (0-1)	0.72
Species Significance (0-1)	0.01
Thereof amphibians (%)	0
Thereof birds (%)	42
Thereof mammals (%)	58
Attribution to mining & quarrying (%)	0
Ecosystem Contribution (0-1)	0.71
Nitrogen retention (%)	15
Pollination (%)	0
Reef tourism (%)	0
Sediment retention (%)	0
Carbon storage (%)	15
Moisture regulation (%)	0
Coastal risk reduction (%)	0
Timber production (%)	15
Fuelwood (%)	15
Flood mitigation (%)	15
Riverine fish (%)	0
Marine fish (%)	0
Grazing (%)	15
Nature access within 1 hour travel (%)	10
Area Overlapping with Protected Areas (ha)	0
Area Overlapping with KBAs (ha)	0

Appendix 3

Local Biodiversity & Nature-Focused Regulation

As noted above, biodiversity-focused regulation is still in its early stages, although it has been developing very rapidly over recent years. Many countries have now implemented environmental legislation with biodiversity and conservation objectives and several key initiatives and national policy changes are summarised below. That said, the countries and regulations highlighted here are certainly not a comprehensive overview of all such national conservation-focused regulations and policy initiatives. Rather, they were chosen simply to offer a broadly balanced perspective, covering geographical diversity and the representation of different regions; a range of approaches, such as conservationist versus restorative approaches; and to include representation of countries that host significant mining activity.

EU

In February 2024, the EU endorsed legislation designed to safeguard nature as part of its comprehensive EU Green Deal initiative and Biodiversity Strategy[108], aimed at bolstering the EU's climate objectives. The legislation will come into effect following formal adoption and ratification by member states.

The legislation requires EU member states to restore a minimum of 20% of both land and seas by 2030 (and states should address all ecosystems in need of restoration by 2050).[109] These targets align with the EU's commitment under the UN's Kunming-Montreal GBF. Additionally, as of December 2024, importers and exporters engaging in trade with the EU must demonstrate that their products originate from areas that have not been recently deforested or caused forest degradation.

Finally, the Corporate Sustainability Reporting Directive (CSRD) also requires reporting on material biodiversity impacts, risks, and opportunities.[110] The European Financial Reporting Advisory Group (EFRAG) has developed draft standards for biodiversity and ecosystems (ESRS E4).

UK

In February 2024, the biodiversity net gain rules came into force as part of the government's Environment Act.[111] This legislation, seen as one of the most ambitious biodiversity frameworks worldwide, means that all building projects going forward must achieve a 10% net gain in biodiversity or habitat, which needs to be maintained for at least 30 years. Any development proposals are obliged to "leave biodiversity in a better state than before."

Assessment of net gains will be conducted using a designated biodiversity metric. This metric factors in habitat size, distinctiveness, diversity or rarity of the habitat, plant communities, and habitat quality, among other criteria. Notably, the metrics solely focus on habitats and do not account for protected species. Each habitat on-site is assigned a 'unit value' based on its relative biodiversity significance. Once values are established for the existing site and proposed development, local authorities can compare them to inform planning decisions.

Costa Rica

Costa Rica has long been renowned for its progressive approach to biodiversity and environmental conservation. As early as 1998, Costa Rica approved groundbreaking biodiversity legislation, positioning itself among the pioneers in this field. The law was grounded in strong social principles, such as respect for human rights, equity in benefit distribution, and democratic decision-making processes. These foundational aspects align closely with frameworks like the TNFD and Kunming-Montreal agreements, positioning Costa Rica as a significant testing ground for biodiversity and conservation strategies.

Subsequently, the country has made concerted efforts to preserve at least 30% of its territory. Integral to Costa Rica's conservation endeavours is its establishment of 27 national parks, 58 wildlife refuges or sanctuaries, and 32 protected zones, underscoring its dedication to safeguarding its rich biodiversity.

108. https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en
109. https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en
110. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
111. https://www.gov.uk/guidance/biodiversity-net-gain

China

Given China's immense size and economic power, it holds significant potential to address environmental challenges. Over recent years, China has prioritized biodiversity conservation efforts, notably with the introduction of the '*Ecological Civilization*' concept in 2012. This marked a strategic shift, further solidified by its incorporation into the 2018 Constitution, underpinning policies like 'ecological civilization' and *'beautiful China'*.

Since then, biodiversity preservation has gained prominence within China's political agenda, reflected in its Five-Year Plans and environmental strategies.[112] China's approach also embraces technological advancements, exemplified by its comprehensive species database covering over 2,376 administrative units and the application of advanced monitoring tools such as satellite tracking and infrared cameras.

Moreover, China has demonstrated a substantial financial commitment to biodiversity causes. Notably, the establishment of the Kunming Biodiversity Fund in 2021, with an initial budget of 1.5 billion yuan (around US$210 million), underscores the government's dedication to implementing nature protection measures.

Ecuador

In 2008, Ecuador made history by becoming the first country to officially grant rights to nature. This landmark decision was enshrined in Chapter 7 of its constitution, recognising the rights of *Pachamama* – that is, 'Mother Earth'. This decision is marked by indigenous worldviews and experiences, as well as the concept of a pluralistic society where Indigenous peoples are recognized. Within this perspective, the rights of mother nature are strongly linked to the indigenous principle of *Sumak Kawsay,* which emphasises living in harmony and balance with nature, community, and oneself.[113]

The Constitutional Court applied these rights for the first time in a 2021 case involving a mining project, ruling that the project infringed on the rights of nature. Specifically, the court found that permits granted for exploratory operations within the protected *Los Cedros* forest failed to uphold nature's rights. This decision was based on the state's failure to fulfil its obligation to implement precautionary measures and restrictions on activities that could endanger species and lead to extinction.[114] In 2023, the Constitutional Court again ruled that mining companies were violating nature's rights to be protected, as well as the right of affected communities to be consulted before the beginning of a project.

While this approach may not strictly protect biodiversity, it acknowledges nature as a legal entity with inherent rights, embodying principles of respect, protection, and environmental balance. As such, it represents a broader philosophical perspective. In contrast, biodiversity regulation serves as a practical legal instrument aimed at managing nature through the implementation of policies, strategies, and processes. To advance biodiversity protection, Ecuador has adopted laws that protect over 30 percent of its national territory.

Brazil

A very recent law passed by the Brazilian Chamber of Deputies changes several rules of the country's environmental licensing framework, easing the constraints placed on the developers of infrastructure projects deemed to be 'strategic' by the federal administration. The new bill is seen as a substantial reversal of the recent trend in Brazil's regulation of environmental impacts and a potential challenge to many of its international commitments.[115]

The Brazilian government had recently introduced several new laws aiming to build and expand on its existing nature-related regulations with further decrees targeting enhanced biodiversity management[116], stricter guidance and controls on genetic resource management, and new forms of international collaboration. The recent agreement between UNEP and Brazil's Ministry of Environment also sought to ensure closer alignment of national policies with international standards, with the aim of directing the country's capacity to address climate change, biodiversity loss, and pollution challenges in a more integrated and pro-active manner.[117]

There is, however, still some uncertainty regarding the final content and eventual impacts of the new law relaxing environmental licensing and protection requirements, not least given government ministers' resistance to it.

112. *Ecological civilization: China's effort to build a shared future for all life on Earth* (2021), Fuwen Wei, Shuhong Cui, Ning Liu, Jiang Chang, Xiaoge Ping, Tianxiao Ma, Jing Xu, Ronald R Swaisgood, Harvey Locke, *National Science Review*, Volume 8, Issue 7
113. *What is Sumak Kawsay? A Qualitative Study in the Ecuadorian Amazon* (2021), C. A. Coral-Guerrero, F. García-Quero, & J. Guardiola, *Latin American Perspectives*, Vol. 48, Issue 3
114. *https://www.centerforenvironmentalrights.org/news/press-release-rights-of-nature-victory-in-ecuador*
115. https://apnews.com/article/brazil-environment-protection-bill-climate-fb3fb4207bd6c6ae4e0e6c85399c4c39
116. Federal Decree No. 12,017/2024; and Resolutions No. 42/2024; No. 43/2024; and No. 44/2022, from the Genetic Heritage Management Council
117. https://www.unep.org/news-and-stories/press-release/unep-and-ministry-environment-sign-agreement-reinforce-environmental

United States

At the time of writing, it is probably too early to gauge whether the change in US administration after the 2024 election will result in a significant and enduring shift in conservation policies, but we must acknowledge that the current government is prioritising deregulation and short-term economic development over conservation and ecological protection. The proposed revision of a range of US environmental laws is often framed to favour the rapid development of particular industries (with the extractives sector, particularly fossil fuel producers, identified as key potential “beneficiaries”). These laws include rolling back regulations that may result in the following:

- Making it easier to remove species from endangered lists and reducing protections for threatened species.
- Revoking or weakening prohibitions to avoid exploitation of protected public lands and wildlife.
- Changing the definition of "harm" to endangered species, to potentially allowing economic activities even if they harm protected habitats.

It should be noted, however, that at least some of these policy shifts are very likely to be subject to legal challenges[118] and it is therefore difficult to understand the longer-term implications (for any sector) of the volatile US regulatory landscape as applied to nature and biodiversity-focused policies and laws.

More generally, a survey of global trends and developments on environmental protection regulations suggests the recent US policy shifts are broadly perceived as regressive and out of step with the direction of travel elsewhere.[119]

118. For example, the 2019 revisions weakening the US Endangered Species Act were reversed by a federal district court ruling in 2022 - https://biologicaldiversity.org/w/news/press-releases/federal-court-restores-critical-endangered-species-act-protections-2022-07-05/
119. See, for example, https://www.law.georgetown.edu/environmental-law-review/blog/the-trump-administrations-environmental-policies-make-the-united-states-an-outlier-in-the-global-shift-to-clean-energy/

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