In collaboration
with Oliver Wyman

WORLD ECONOMIC FORUM

Nature Positive: Role of the Mining and Metals Sector

INSIGHT REPORT

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Foreword

Duncan Wanblad
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Metals and minerals play a critical role in modern life – they are the building blocks that underpin goods and services that improve living standards, new technologies and infrastructure for energy decarbonization, and agricultural inputs to improve food security. As miners, we interact with the natural environment and communities every day, which brings a deep responsibility to operate sustainably for people and our planet.

Nature is not a new topic for the mining sector; indeed, a 2023 ICMM survey, *Understanding the Perceptions of Mining*, indicated that taking action on nature is the most important thing we can do to change negative perceptions of mining. Through environmental and social impact assessments, we understand the complex interconnectivity of nature with stakeholders where we work. Coupled with our collective experience in delivering large-scale projects, we can help restore ecosystems and habitats beyond our footprint and at scale, in partnership with others. We have also made positive steps towards commitments for nature in recent years, including through ICMM's 2024 *Nature Position Statement*.

The metals and minerals the world needs will increasingly be found in areas that are more complex from a physical and socio-economic perspective, and where water and biodiversity are of critical importance, raising the challenge of balancing competing resource needs. At our Quellaveco copper mine in Peru, we implemented a transformative water management approach to balance operational needs with community and environmental priorities. We rerouted the Asana River outside the mine site to preserve its role as a vital freshwater source for the community. Additionally, we built the Vizcachas dam, a shared value infrastructure project, to capture excess water during the rainy season and allow the seasonal river to flow throughout the year, enhancing both water availability and quality for downstream agricultural and community users. Our operations, meanwhile, use the water from the Titire River as the main water source, which is unsuitable for agriculture and human consumption due to its high volcanic mineral content. The project was successful due to a deep dialogue process with local stakeholders and an innovative approach to delivering sustainable solutions as part of securing our license to operate. This is the experience we are taking forward at our next developments at Woodsmith in the UK and then at Sakatti in Finland.

As a sector, we must integrate work to protect and restore nature with work on climate, water and social impact into all aspects of an operation throughout its life, from exploration to life beyond mining. Strengthened data and disclosure, supported by initiatives such as the Taskforce for Nature-related Financial Disclosures (TNFD), can help keep us accountable and identify opportunities for collective action. We have a role in supporting regional and local governments with the delivery of the *Global Biodiversity Framework* goals to accelerate the protection and restoration of nature. Of course, we cannot do this alone. Through building trust, collaborative relationships and strategic partnerships with communities, governments and partners across industries and the entire value chain, we can ensure that we are preventing and mitigating adverse impacts while catalysing a systemic and sustainable positive legacy.

In summary, the mining sector has an important synergistic association with nature. Nature should not be seen as a cost to our businesses or just a risk to be managed, but a driver of real value. As an industry, we have an opportunity to enable positive change, collaborating widely to drive measurable actions on the ground.

Let's make nature collaborative, not competitive.

Foreword

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On 22 July 2024, Earth recorded its hottest day on record according to the World Meteorological Organization, and August 2024 marked the 15th consecutive month of record-high global temperatures. Ocean temperatures are higher than they have ever been in modern times, causing rising sea levels, more intense storms and faster-than-usual ice loss in the Arctic in June, according to the National Snow and Ice Data Center in the US. The world is seeing unprecedented levels of biodiversity and ecosystem loss, pollution and pressure on water availability.

The World Economic Forum's 2020 *Future of Nature and Business* report estimates that more than half of the world's gross domestic product (GDP) is moderately or highly dependent on nature and its services, meaning companies and investors cannot afford to delay actions to reverse climate change and prevent nature loss any longer. The world is at a tipping point and only accelerated action can prevent widespread, irreversible harm.

The international discourse on nature is indeed turning towards action. The 2015 Paris Agreement and the 2022 Kunming-Montreal Global Biodiversity Framework provided governments and businesses with goals and targets, and, at the 2024 United Nations (UN) Convention on Biological Diversity (CBD COP16) in Cali, Colombia, the focus turned to implementation as stakeholders turned up in force to discuss how to put nature plans into practice. Business momentum is picking up, but industries need sectoral guidance on strategic ways forward. This is particularly true when it comes to preventing nature loss, which will involve tackling an inherently complex set of issues.

The World Economic Forum, in collaboration with Oliver Wyman, has spent the past two years gathering data and insights through research, expert consultation and industry interviews. This work has paved the way for the Forum's 2025 Nature Positive Transitions: Sectors report series. Building from those released on the chemical sector, the household and personal care products sector, and the cement and concrete sector in 2023, these new reports focus on four sectors: mining and metals, automotive, offshore wind and ports. This initiative is part of a broader collaborative effort with Business for Nature and the World Business Council for Sustainable Development (WBCSD).

Halting climate change and preventing further nature loss are inextricably intertwined goals. Therefore, corporate and investor action to address these twin challenges must also be complementary and occur in tandem. Investing in nature is more than just good risk management. Companies that take bold steps today towards a net-zero, nature-positive business model will enjoy competitive advantages, drawing on more resilient and sustainable supply chains, a positive public image, innovative green products and greater support from the financial sector.

If we are to stay within safe and just Earth system boundaries and maintain a sustainable planet, there is no time to delay.

About the Nature Positive Transitions report series

Nature Positive: Role of the Mining and Metals Sector is published by the World Economic Forum in collaboration with Oliver Wyman. It is part of the World Economic Forum's Nature Positive Transitions report series, which outlines the different pathways to halt and reverse nature loss by 2030 – the mission at the heart of the Global Biodiversity Framework.

The series consists of three transitions: business sectors, cities and financial institutions. These reports highlight the relevance of nature-related risks, identify the impacts and dependencies of the economy and society on nature, and provide guidelines for business, city and financial institution leaders on key actions to accelerate the nature-positive transition.

The Nature Positive Transitions report series builds on the New Nature Economy Report Series. For more information, please visit Nature Positive Transitions.

Sector reports:

- Nature Positive: Role of the Cement and Concrete Sector
- Nature Positive: Role of the Household and Personal Care Products Sector
- Nature Positive: Role of the Chemical Sector
- Nature Positive: Role of the Automotive Sector
- Nature Positive: Role of the Offshore Wind Sector
- Nature Positive: Role of the Port Sector
- Nature Positive: Role of the Automotive Sector China Deep-dive

Cities reports:

- Nature Positive: Guidelines for the Transition in Cities
- Nature Positive: Leaders' Insights for the Transition in Cities
- Nature Positive: Financing the Transition in Cities
- Nature Positive: Cities' Efforts to Advance the Transition – Durban

Finance reports:

- Financing the Nature-Positive Transition: Understanding the Role of Banks, Investors and Insurers

Executive summary

There is an urgent need for the mining and metals sector to contribute to the nature-positive transition, to reduce its impacts on nature and unlock new opportunities.

Overall, 9.6 billion tonnes of metal ores were extracted in 2020 alone, equivalent to 10% of global material extraction, supplying activities across almost all sectors of the economy.

Future demand growth will be driven by the clean energy transition, given the key role metals and minerals – such as aluminium, copper, cobalt, nickel, lithium and rare earth elements – play in supporting the scale-up of energy transition infrastructure and the electrification of the transport and mobility system. Indeed, critical mineral demand is expected to increase 4 to 6 times by 2040.

Yet, the mining and metals sector contributes to drivers of biodiversity loss, such as land-use change and ecosystem disturbance, pollution, water abstraction and greenhouse gas (GHG) emissions across its entire value chain. Mining operations are estimated to cover up to 100,000 square kilometres (km^2) of the world's terrestrial surface (equivalent to 0.07%), and 8% of global mining properties coincide with International Union for Conservation of Nature (IUCN) Protected Areas. A total of 16% of critical mineral mines are located in highly water-stressed areas, and over half of energy transition mineral resources are located on or near Indigenous Peoples' lands.

This report summarizes the sector's key impacts and dependencies on nature and sets out priority actions that corporate leaders can take to transform their businesses. These include:

1. **Transform operations across the mine life cycle:** Avoid, then reduce, the land, pollution and emissions impacts of mining operations and restore across the mine life cycle in accordance with the mitigation hierarchy.

2. **Improve water stewardship:** Avoid, then reduce, water abstraction, use and pollution in mining operations, and improve water stewardship across landscapes.

3. **Expand circularity and source responsibly:** Expand circularity across the value chain, embrace standards and transparency, engage with suppliers and source responsibly, and collaborate with and support customers.

4. **Restore and regenerate landscapes:** Support nature conservation and restoration with local communities across and beyond their own value chains and invest in innovative nature financing mechanisms.

5. **Transform policy systems and collaborate across sectors:** Call on governments to strengthen nature-related policy and support cross-sector and cross-industry collaboration.

These priority actions could unlock more than $430 billion in annual business opportunities by 2030 for companies operating across the sector's value chain, presenting a significant opportunity for the mining and metals sector in the new nature-positive economy.

Introduction

Most top companies have climate targets, yet only 12% have one for biodiversity, despite the global economy's dependency on nature.

of the emissions reductions required by 2030 to keep global temperature increases under 2ºC will come from nature-based solutions.

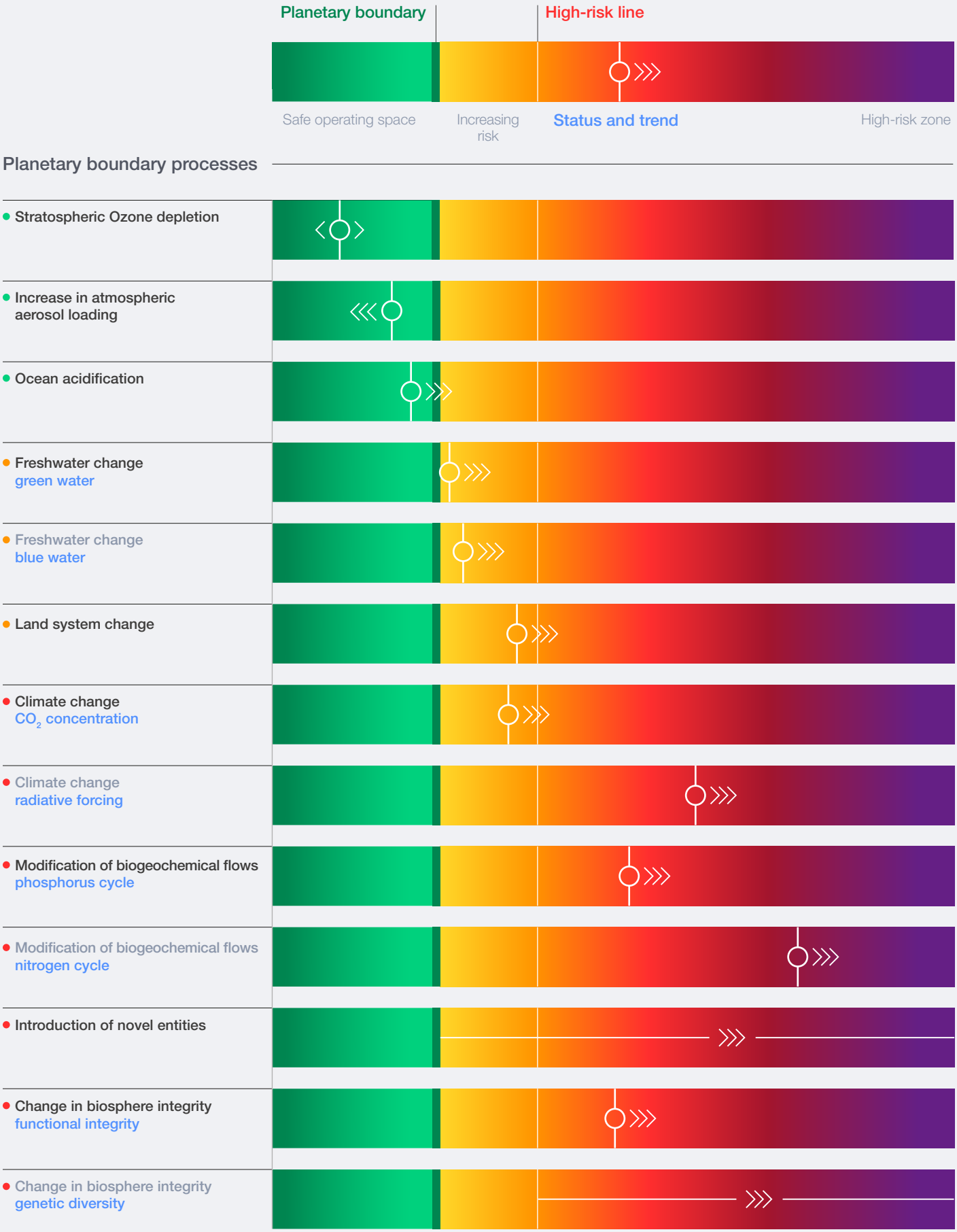
Nature is at a tipping point. Today, the resources humanity uses are equivalent to that of 1.75 Earths. This means that the ecological footprint, a measure that sums up the demands for biologically productive areas like food, timber, fibre, carbon sequestration and infrastructure, exceeds the Earth's capacity by 75%.[1]

Achieving net-zero emissions and halting biodiversity loss are highly interdependent priorities for both society and business. Climate change is one of the five key drivers of biodiversity loss,[2,3] and in turn, land-use change, principally agricultural commodity-driven deforestation, contributes 12-20% of global greenhouse gas (GHG) emissions.[4] At the same time, efforts to tackle climate change cannot succeed without safeguarding nature. It is estimated that 37% of the emissions reductions required by 2030 to keep global temperature increases under 2ºC will come from nature-based solutions.[5]

Recognizing the link between climate change and nature, standard setters are increasingly looking to align efforts, as seen in the linkages between the Science Based Targets initiative (SBTi) Forest, Land and Agriculture (FLAG) targets[6] and the land targets from the Science Based Targets Network (SBTN).[7] Efforts are also being made to integrate social and human rights perspectives to ensure that the nature transition is just, inclusive, and delivers tangible and sustainable benefits for people.

In September 2024, the Potsdam Institute for Climate Impact Research (PIK) published the first annual planetary health check, evaluating the status of the nine planetary boundaries – the Earth system processes essential for maintaining global stability, resilience and life-support functions – against safe operating limits. Overall, six out of nine planetary boundaries, such as land system change, freshwater change, and biosphere integrity, have already breached safe levels[8] (see Figure 1).

FIGURE 1 | **Planetary boundaries health check**



Source: Caesar, L., Sakschewski, B. et al. (2024). *Planetary Health Check: A Scientific Assessment of the State of the Planet.*

Why nature matters for businesses

The importance of nature for businesses and financial institutions is growing as the evidence for nature-related risks rises. In the World Economic Forum's *Global Risks Report 2025*,[9] five out of the top 10 risks over the next decade are environment related: extreme weather events, biodiversity loss and ecosystem collapse, critical change to Earth systems, natural resource shortages and pollution.

In parallel, the calls for rapid change are getting stronger and more frequent, coming from policy-makers, regulators, investors, companies, consumers and citizens (see Figure 2).

Companies that anticipate the risks of nature loss can minimize disruption from incoming policy and regulatory requirements, proactively manage nature-related physical, transition and systemic risks,[10] including dependencies on ecosystem services and assets, and benefit from early nature-related opportunities.

FIGURE 2 **Key nature-related dynamics impacting businesses**

Global Biodiversity Framework

- In total, 196 parties agreed on the landmark Kunming-Montreal **Global Biodiversity Framework** in December 2022.
- Target 15 of the framework explicitly calls for **mandatory assessment and disclosure** and for businesses to reduce their negative impacts on nature.

Guidance and standards

- **Taskforce on Nature-related Financial Disclosures (TNFD)** issued sector-specific guidance for 8 sectors and financial institutions.
- **International Sustainability Standards Board (ISSB)** incorporated nature and biodiversity requirements.
- **EU's European Sustainability Reporting Standards (ESRS)** started in 2024.
- **Science Based Targets for Nature (SBTN)** released updated target-setting guidance.

Businesses

Customers and employees

- Recent studies show **85% of consumers** indicate that they have shifted their purchasing behaviour to be more sustainable in the past five years.
- The Union for Ethical BioTrade (UEBT) **Biodiversity Barometer** has shown consistent growth in biodiversity awareness among consumers over the past decade.

Financial institutions

- In total, 177 financial institutions with €22.1 trillion in assets under management signed the **Finance for Biodiversity Pledge.**
- **Nature Action 100** harnesses investor influence on businesses.

Source: Convention on Biological Diversity. (2022). *Kunming-Montreal Global Biodiversity Framework*; Business for Nature. (2023). *A wake-up call for business: Target 15 commits governments to require nature-related disclosure from large companies and financial institutions*; Taskforce on Nature-related Financial Disclosures (TNFD); Reuters. (2022, 14 December). *Global sustainability rules body steps up focus on biodiversity*; European Financial Reporting Advisory Group (EFRAG). *EU Sustainability Reporting Standards (ESRS)*; Science Based Targets Network (SBTN). (n.d.). *For companies*; Nature Action 100; Finance for Biodiversity Foundation; Union for Ethical BioTrade (UEBT). *Biodiversity Barometer.*

> In the past three years, 177 institutions with €22 trillion in assets under management signed the Finance for Biodiversity Pledge.

Global Biodiversity Framework

The agreement of the Kunming-Montreal Global Biodiversity Framework[11] in December 2022 set the ambition to halt and reverse biodiversity loss, calling for a collective effort from all sections of society on the four goals and 23 targets by 2030.

Guidance and standards

Many regulators will soon require mandatory nature-related disclosure from companies, with regulations like the European Sustainability Reporting Standards (ESRS)[12] under the EU's Corporate Sustainability Reporting Directive (EU CSRD) and the EU Taxonomy for Sustainable Activities[13] pushing businesses to disclose their **impact** on nature and their **exposure** to nature and biodiversity loss. Standards are also being adopted in countries like India[14] and China,[15] requiring companies to disclose material sustainability information.

Companies are encouraged to start collecting data and building internal capacity in alignment with voluntary disclosure frameworks like the Taskforce on Nature-related Financial Disclosures (TNFD),[16] which has seen at least 502 organizations, including 129 financial institutions, commit to getting started with voluntary reporting of their nature-related issues.[17]

Financial institutions

Financial institutions are also recognizing the risks associated with nature, for example, 36% of Dutch financial institutions' assets were found to be highly dependent on nature,[18] and starting to take action. In the past three years, 177 institutions with €22 trillion in assets under management signed the Finance for Biodiversity Pledge, and institutional investors are convening through the Nature Action 100 programme to engage with companies and policy-makers on nature.[19]

The nature-positive transition will unlock new business opportunities for financial institutions. Innovative nature financing mechanisms, including biodiversity credits, impact investments and blended finance mechanisms, have seen significant growth in the past years, including 10% growth between 2022 and 2023.[20] Governments are developing the market infrastructure to mobilize private finance for nature conservation and restoration. For example, in 2023, the UK government introduced the Biodiversity Net Gain (BNG) legislation,[21] mandating that all new development projects achieve a 10% net gain in biodiversity, and the Australian government is in the process of establishing a Nature Repair Market[22] to enable individuals and businesses to voluntarily invest in nature repair projects across Australian land, waters, or a combination of both.

Financial institutions can start taking action by building internal capacity to act on nature, developing financing policies, strategies and transition plans that favour nature (including sector-, location- or asset class-specific policies where appropriate), embedding nature in risk management systems, developing robust nature-related reporting systems, and engaging with high nature-impact and high nature-risk businesses.

Consumers and employees

Similarly, wider society and other stakeholders, such as employees and consumers, are raising their expectations for corporate action to protect nature and biodiversity.

In the Union for Ethical BioTrade's 2022 Biodiversity Barometer, biodiversity loss was the second most urgent environmental concern for consumers after climate change. In countries such as Brazil and China, the concern comes out on top, with 54% of consumers wanting information on a product's impact on biodiversity. A survey by Simon-Kucher & Partners in 2021 showed that 85% of consumers have made changes to make their purchasing behaviour more sustainable in the past five years.[23]

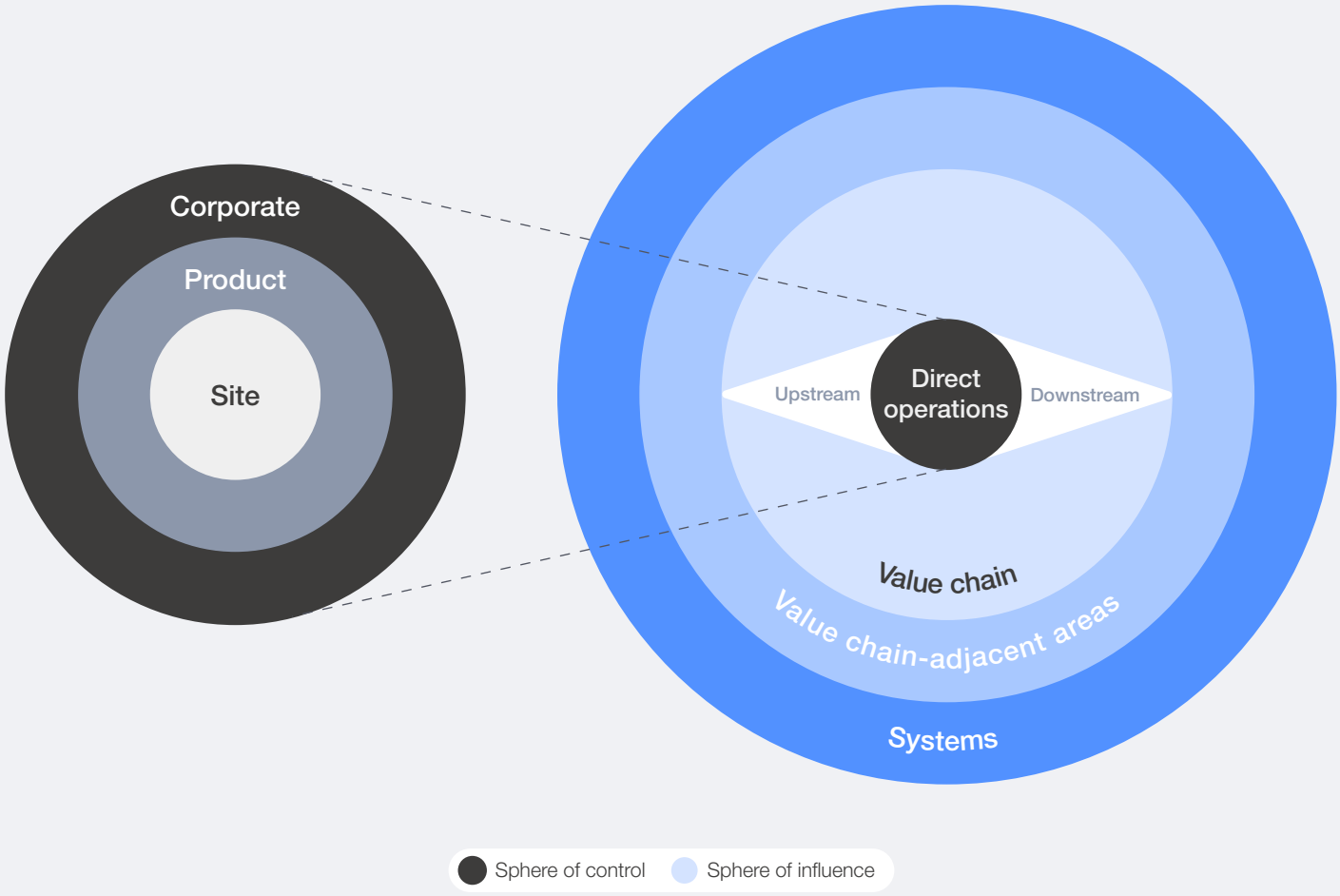
Additionally, employees are elevating their expectations regarding their employers' commitment to protecting nature and biodiversity. For example, a 2022 global survey by Deloitte[24] found that protecting the environment remains a top priority for Gen Zs and millennials, who want to see their employers prioritize visible actions that enable employees to get directly involved. A total of 64% of Gen Zs said they would pay more to purchase an environmentally sustainable product.

Setting credible nature strategies

Despite the increased momentum on nature over recent years, not enough is being done. While 78% of Fortune Global 500 companies have climate change targets, only 26% have freshwater consumption targets, and just 12% have targets for biodiversity loss.[25] Only 5% of companies have assessed their impacts on nature, with less than 1% understanding their dependencies.[26]

Companies can contribute to nature positive by establishing credible nature strategies, where nature positive represents a "global societal goal to halt and reverse nature loss by 2030 on a 2020 baseline, and achieve full recovery by 2050".[27] Individual companies, financial institutions and investors can contribute to this shared goal by adopting nature-positive strategies across their spheres of control and influence, including at sites of high-biodiversity importance, in their direct operations as well as across their value chains (see Figure 3).

FIGURE 3 | **Spheres of control and influence**



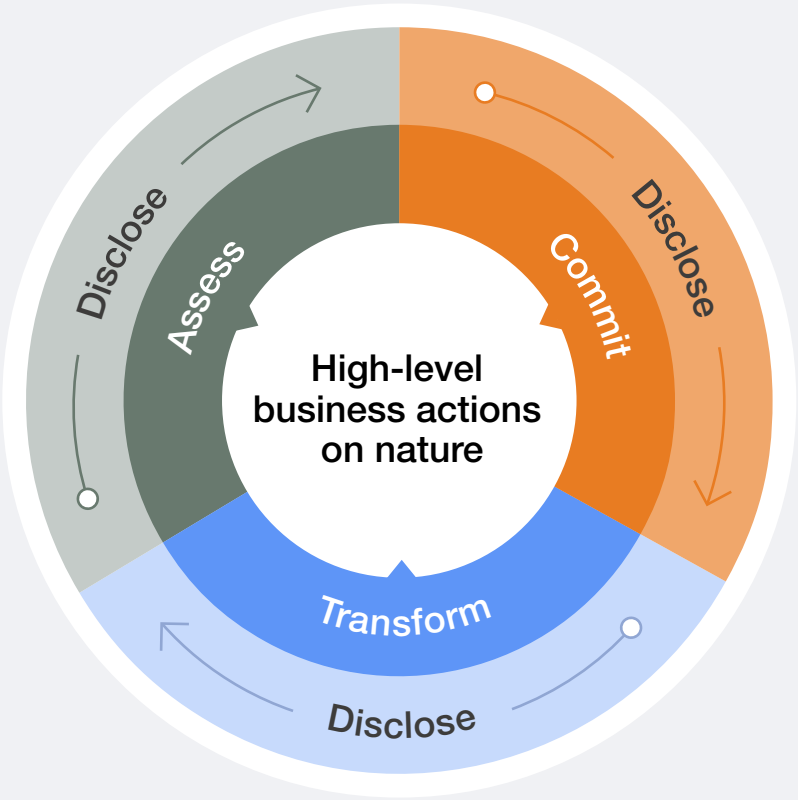
Source: Adapted from Science Based Targets Network (SBTN). (2020). *Science-Based Targets for Nature: Initial Guidance for Business, 2020.*

A credible corporate nature strategy should be built on four high-level steps: assess, commit, transform and disclose[28] (see Figure 4). Businesses can and should act now to:

- **Assess:** Conduct an initial materiality assessment to prioritize efforts; identify, measure, value and prioritize impacts and dependencies on nature; assess risks and opportunities; and consider climate and people within nature assessments.
- **Commit:** Define ambition and goals, and set transparent, time-bound, specific, science-based targets to put companies on the right track towards operating within the Earth's limits.
- **Transform:** Avoid and reduce negative impacts; restore and regenerate; shift business strategy and models; collaborate, both along value chains and at a landscape, seascape and river basin level; advocate for ambitious policies and initiatives; and embed nature within corporate governance.
- **Disclose:** Disclose material nature-related information across all three high-level actions above; seek out independent validation and verification to enhance the credibility of actions; and align reporting with major reporting standards such as TNFD, International Sustainability Standards Board (ISSB) or the EU's CSRD recommendations.

Momentum is building. In May 2023, 17 companies started a target validation pilot for the SBTN methods[29]. For more details, companies can refer to the *Nature Strategy Handbook*, a practical guide to support all businesses in developing a nature strategy.

FIGURE 4 | **ACT-D high-level business actions on nature**



Assess

Measure, value and prioritize your impacts and dependencies on nature to ensure you are acting on the most material ones.

Commit

Set science-based targets to put your company on the right track towards operating within the Earth's limits.

Transform

Avoid and reduce negative impacts, restore and regenerate, collaborate across land and seascapes, shift business strategy and models, embed nature in governance and advocate for policy ambition.

Note: Disclose material nature-related information across all three high-level actions above.

Source: Business for Nature. (n.d.). *High-level Business Actions on Nature.*

The need for a sectoral approach

As nature impacts and dependencies differ significantly across real economy sectors, sector-specific analyses and guidance can help companies understand their relationship with nature and the actions they can take to accelerate the transition to a nature-positive future.

To inform sectoral approaches, the World Economic Forum, alongside Business for Nature and the World Business Council for Sustainable Development (WBCSD), produced guidance on 12 global sectors as part of the initial phase of the Sector Actions Towards a Nature-Positive Future initiative. For each sector, the guidance outlines the priority actions companies should take to transform their operations and value chains to make a meaningful contribution towards the Global Biodiversity Framework and help halt and reverse nature loss by 2030.

In the second phase, the World Economic Forum has conducted analysis on four additional sectors: mining and metals, automotive, offshore wind and ports. This report, published in collaboration with Oliver Wyman, identifies and makes the business case for sector-specific priority actions in the mining and metals sector.

1 Where the sector is today

To meet energy transition demands sustainably, companies must minimize impacts on nature and transform business models to focus on critical minerals supply and circularity.

1.1 Sector overview

Critical mineral inputs for clean energy technologies are projected to increase 4 to 6 times by 2040.

Overall, 9.6 billion tonnes of metal ores[30] were extracted worldwide in 2020 alone, making up 10% of global material extraction across biomass, fossil fuels, metal ores and non-metallic minerals. Almost all other sectors rely on these commodities, including the construction industry, energy and transport infrastructure, manufacturing equipment, consumer goods (such as vehicles and electronics), agriculture, and defence sectors.

Currently, of all metals, extraction of iron ore was the fastest growing, driven by rising demand for steel in the construction sector,[31] which accounts for over 50% of global steel demand,[32] and a second wave of urbanization in the Global South.[33]

Future demand growth, however, will be driven by the clean energy transition, given the essential role of metals and critical minerals, such as aluminium, copper, cobalt, nickel, lithium and rare earth elements, in supporting the scale-up of energy transition infrastructure, for renewable energy (solar panels and wind turbines), energy transmission and energy storage capacity, and the electrification of the transport and mobility system.[34] Critical mineral inputs for clean energy technologies are projected to increase 4 to 6 times by 2040.[35] A typical electric car requires 6 times more mineral inputs than a conventional car, and an onshore wind plant requires 9 times more mineral resources than a gas-fired power plant.[36]

Mining operations across large-scale, artisanal and small-scale mining are estimated to cover up to 100,000 square kilometres (km^2), equivalent to 0.07% of the world's terrestrial surface.[37] Extraction is concentrated in specific, resource-rich locations. For example, over 65% of iron ore and bauxite is from Australia, China, Brazil and Guinea,[38] 75% of cobalt is from the Democratic Republic of the Congo, 90% of platinum group metals are from South Africa and Zimbabwe,[39] 45% of lithium is from Australia and 70% of rare earth elements are from China.[40,41] Processing operations are even more concentrated: China is responsible for processing over 50% of aluminium and steel, and 65 to 90% of lithium, cobalt and rare earth elements.[42,43] Productivity varies significantly across mining areas, with a small share of sites responsible for the majority of resource extraction volumes,[44] and land ownership and management systems also differ across regions.

BOX 1 Definition of the mining and metals sector

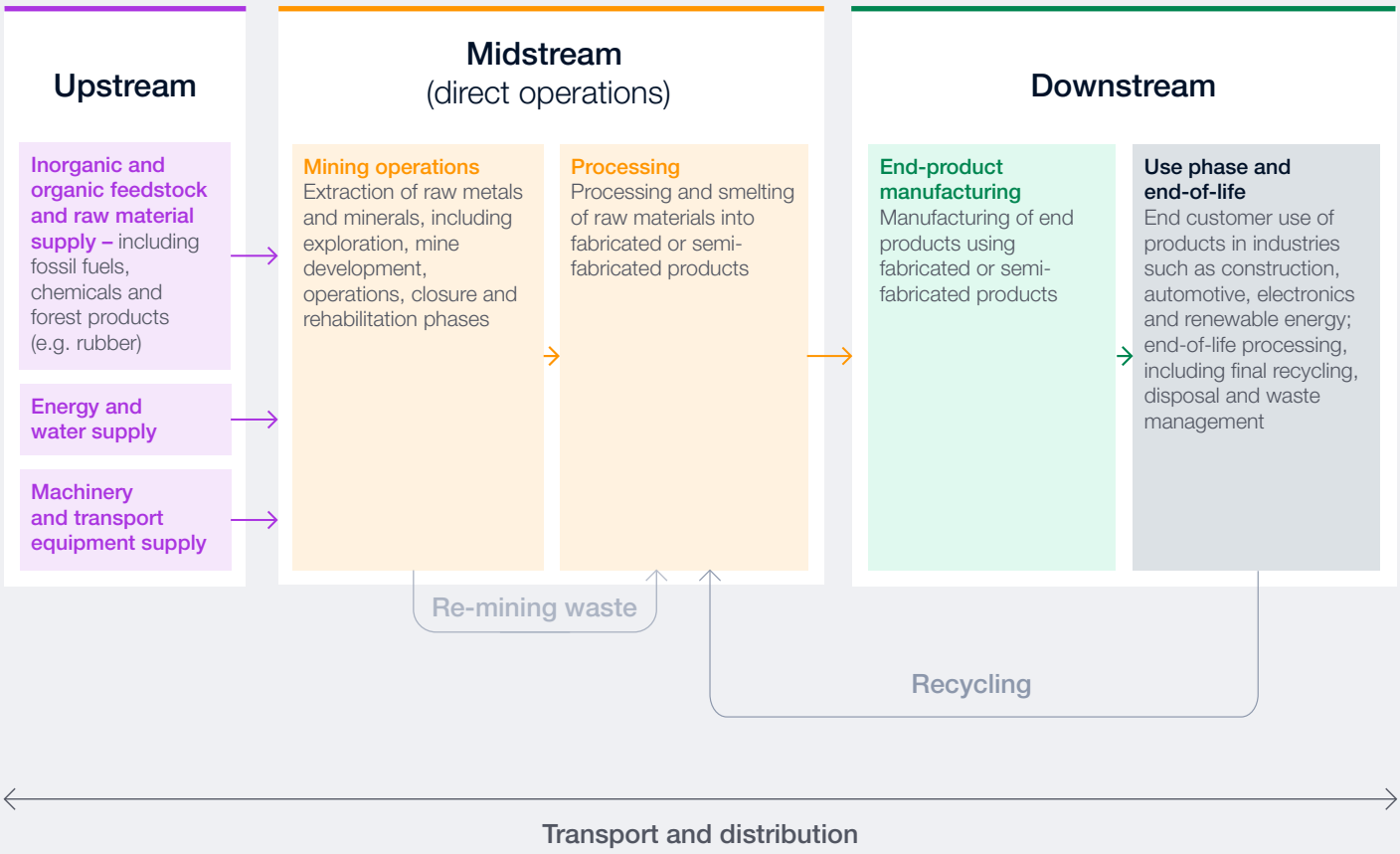
The scope of this report is defined by the Sustainability Accounting Standards Board (SASB) Sustainable Industry Classification System (SICS),[45] and includes "Extractives & Minerals Processing – Metals & Mining" and "Extractives & Minerals Processing – Iron & Steel Producers". This comprises mining operations to extract metals and minerals, processing and smelting of raw materials into fabricated or semi-fabricated products, and mining support activities. While this report covers both mining and metals, it focuses mostly on mining, given that many of the most material drivers of nature loss are concentrated in this part of the value chain.

In addition, this report will also consider the full value chain for the mining and metals sector, including industries that provide inputs into mining and processing operations, end-product manufacturers, the use phase of products and end-of-life management.

The mining and metals sector is commonly segmented into iron and ferrous alloy (ferroalloy) metals; non-ferrous metals, such as aluminium, cobalt, copper, lithium and rare earth elements; precious metals, such as gold, silver and platinum-group metals; and industrial minerals, such as potash.

This report focuses on land-based mining and does not cover deep-sea mining or other marine activities. However, it notes that deep-sea mining is potentially associated with irreversible changes to deep-sea ecosystems and the broader ecosystems they support, where the extreme conditions have given rise to a unique set of species, many of which are highly vulnerable or as yet unknown.[46] Mining of coal and construction materials, such as stone, gravel and sand, is also out-of-scope, where it is acknowledged that a rapid phase-out of coal-fired power plants is required to reach a nature-positive, net-zero future.

FIGURE 5 | **Simplified value chain of the mining and metals sector**



The mining and metals sector and nature are intrinsically interlinked. The sector depends on environmental assets and ecosystem services to function and grow.

As a result of the projected critical mineral demand requirements and concentration of resources, countries across the world have rolled out substantial updates to international cooperation mechanisms and strategic plans to support critical mineral supply chain security and resilience, promote innovation and encourage sustainable and responsible practices.[47] According to the International Energy Agency (IEA), nearly 200 policies and regulations now affect critical mineral supply, half of which were enacted in just the past few years.[48]

Indeed, the Group of Seven (G7) countries adopted a Five-Point Plan for Critical Minerals Security and pledged $13 billion in support in April 2023, and the Group of Twenty (G20) have emphasized the need for diversified, sustainable and responsible supply chains for the energy transition. The combination of recent geopolitical turbulence and China's domination of global critical raw material supply and production is encouraging the development of partnerships such as the Sustainable Critical Minerals Alliance, launched by Canada, Australia, France, Germany, Japan, the United Kingdom and the United States at the United Nations Biodiversity Conference (COP15).[49] Overall, critical minerals are increasingly shifting to a state-influenced business, where producer nations are looking to move down value chains and buyer nations are eager to secure supply while supporting the development of local industries.[50]

This dynamic is accompanied by rapidly accelerating technological change, which is driving improved efficiency, reduced emissions and mitigating safety risks in the mining and metals sector. In addition, increased permitting timelines have resulted in companies redirecting resources towards re-mining and other innovations, such as improving leaching or managing lower-grade ores.[51]

Like other sectors, the mining and metals sector and nature are intrinsically interlinked. The sector depends on environmental assets and ecosystem services to function and grow, such as the provision of metal, mineral, energy and cultivated biological resources, freshwater supply, soil and sediment retention, flood protection and global climate regulation.

A recent study found that more than half of energy transition mineral mining projects were located on or near the lands of Indigenous Peoples with rights to consultation and FPIC.

However, it also contributes to drivers of nature loss, including land-use change and water abstraction in upstream industries, mining operations and midstream production, as well as pollution and GHG emissions across the value chain. Mining activities can impact nature beyond the direct physical footprint of projects. These impacts can occur indirectly, for instance, through industries that support mining operations or stakeholders who gain access to biodiversity-rich areas due to mining. Additionally, cumulative effects arise when multiple mining activities are concentrated within the same region.

In addition, mining can adversely impact Indigenous Peoples and other local communities, including peasant communities, Afrodescendent communities and fisherfolk. Negative impacts on nature can lead to violations of the rights of Indigenous Peoples and other communities and related negative social impacts. For example, contamination of land and water resources can impact the ability to access and use resources such as firewood, medicinal plants, drinking water, fish and amphibians.

It is vital that companies consult with Indigenous groups and civil society throughout all stages of project development[52] and respect the right of Indigenous Peoples to give or withhold consent regarding projects affecting their lands, territories and resources. A recent study by the University of Queensland found that more than half of energy transition mineral mining projects were located on or near the lands of Indigenous Peoples with rights to consultation and free, prior and informed consent (FPIC).[53] Economic or material benefits should also be distributed equitably, and benefit-sharing agreements are best positioned when they reflect a genuine negotiation and participatory decision-making process with Indigenous leaders. This is advancing in some regions, such as in Canada, where there are over 500 agreements between Indigenous communities and the mining industry that outline employment, procurement and royalty arrangements.[54]

In most countries, mining remains the most hazardous occupation for workers and is responsible for approximately 8% of fatal incidents at work. In some countries, many more people are employed in small-scale, often informal, mining than in the formal mining sector. These jobs can be precarious and do not conform with international and national labour standards; accident rates in small-scale mines are routinely 6 or 7 times higher than in larger operations, even in industrialised countries.[55]

BOX 2 Large-scale mining, artisanal and small-scale mining and illegal mining

It is important to distinguish between the impacts of large-scale mining (LSM), artisanal and small-scale mining (ASM) and illegal mining to identify the entry points for addressing impacts.

LSM is defined as a formal and regulated activity using modern industrial-scale extraction and processing technologies. It involves a wide range of commodities and typically larger project sizes, leading to significant post-closure restoration and rehabilitation requirements.

The ASM sector, on the other hand, is typically informal by nature and less regulated, which means it often uses more environmentally harmful extraction methods with few rehabilitation measures in place. Workers can also face difficult or dangerous working conditions,[56] and ASM can be responsible for opening new mining frontiers that LSM moves into. However, with anything from 40 to 100 million artisanal miners globally in more than 80 countries, the industry can be essential to the livelihoods of some of the world's most marginalized communities and people and an important source of critical minerals.[57,58,59,60]

Illegal mining can take place at both abandoned and operating mines. It can cause both significant environmental and social impacts, for example, as a result of the use of harmful extraction methods or operators working under dangerous conditions. It also has a range of negative social and financial impacts on the state, the mining sector, companies and employees due to the loss of revenue, taxes, employment opportunities, capital expenditure, exports, foreign exchange earnings and procurement, among other factors.[61]

1.2 Progress is promising but needs to accelerate

CDP analysis indicates that 31 mining and coal extractive companies have made public commitments related to biodiversity. However, only 12 have committed to NNL and 5 have committed to NPI.

Within the sector, business action on nature is gathering momentum, with several major industry associations establishing targets and guidance for members in support of the nature-positive transition.

The ICMM, which represents one-third of the world's mining industry,[62] launched its *Nature: Position Statement* at the Forum's Annual Meeting in Davos in 2024[63] that requires its members to contribute to a nature-positive future in line with the Global Biodiversity Framework's 2030 targets. They must also conform with collective position statements on climate and water, including committing to reach net zero (Scope 1 and 2 emissions) by 2050, address Scope 3 emissions[64] and adopt a catchment-level, context-based approach to manage and use water responsibly.[65]

The Mining Association of Canada (MAC) has established the Towards Sustainable Mining (TSM) standard, which provides tools and indicators to support companies with environmental and social action on the ground, including a Biodiversity Conservation Management Protocol developed in 2009.[66] It also covers related areas, such as responsible tailings management and climate change (aligned with the Task Force on Climate-Related Financial Disclosures). Participation is mandatory for all members' Canadian operations, and the standard has since been adopted across the world, including by the Minerals Council of Australia (MCA).[67]

ICMM, MAC, The Copper Mark and the World Gold Council are also working towards consolidating their individual voluntary responsible mining and metals standards into a single global responsible mining standard and multistakeholder oversight system.[68]

Alongside industry association nature commitments, individual companies such as Teck Resources[69] and Anglo American[70] have gone further than ICMM's required No Net Loss (NNL) target by completion of closure,[71] by committing to deliver Net Positive Impact (NPI) on biodiversity across all operating sites. Over 10 mining and metals companies have also joined TNFD's Adopters cohort, including Anglo American, Cerrejón, Endeavour Mining, Freeport-McMoRan, Hindalco, Hindustan Zinc, Newmont, Rio Branco, Teck Resources, Vale and Vedanta.[72]

While recognizing these efforts, more needs to be done. CDP analysis indicates that of the 38 mining and coal extractive companies reporting to them, 31 have made public commitments related to biodiversity. However, only 12 have committed to NNL, and 5 have committed to NPI. Also, only 4 have made commitments at a more granular level for selected mines, business units or geographies.[73] Alongside setting targets, companies need to pair strategic planning with accelerated on-the-ground implementation and increased regulatory accountability and enforcement.

To help tackle the pressing challenges faced by the industry, the World Economic Forum's Securing Minerals for the Energy Transition initiative unites industry leaders along the minerals value chain with international organizations and governments to overcome the challenges to secure minerals for the energy transition. The Forum and UpLink will also run a series of Accelerating Innovation for Sustainable Mining challenges from 2024 to 2026, in partnership with Prospect Innovation, to support the identification and scale-up of new ventures by connecting high-potential start-ups with interested investors, end users, governments and ecosystem partners.[74]

The economy and society depend on resources that provide the foundations for many global sectors, from the built environment to mobility to food and energy. The rate at which resources have been extracted, used and disposed of has increased rapidly due to the combination of population and economic growth and improvements in social well-being in the past decades. Last year, more than 100 billion tonnes of resources were extracted.[75] In the past six years, resources equivalent to those used throughout the entire 20th century have been consumed.[76]

The scale and methods employed today to extract resources, together with their increasing consumption, are one of the leading causes of the triple planetary crisis: climate change, biodiversity loss and pollution.

Additionally, as highlighted by the International Resource Panel in September 2024,[77] social inequality is a driver and a consequence of current resource use patterns. While lower-income and middle-income countries have historically supplied resources to higher-income nations, this trend shifted in 2014, and upper-middle-income countries, including China, Brazil, Mexico and South Africa, now extract approximately half of the resources used. This relocation is driven by the outsourcing of material- and energy-intensive production processes by higher-income countries and the increasing demand for materials to develop infrastructure in newly industrializing countries. However, upper-middle-income countries are also likely to have lower environmental standards, which generates a net displacement of environmental impacts from high-income countries into the producing and exporting regions.

This challenge extends beyond resources to consumption as a whole. Indeed, in 2022, more than half of global land and biodiversity-related loss occurred in Africa and Latin America, but less than 10% of global value-added was generated in these regions. On the other hand, almost half of the global value-added is generated in Europe and North America, although less than 10% of global water stress and biodiversity loss happens in these regions.

How can these patterns change to become resource stewards and transition to responsible resource use patterns? This was the question posed to the Global Future Council on Responsible Resource Use from 2023 to 2024. First, it is vital to prioritize reducing demand for new extraction where possible by ensuring that the lifetime value of materials is maximized in a circular economy and consumer habits are adapted. Second, any new extraction must be conducted responsibly while respecting communities and the environment. Third, it is necessary to change use patterns and decouple economic growth and human well-being from increasing resource consumption.[78]

This report's primary aim is to contribute to the advancement of this second step: responsible extraction. Decision-makers are invited to consider these recommendations, which lay out how to improve extractive industries from an environmental and social standpoint, as a critical and necessary step of the responsible resource use journey.

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Corporate leaders should start to assess, commit, transform and disclose – as per the ACT-D framework – in a more systematic way. As noted in the Introduction, companies need to: identify, measure, value and prioritize their nature-related impacts and dependencies across their value chains to ensure they act on the most material ones; set transparent, time-bound, specific, science-based targets when material; take actions to transform their businesses; and track performance to publicly disclose material nature-related information. Pursuing action to contribute to nature-positive alongside existing climate action can allow businesses to mitigate risks, capture nature-related opportunities and build long-term resilience. For more information on tools and guidance available for the ACT-D set of high-level actions, see Table 1.

A range of other activities will also be needed to support the stages of ACT-D, including agreeing on definitions, determining materiality thresholds, mapping assets and operations, gathering information on existing nature-related activities, making the case for nature action internally within an organization (beyond disclosure), and establishing the vision of success.

TABLE 1 | **Selected tools and guidance available for ACT-D high-level actions**

Assess	Consult the **locate-evaluate-assess-prepare (LEAP)** approach and metals and mining sector guidance[79] from TNFD. Follow the technical guidance to **assess**[80] and **prioritize**[81] from SBTN. Consult the Organisation for Economic Co-operation and Development's (OECD) **due diligence guidance** on mineral supply chains, and conflict-affected and high-risk areas.[82]
Commit	Set **NNL** or **BNG** targets for all sites, using the International Finance Corporation's (IFC) Performance Standard 6 for guidance.[83] Follow the approach the International Union for Conservation of Nature (IUCN) is developing to **measure nature-positive**[84] and **set targets**. Set science-based targets, taking inspiration from the technical guidance provided for **freshwater** and **land** by SBTN.[85] For **climate**, refer to the guidance from the SBTi.
Transform	Take inspiration from the World Economic Forum's Nature Positive Transitions: Sectors report series;[86] invest resources and commit management to deliver against clear targets.[87] Consult the Initiative for Responsible Mining Assurance's (IRMA) full documentation and guidance,[88] The Copper Mark standards[89] or the Aluminium Stewardship Initiative (ASI) performance standard.[90] Follow the **mitigation hierarchy** at a site-level for direct operations, across the mine life cycle.[91, 92,93,94]
Disclose	Consult the final **recommendations**[95] from TNFD for nature-related disclosures. For climate, refer to the ISSB guidance on disclosure of **sustainability-related financial information** and **climate-related disclosures**.[96] Use CDP's **disclosure platform**, which includes guidance on climate change, forests, water security, biodiversity and plastics.[97] Consult the Global Reporting Initiative's (GRI) sector standard for responsible mining.[98]

Note: This table is non-exhaustive. For more tools and guidance, see *High-level Business Actions on Nature* and *The Nature Strategy Handbook*.

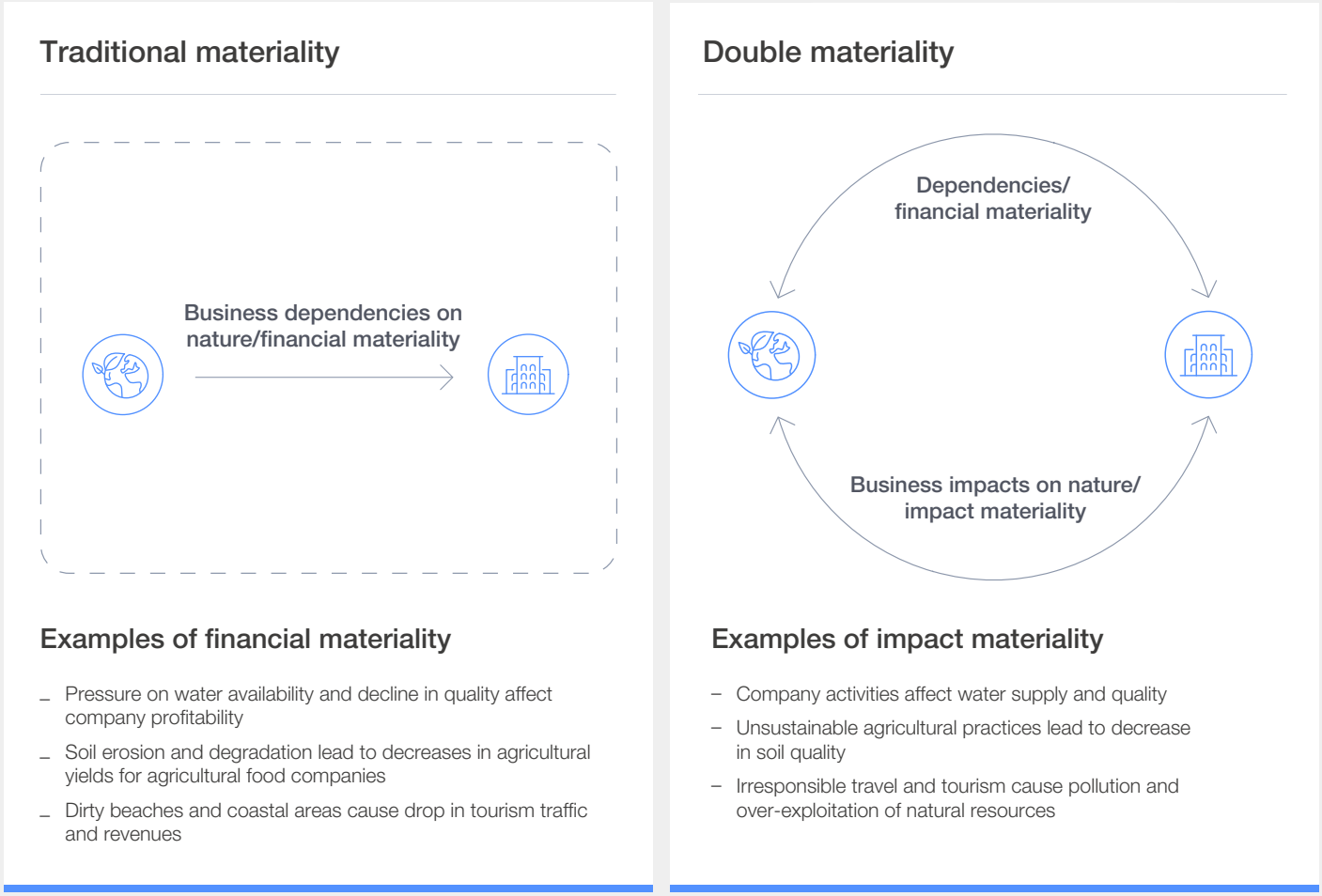
2 Nature-related impacts and dependencies

Without corrective action, nature-related risks will escalate, threatening profitability for a sector dependent on nature and supply security of critical minerals for other industries.

2.1 Double materiality

The principle of "double materiality", a concept at the heart of the EU's CSRD, defines a company's impact on the environment and its dependencies on it as highly interdependent (see Figure 6). In other words, the economic activities of businesses have impacts on both the environment and society (known as impact materiality), while concurrently, businesses also encounter risks (and opportunities) arising from their dependencies on the environment and society (known as financial materiality).

FIGURE 6 **Double materiality**



Source: World Economic Forum. Definition of double materiality sourced from: Deloitte. (2023). *Double Materiality: 5 challenging key aspects to consider*.

Like many others, the mining and metals value chain is highly dependent on a number of environmental assets and ecosystem services. For mining operations, this includes:[99]

- **Metal, mineral and energy resources:** Provision of metal and mineral resources to mine, alongside a stable supply of energy to operate. Energy is currently sourced from both renewable and non-renewable sources, with an increasing shift towards renewable sources.
- **Cultivated biological resources:** The sector relies on the provision of forest products, including timber for mining operations, and other resources, such as seed for rehabilitation.
- **Freshwater:** Although companies are increasingly reducing overall ground and surface water consumption, improving water circularity and switching to other water sources such as seawater and greywater, especially in water-scarce areas, the sector continues to rely on freshwater as an important resource. Mining operations depend on water for activities such as ore processing and refining, dust suppression, cooling and lubrication of machinery, and slurry transport to tailings dams. Indeed, according to CDP, in 2018 alone, the mining and metals sector suffered over $20 billion in water-related financial impacts,[100] such as increased operating costs, reduction or disruption in production capacity and fines or penalties.

More than 90% of the gross value-added across mining and metals companies' direct operations and supply chains is moderately dependent on nature.

- **Soil and sediment retention, and flood protection:** Mass stabilization, erosion control and green infrastructure[101] protects roads, camps and infrastructure leading to mines from landslides and other natural hazards, which can suspend operations, leading to missed production targets, reduced investor confidence and negative social impacts.

- **Global climate regulation:** Mining operations depend on the regulation of temperature, precipitation and the hydrological regime, including the absence of extreme events such as heatwaves or floods, provided by nature through the long-term storage of carbon dioxide in soils, vegetable biomass and the oceans.

Other sectors across the value chain are also highly dependent on these and other environmental assets and ecosystem services, in particular, upstream energy operations, transport and the downstream construction industry. According to the World Economic Forum's report *Nature Risk Rising*, more than 90% of the gross value-added across mining and metals companies' direct operations and supply chains is moderately dependent on nature.[102] These dependencies can materialize as risks to businesses if not properly assessed and managed and if action is not taken to safeguard nature. This strengthens the business case for investing in protecting and restoring nature to build sustainable, responsible and resilient supply chains and ensure the long-term viability of business models.

However, the mining and metals sector continues to impact nature, contributing to drivers of biodiversity loss such as land-use change and ecosystem disturbance, pollution, water abstraction and GHG emissions.[103] Wherever possible, mining and metals companies should avoid, then reduce, these drivers of nature loss in their operations and value chains, alongside related negative social impacts on communities at and around project sites, to mitigate risks and unlock nature-related opportunities across the value chain.

TABLE 2

Top four drivers of nature loss in the value chain of the mining and metals sector

	Upstream	Midstream (direct operations)	Downstream
Land-use change and ecosystem disturbance	✓	✓*	
Pollution	✓	✓	✓
Water abstraction	✓	✓	
Greenhouse gas emissions	✓	✓	✓*

Pressure materiality rating (ENCORE): High Medium

*Manually adjusted based on expert feedback. **Note:** See methodology in the Appendix.

BOX 4

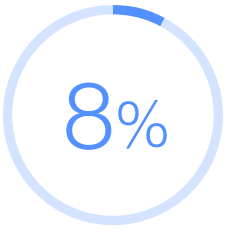
Conduct company-specific assessment of impacts and dependencies

The analysis of impacts and dependencies presented in Chapter 2 is a sector-average analysis for companies in the mining and metals sector, but company-specific impacts and dependencies will vary according to their activities, supply chains and operational locations.

Companies will need to conduct assessments to locate their interface with nature and evaluate their impacts and dependencies using company-specific operational and supply chain information. TNFD's LEAP approach[104] and metals and mining sector guidance,[105] as well as the SBTN's step 1 (assess)[106] and step 2 (prioritize)[107] are useful frameworks to guide companies through their own assessments.

The full methodology and results of this sector-average assessment can be found in the Appendix.

2.2 Land-use change and ecosystem disturbance



of known mining properties coincide with global IUCN Protected Areas.

Both upstream input industry activities (including from the energy, chemicals, timber and rubber sectors), mining operations (including exploration, construction, ore extraction and waste storage), and the development of supporting infrastructure for mines (including linear infrastructure such as pipelines, transport infrastructure and accommodation), can result in:[108]

- Land clearance and ecosystem fragmentation
- Soil degradation, erosion and compaction, increasing flows of sediment into nearby rivers
- An increase in non-natural fires and landslides, from the use of heavy machinery and explosives
- Disruption or diversion of surface water regimes and groundwater systems
- Introduction of non-native species from transport, including through shipping, rail and vehicle use

These impacts can vary significantly by region, commodity, ore tonnage or grade, company size (LSM or ASM) and mine type. In particular, open pit mines result in notably greater land clearance and corresponding rehabilitation requirements than underground mines.

Of global mining operations, 8% of known mining properties coincide with global IUCN Protected Areas, 7% with Key Biodiversity Areas (KBAs), and 16% with Remaining Wilderness,[109] and nearly a third of the world's mine tailings are stored within or near protected conservation areas[110]. In particular, in forest ecosystems, mining is the fourth largest driver of direct deforestation[111] and may already affect up to one-third of the world's forest ecosystems when indirect impacts are taken into account.[112] In total, 84% of global direct mining-related deforestation (MRD) in the past 20 years occurred in just 10 countries. Deforestation was most prevalent in Indonesia (accounting for 25% of global MRD) and Brazil (12%). Gold caused the highest direct deforestation between 2001 and 2019, followed by bauxite, iron ore and copper.

As indicated in section 1.1, the area of influence of mining operations is generally larger than the direct physical footprint of projects due to both indirect and cumulative impacts. In particular, mining-associated infrastructure development can attract human populations, causing new threats or exacerbating pre-existing threats, such as overexploitation (e.g. hunting, fishing, logging), establishment of invasive or exotic species (e.g. through inadvertent introduction by humans), and habitat loss for other land uses (e.g. agricultural expansion and illegal mining).[113,114,115]

Mining can also violate the rights of Indigenous Peoples, and the rights of local communities, for example, where mining expansion or processing affects areas of high ecological, cultural or community significance. Through the alteration of landscapes, mining can lead to fragmentation of lands that hold deep cultural and spiritual significance for Indigenous Peoples. These landscapes are not merely economic resources but are integral to cultural identity, traditional knowledge systems and the transmission of spiritual practices. Fragmentation can disrupt sacred sites, ceremonial areas and traditional routes, undermining the cultural integrity and continuity of Indigenous communities. Disruptions to water systems caused by mining operations can also severely impact Indigenous Peoples who rely on them. Altered hydrological patterns can lead to the degradation of wetlands and river systems that are crucial for maintaining the health of entire ecosystems, impacting fish populations, wildlife and plant species that are central to Indigenous ways of life.

These impacts can be more pronounced when local communities and rightsholders are not meaningfully engaged, when Indigenous Peoples' rights to self-determination and FPIC are not respected, or when robust human rights due diligence activities are not undertaken to avoid causing or contributing to negative human rights impacts.

Building on existing practices, international principles and standards such as the Society for Ecological Restoration's (SER) framework, launched in 2022, have emerged to strengthen rehabilitation and restoration approaches and improve outcomes in mining landscapes.[116] However, collaboration between companies, governments and local communities is needed to ensure these standards are adopted and adhered to consistently.

2.3 Pollution

Un-remediated mine pollutants have the potential to alter the geochemistry of watersheds over large footprints, and acidic conditions and toxic elements can continue after a mine has been abandoned.

Many countries have implemented policies and regulations that place controls on sectoral pollution levels. For example, regulation is especially strong in the EU, where the Industrial Emissions Directive requires companies to implement the best available techniques (BAT) to reduce the use and impacts of hazardous chemicals.[117]

Pollution impacts are caused by LSM, ASM and illegal mining. LSM companies need to comply with environmental regulations, but ASM is typically informal and less regulated, and while essential to many livelihoods, can often employ more environmentally harmful extraction methods.[118,119] For example, artisanal and small-scale gold mining (ASGM) is crucial to the livelihoods of up to 20 million miners in over 80 countries and produces up to 20% of the world's gold. However, it is the largest source of anthropogenic mercury pollution, contributing 40% of all mercury that enters the atmosphere.[120] In an attempt to combat global mercury pollution, including from ASGM, 148 countries have committed to the Minamata Convention on Mercury.[121]

Overall, voluntary and involuntary activities from LSM, ASM and illegal mining across the value chain can lead to four types of pollution, particularly in jurisdictions where regulatory standards and enforcement are weak:[122]

1. **Land, freshwater and ocean pollution**, including the leaching of toxic chemicals and heavy metals, the release of highly saline or acidified wastewater and higher-temperature water. In particular, this is driven by mining activities and processing operations, including the use of drilling fluids, material removal and processing (e.g. cooling), and leaching from ore heaps and tailings.

2. **Non-GHG emissions** (including nitrogen oxides and sulphur dioxide), **dust/particulate matter and other pollutants** released into the atmosphere from mining operations (including equipment operation, cyanide vaporization, explosives use and waste drying); metal processing operations; input industries processes (including from the energy, chemicals, construction machinery and heavy trucks sectors); downstream manufacturing processes; and shipping.

3. **Waste** generated from non-product outputs, produced through mining, production and refining processes (such as tailings and slags), downstream manufacturing processes (ranging from dust to packaging and spent batteries), and end-of-life product waste.

4. **Noise and light pollution**, for example, from disruptions caused by mining operations, such as drilling or the use of explosives, and machinery operation.

Un-remediated mine pollutants have the potential to alter the geochemistry of watersheds over large footprints,[123] and acidic conditions and toxic elements can continue after a mine has been abandoned.[124]

“ At least 23 million people currently live on floodplains that are contaminated by potentially harmful concentrations of toxic waste from metal mining activities.

Abandoned mines also contribute to long-lasting environmental degradation, as acid-mine drainage can pollute groundwater and surface water. Accountability for closure and rehabilitation of operational or new mines is now clearer, however, impacts on nature arise from a historical legacy of inadequate, insufficient or non-existent mine closure. The lack of clearly assigned (or assumed) responsibility for old mines, alongside other factors, has resulted in delayed action from all parties, including industry, governments and communities.[125]

Pollution can also impact local communities as impacts spread over large spatial footprints through the release of particles, which can cause health problems,[126] contamination of drinking water and the contamination of local wild animal populations, affecting food sources for communities.[127,128] At least 23 million people currently live on floodplains that are contaminated by potentially harmful concentrations of toxic waste from metal mining activities.[129]

Industrial disasters in the mining industry have also had catastrophic environmental and social impacts over the last decade. These include the Brumadinho dam disaster in 2019, where Vale’s iron ore tailings dam collapsed, taking the lives of over 270 people, and the Mariana dam disaster in 2015, which released water and mine waste that travelled over 500 km along the Doce River to the Atlantic coast.[130] In 2014, the Canadian Mount Polley mine tailings pond broke and released 25 billion litres of contaminated materials into Polley Lake, Hazeltine Creek and Quesnel Lake.[131] Such events have reinforced the need for stronger international standards on tailings management and regulatory governance. The Investor Mining and Tailings Initiative (IMTSI), a coalition of over 100 investors with more than $25 trillion in assets under management, was founded in 2019, calling for the development of a Global Industry Standard on Tailings Management (GITSM).[132] This standard has now been endorsed by over half of the mining sector,[133] and a new independent body, the Global Tailings Management Institute, was established in 2023 to oversee implementation.[134]

Many rights holders and stakeholders contend that current industry standards, including the GITSM, do not go far enough to adequately protect communities and ecosystems from failures. In 2022, 164 mining-impacted communities, Indigenous governments, academics, scientists, human rights and environmental rights organizations developed a set of 17 guidelines for responsible tailings management, which promote respect for impacted communities and stronger corporate accountability.[135]

2.4 Water abstraction

The mining and metals sector uses water across its entire value chain and has a CDP Water Watch impact rating of “critical” (highest category).[136]

Mining activities abstract and use freshwater (groundwater and surface water) alongside alternative water sources, such as seawater and greywater, for a range of activities. These include ore processing and refining to separate valuable metals and minerals via chemical and physical processes such as froth flotation; centrifugal separation, leaching and electrochemistry; dust suppression during mining operations for mineral processing and around conveyors and roads; cooling and lubrication of machinery to maintain longevity by reducing wear and preventing overheating; and slurry transport to tailings dams for disposal and storage. Water use intensity can vary significantly by commodity. For example, lithium and rare earth elements use 0.64-0.78 cubic metres

> In Chile's Salar de Atacama, lithium and copper extraction have reportedly already consumed over 65% of the local water supply, and operations are expanding at a rate of 7% per year.

of water per kilogram of ore (m^3/kg), whereas cobalt, copper and nickel use 0.03-0.06 m^3/kg, and iron requires 0.001 m^3/kg.[137]

Water use across a range of upstream input industries is also material, including the energy, chemicals, construction machinery, heavy trucks and rubber sectors.[138]

Overall, mining accounts for 2-4.5% of global freshwater use[139] and can have a significant impact on water resources at a local and regional level,[140] both directly and cumulatively. As a result, water abstraction creates competition for water availability with local industries and communities, which can lead to displacement or conflict. The impacts of mining on nature and people are magnified where ore deposits lie in arid places – the World Resources Institute (WRI) found that 16% of critical mineral mines, deposits and districts are in highly water-stressed areas, and in these locations, at least 40% of water supply is required to meet existing demand each year. For example, in Chile's Salar de Atacama, part of the "lithium triangle" in Latin America, which contains 60% global lithium supply,[141] lithium and copper extraction have reportedly already consumed over 65% of the local water supply, and operations are expanding at a rate of 7% per year.[142,143]

The reduction in the availability of local freshwater can put company operations at risk. Water basins in China, the US, Australia and Russia emerge as the highest risk globally.[144] Mining companies are starting to make progress towards improving water stewardship by completing water footprint assessments, setting contextual targets and taking actions such as increasing water recycling and using alternative water sources, like greywater or seawater. For example, Anglo American aim to reduce freshwater withdrawal by 50% in water-scarce areas from 2015 to 2030.[145] Similarly, Teck Resources plans to design all development projects in water-scarce regions with a seawater or low-quality water source from 2025 and transition to seawater or low-quality water sources for all operations by 2040.[146]

Pressure to improve water stewardship is growing. Regulators are increasingly introducing requirements for businesses to safeguard the availability of freshwater, such as in Mexico, where new laws require companies to bid for water allocation and submit monthly water consumption reports.[147]

2.5 Greenhouse gas emissions

The mining and metals sector is responsible for 2-3% of global GHG emissions.[148] This share can rise significantly in countries where the mining sector represents a large part of the economy.[149] Emissions intensity can vary by region, commodity and across mines, depending on power sources, production pathways and operational practices.[150] For example, within copper and iron ore, there is a twentyfold variation in the emissions intensity of mines.[151]

Within mining operations today, 40-50% of Scope 1 and 2 carbon dioxide (CO_2) emissions come from diesel used in mobile equipment, and another 30-35% come from the use of non-renewable electricity.[152] Following this, the next main source of emissions is comminution, given the energy required to crush ores before processing.[153]

Iron and steel production is responsible for an additional 7% of global GHG emissions.[154] Emissions are primarily generated by energy-intensive processes, such as smelting, and the use of coke coal as a reductant in steel production. It takes approximately 770 kg of coal to make one ton of steel.[155] Looking across the value chain, transport is also a major emissions driver, particularly as international shipping accounts for 2% of global emissions[156] and mined commodities make up over 20% of global maritime trade.[157]

The sector is already taking action to tackle its emissions, engaging in both climate mitigation and adaptation. Companies and industry associations are setting and making progress towards emissions reduction targets. For example, ICMM members have committed to net-zero Scope 1 and 2 GHG emissions by 2050 or sooner, while accelerating action to address Scope 3 emissions.[158] Individual companies have gone further, including Rio Tinto, who have committed to reducing Scope 1 and 2 emissions by 50% by 2030.[159] The Minerals Council of Australia have also identified 30 actions in their 2020 *Climate Action Plan* and reported that member companies had reduced their Scope 1 and 2 emissions by 4.7% between 2021 and 2022.[160] Similarly, over 40 World Steel Association members have committed to nine principles as part of their Sustainability Charter. More broadly, members responsible for over 50% of global crude steel production report data on sustainability indicators each year to support the monitoring and reporting of industry performance.[161] Given emissions are spread across the value chain, collaborative action with suppliers and customers is essential to achieving Scope 1, 2 and 3 emissions reductions.

3 Five priority actions

By taking five priority actions on nature, the sector can unlock more than $430 billion of value by 2030.

Mining and metals companies can contribute to a nature-positive future by prioritizing actions to 1) transform operations across the mine life cycle, 2) improve water stewardship, 3) expand circularity and source responsibly, 4) restore and regenerate landscapes, and 5) transform policy systems and collaborate across sectors.

These priority actions require companies to actively engage with suppliers, customers, peers and other industries to transform their value chains. **While many of these actions are already being employed or gradually rolled out by businesses, this report calls for accelerated efforts in the mining and metals sector.**

FIGURE 7 **Five priority actions for the mining and metals sector**

Undertaking the priority actions for the mining and metals sector could unlock more than $430 billion in cost savings and revenue upside by 2030.

The nature-positive transition can also present enormous opportunities for companies in this sector. The Forum's *Future of Nature and Business* report estimated that a full nature-positive transition in the global economy could create $10.1 trillion of annual business opportunities by 2030. Of this amount, estimates show that undertaking the priority actions for the mining and metals sector could unlock more than $430 billion in cost savings and revenue upside by 2030 for businesses operating across the sector's value chain. In particular, energy and water efficiency in operations, mine rehabilitation and efforts to move towards circularity through resource recovery present significant business opportunities (see Figure 8 and Table 3).

To calculate the opportunity summarized in the waterfall in Figure 8, the following opportunities from the *Future of Nature and Business* report were identified as relevant (see Table 3). Further information on the calculation methodology can be found in the Appendix.

FIGURE 8 **Business opportunities for the mining and metals sector by 2030 ($, billion)**

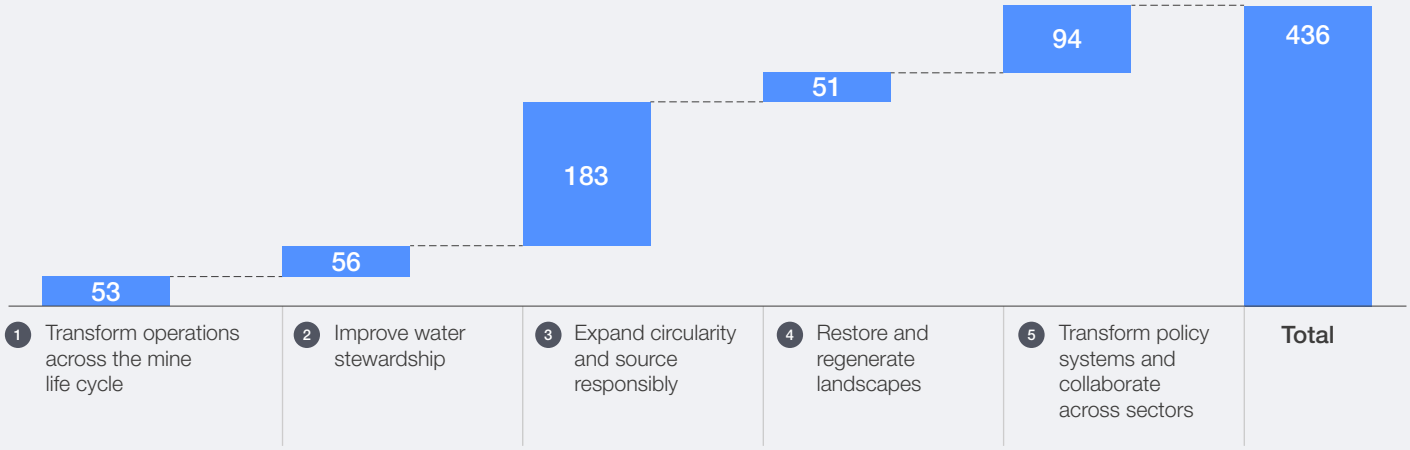


TABLE 3 | **Deep-dive on business opportunities for the mining and metals sector**

Priority action	Business opportunity from *Future of Nature and Business* report	Original size in *Future of Nature and Business* report ($ billion)	Adjustment factor to size share of mining and metals sector	Opportunity size for mining and metals sector ($ billion)
1 **Transform operations across the mine life cycle**	Expansion of renewables	650	Mining and metals sector share of global GDP: 1.01%	6.6
	Energy efficiency – buildings	825		8.3
	Energy efficiency – energy intensive sectors*	187		1.9
	Sustainable substances in extraction	20	Mining and metals revenue share excluding coal: 72%	14.4
	Technology in energy and extractives supply chain	30		21.6
2 **Improve water stewardship**	Water efficiency in mining	75		54.0
	Waterwaste reuse	50	Mining and metals sector share of global GDP: 1.01%	0.5
	Natural systems for water supply	140		1.4
3 **Expand circularity and source responsibly**	Circular economy – automotive	870		8.8
	Circular economy – appliances	565		5.7
	Circular economy – electronics	390		3.9
	End-use steel efficiency	210		2.1
	Resource recovery	225	Mining and metals revenue share excluding coal: 72%	162.0
4 **Restore and regenerate landscapes**	Mine rehabilitation	70		50.4
	Nature climate solutions	85	Mining and metals sector share of global GDP: 1.01%	0.9
5 **Transform policy systems and collaborate across sectors**	Shared infrastructure	130	Mining and metals revenue share excluding coal: 72%	93.6

*Additional opportunity beyond *Future of Nature and Business* report analysis.

Taking these five priority actions across operations and the wider value chain will help companies in the sector avoid or reduce the four drivers of biodiversity loss (land-use change and ecosystem disturbance, pollution, water abstraction and GHG emissions) across the four nature realms (land, ocean, freshwater and atmosphere), mitigate risks to operations and unlock commercial opportunities. These actions will also contribute to the targets of the Global Biodiversity Framework, which aims to halt and reverse biodiversity loss by 2030 (see Table 4).

TABLE 4 | **Mapping of five priority actions to GBF framework**

For each action, companies should also set measurable and time-bound targets and report against the progress regularly to increase their accountability (see Chapter 4 for more details).

Priority action 1

3.1 Transform operations across the mine life cycle

Avoid, then reduce, impacts of mining operations and restore across the mine life cycle in accordance with the mitigation hierarchy.

Companies should follow the mitigation hierarchy sequentially at site-level, in a landscape context, taking into consideration direct, indirect and cumulative impacts. They should first **avoid** impacts, then **reduce** impacts, **restore**, and finally, **compensate**[162] for unavoidable residual impacts.[163,164,165,166,167] Mitigation efforts should align with a NNL or BNG goal for each project.[168,169]

BOX 5 Principles for applying the mitigation hierarchy

The mitigation hierarchy is a four-step decision-making framework designed to support the mitigation of nature impacts. To improve the application of the mitigation hierarchy, The Nature Conservancy identified six principles to guide its application:[170]

- **Mitigation hierarchy steps:** The steps should be followed sequentially – avoid, reduce, restore and then compensate for impacts.
- **Landscape context:** Apply the mitigation hierarchy in a landscape context, taking into consideration direct, indirect and cumulative impacts.
- **Goal:** Mitigation policy goals at the national, regional and/or local level should ensure the mitigation hierarchy is applied to support conservation objectives and drive accountability for application. As of 2016, over 100 countries had or were developing national mitigation policies that require offsets or enable the use of offsets.[171]
- **Limits to offsets:**[172] There are limits to what can be offset and impacts that cannot be offset should be avoided as this may be the only means to prevent irreplaceable loss.
- **Sustainable outcomes:** Mitigation should support long-term, durable outcomes.
- **Stakeholder engagement practices:** Mitigation should follow best practices for stakeholder engagement, guided by the following principles for meaningful and inclusive stakeholder engagement – inclusiveness, transparency, rights-based approaches, and science and traditional knowledge.

Additional principles have also been established specific to the "compensate" step – see more guidance under the "Compensate for unavoidable residual impacts" sub-section of this priority action.

Avoid exploring or mining in biodiversity hotspots, and strengthen biodiversity assessment, planning and management

For all new mines, companies should:

- Not explore or mine in IUCN categories Ia and Ib Protected Areas,[173] Alliance for Zero Extinction sites,[174] World Heritage Sites[175] and other designated critical habitats where mining is not permitted.

- Avoid exploring or mining in critical habitats as defined by IFC PS6,[176] IUCN categories II-IV Protected Areas,[177] other KBAs,[178] and areas of high ecological, cultural or community significance. Exceptions can be considered only where mining operations will support positive climate, environmental or social outcomes at local scales. Where exceptions are made, safeguards should be put in place to minimize negative impacts (e.g. requiring avoidance and protection of key habitats or species population management). For sites in critical habitats, companies should align the implementation of the mitigation hierarchy with a BNG goal and endeavour to do the same for the other priority areas outlined above.

For sites with existing approvals or operations, companies should map and classify areas of high ecological, cultural or community significance (in line with IFC Performance Standard 6[179]). Then, implement safeguards to both avoid and minimize negative impacts, including through the project activity design and infrastructure siting, prioritizing actions at the identified significant areas. Companies should also assess the trade-offs between the impacts of expanding existing sites compared to establishing new mines. Avoidance and minimization of impacts may be iterative as companies learn more about their areas of influence throughout project development.

Overall, companies can collaborate with governments to delineate no-go areas from mining areas and establish safeguards to minimize negative nature impacts (see section 3.5).

In addition, companies should conduct biodiversity assessments such as species monitoring for all sites, including operational and non-operational lands, evaluate dependencies on critical ecosystem services, and develop biodiversity management plans aligned to the mitigation hierarchy.[180] A range of methods, including innovative new technologies, are available to support biodiversity assessment. For example, Anglo American and Rio Tinto are using environmental DNA (eDNA) data to assess biodiversity at their sites.[181]

Alongside the nature-related considerations outlined above, for both new and existing sites, companies should conduct meaningful consultations to evaluate social impacts and identify local ecological, community and cultural values, perform participatory planning and project design, respect the right to self-determination and FPIC of tribal and traditional communities and Indigenous Peoples with collective land and resource rights, throughout all stages of exploration and extraction (see Box 6), and conduct ongoing participatory monitoring of impacts. FPIC also encompasses the right of Indigenous Peoples to withhold consent.

The following is an explanatory note excerpted from the Securing Indigenous Peoples' Rights in the Green Economy (SIRGE) Coalition's *Guide on Free, Prior and Informed Consent*:[182]

"The [United Nations Declaration of the Rights of Indigenous Peoples (UNDRIP)] includes provisions expressly recognizing the duty of States to secure Indigenous Peoples' FPIC in the following circumstances:

Before Indigenous Peoples' relocation or resettlement (Article 10)

Before the use of Indigenous Peoples' cultural, intellectual, religious and spiritual property (Article 11)

Before implementation of any legislative or administrative measures that could affect Indigenous Peoples (Article 19)

Before the use of Indigenous Peoples' lands (Article 28)

Before the storage or disposal of hazardous materials on Indigenous Peoples' lands (Article 29)

Before state approval of any project affecting Indigenous Peoples' lands, territories, and resources, especially projects related to the development, use, or exploitation of mineral, water, or other resources (Article 32)

FPIC includes both:

A process of engagement and dialogue (being consulted, asking questions, negotiating, taking the time to fully understand the proposed project)

The right to give or withhold consent during or after that process of engagement."

It is vital to note that "the consent of Indigenous Peoples should be determined in accordance with their customary laws and practices." This does not necessarily mean that every single member must agree – rather "the consent process will be undertaken through procedures and institutions determined by Indigenous Peoples themselves".[183]

Various standards and guidelines exist to support company engagement with Indigenous Peoples, other local communities, and with FPIC. For example, the IFC's *Performance Standard 7: Indigenous Peoples*[184] recognizes the rights of Indigenous Peoples to their lands, territories and resources. It also emphasizes the principles of FPIC throughout the project life cycle and ensures that Indigenous Peoples benefit from mining activities in a fair and equitable manner through mechanisms such as benefits sharing, capacity building, employment opportunities, support for local development, and meaningful consultation and participation.

Other resources include:

United Nations *Declaration on the Rights of Indigenous Peoples*[185] and *Guiding Principles on Business and Human Rights*[186]

International Labour Organization's *Indigenous Peoples: Consultation and Participation* guidance on Convention 169[187]

The Securing Indigenous Peoples' Rights in the Green Economy (SIRGE) Coalition's *A Guide on Free, Prior and Informed Consent*[188]

Forest Peoples Programme's guidance on good faith consultation and negotiations with Indigenous and tribal communities[189]

The Asia Indigenous Peoples Pact's (AIPP) Handbook on *Extractive Industries and Free, Prior and Informed Consent of Indigenous Peoples*[190]

OECD's *Due Diligence Guidance for MeaningfulStakeholder Engagement in the Extractive Sector*[191]

TNFD's *Guidance on engagement with Indigenous Peoples, Local Communities and affected stakeholders*[192]

SBTN's *Stakeholder Engagement Guidance*[193]

IRMA's *Free, Prior and Informed Consent (FPIC)* guidance[194]

Tools can also help companies identify areas that have been traditionally owned, occupied or otherwise used and/or acquired by Indigenous Peoples and other local communities, and other areas of biocultural importance, including:

The Indigenous Peoples' and community conserved territories and areas (ICCAs)[195]

The Global Land Governance Index's LANDex Indicators[196]

WRI's LandMark platform[197]

The Indigenous Navigator[198]

Optimize energy use and increase the use of renewables and clean technology

There are a number of actions that companies can take to reduce GHG emissions, in order to both manage risks and capture business demand for low-carbon or carbon-free metals. Companies can:

Increase use of renewables and clean technology:

- Increase use of renewables, which are economical and feasible today for many mines and metals,[199] ensuring procurement is in line with standard due diligence and economic requirements, and embeds criteria to optimize environmental sustainability, social equity, and climate resilience of projects.[200,201,202] For example, Antofagasta Minerals has used 100% renewable power since 2022.[203]
- Use novel clean breakthrough technologies to decrease dependence on fossil fuels. For example, for steel, this includes hydrogen direct reduction, carbon capture use and storage (CCUS), and electrolysis-based production processes. For aluminium, this includes using inert anodes, CCUS, green hydrogen and mechanical vapour recompression. The Forum's FMC advances the most critical, emerging climate technologies by leveraging members' collective purchasing power.[204,205,206]
- Decarbonize equipment, logistics and transport. This includes:
  - Transitioning from fossil fuels to electric or hydrogen-powered vehicles and equipment, either via:
    - Retrofitting (where some companies are hosting auctions for decommissioned equipment)
    - Circular rental or sharing schemes for vehicle use
    - Replacement (for example, Fortescue acquired Williams Advanced Engineering in 2022 to bring their battery and electrification technologies to support the decarbonization of Fortescue's freight trains, haul trucks and industrial equipment[207])
  - Supporting shipping providers to transition to low-carbon or carbon-free fuels.
  - Optimizing routes and use efficiency, such as via transport sharing with other companies.

Optimize energy use and resource efficiency in mining and production processes:[208]

- Implement energy management systems and standards, smart use strategies, and perform ongoing monitoring and optimization of manufacturing processes to increase natural resource-use efficiencies.
- Innovate manufacturing processes to reduce energy and heat intensity and recovery, improve heat management and recycle heat in manufacturing. For example, ArcelorMittal launched a partnership with Capgemini and the French government to evaluate potential heat recovery solutions, which resulted in ArcelorMittal saving an estimated 10% energy per plant.
- Improve equipment selection to support future efficiency improvements.

Support the development of grid-connection infrastructure and the scale-up of technologies such as CCUS:

- For example, Eramet partnered with Air Liquide, forming a multi-year contract to build a pilot carbon capture and storage project to capture CO_2 from the combusted gas of two manganese alloy-producing furnaces.[209] Green Gravity's Gravity Energy Storage System (GESS) uses heavy weights moving vertically through legacy mine shafts to capture and release gravitational potential energy as a low-cost, long-life energy storage technology.[210]

Avoid, then reduce, land and pollution impacts from exploration, extraction and waste

Companies can invest in innovation to avoid and reduce impacts, working with start-ups to accelerate research and development, develop new lower-impact technologies and support the scale-up of economically viable technologies.

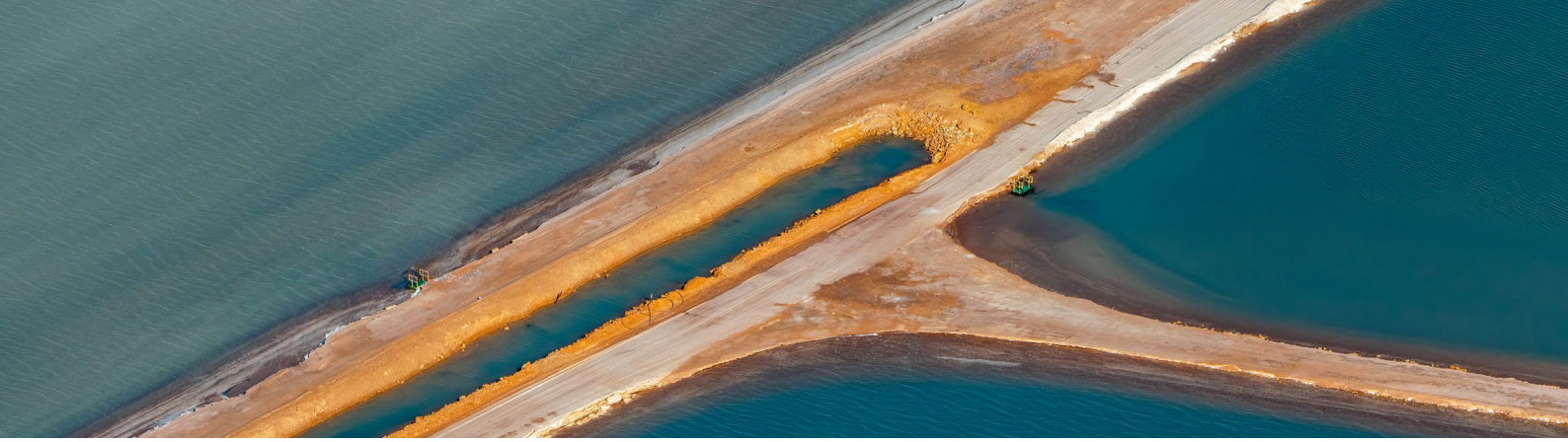
For exploration, opportunities exist in new technologies that improve the accuracy of location targeting for drilling, such as remote sensing, autonomous drone technologies, LiDAR (light detection and ranging), and artificial intelligence (AI) and machine learning models. For example, TerraEye applies integrated AI and machine learning to real-time satellite data, enabling companies to identify mineral deposits more efficiently.[211] Companies can also innovate to reduce the need to drill and collect core samples. For example, Datarock's cloud platform uses AI to extract geological and geotechnical data from core imagery, to optimize analysis and improve ore body knowledge.[212]

For extraction, this includes:

- Prioritizing underground mining over open-cast mining to reduce surface-level spatial footprint
- Improving extraction efficiency rate to reduce material removal requirements
- Optimizing purification and beneficiation of ores to improve post-extraction ore quality and enable downstream customers to use lower-impact technologies
- Investing in the development of in-situ leaching to eliminate the requirement to remove material, following an assessment of the nature impact trade-offs between material removal and in-situ pollution
- Developing sustainable or natural chemical and non-chemical extraction techniques.
  - For example, companies can use chemicals such as methanesulfonic acid or ionic liquids, which are lower-toxicity, less volatile, require reduced inputs or are recyclable,[213,214] or living microorganisms. Endolith uses microbes to extract critical minerals from low-grade ores, with minimal to no changes in existing mining operations.[215]

Companies can also innovate to avoid, reduce, reuse, re-mine and recycle mining and metals waste in operations:

- **Reduce initial waste production**, for example:
  - Vale has redesigned processes at their Brucutu mine, incorporating new minerals processing stages to generate a new by-product called ore sand and significantly reduce the amount of material disposed of conventionally as tailings. Ore sand not only reduces the risks of conventional mine waste management but can also be a competitive option to conventional sand, thus contributing to alleviating the damage caused by the excessive extraction of sand from rivers and sensitive coastal environments.[216]
  - Hydro has developed a novel "tailings dry backfill" technology, which eliminates the need for bauxite tailings dam storage.[217]
  - ArcelorMittal is piloting non-wet or reduced-moisture tailings disposal methodologies in iron ore mines in Mexico, Brazil and Quebec.[218]
- **Re-mine materials from slags and tailings**, for example:
  - Envicore offers solutions to transform mine waste into supplementary cementitious materials (SCMs), enabling up to 20% cement replacement.[219]
  - Rio Tinto is extracting elements such as tellurium, scandium and aqua-catalysed hydrated lime (CHAC) from metal production by-products for use in other industries, such as aerospace, clean technology and agriculture.[220]
  - Genomines harness the natural ability of hyperaccumulator plants to extract nickel from tailings.[221]
- **Reduce yield losses in operations**, as nearly half of all liquid metal becomes scrap on its journey to a final product.[222]



Some leading companies have established start-up accelerators to encourage innovation. For example:

- BHP's Xplor accelerator programme supports innovative, early-stage mineral exploration companies in fast-tracking and de-risking their geological concepts to become investment-ready; two cohorts and 13 innovators have been selected to date.
- Vale's Ventures programme invests in pioneering early-stage start-ups focused on decarbonization in the mining value chain, zero-waste mining, energy transition minerals and the future of mining.[223]

Other mining companies have also partnered with local organizations to call for innovation in response to specific issues, such as Expande,[224] Unearthed,[225] mininghub[226] and ReThink Mining.[227]

Alongside innovation, companies can also take steps within existing operations to reduce exploration, extraction and waste impacts. This includes optimizing the efficiency of mine sites and surrounding infrastructure; reducing tailings where possible and managing tailings safely and efficiently in line with international standards[228, 229] to reduce pollution and prevent industrial disasters; and strengthening security to prevent illegal mining on owned land.

Address indirect and cumulative impacts

Beyond efforts to avoid and reduce land and pollution impacts, companies should also collaborate across the sector and with other industries, local governments, Indigenous Peoples, local communities and academia to identify, assess, then address indirect or induced and cumulative impacts across landscapes, drawing from available industry guidance such as the MCA's *Cumulative Environment Impact Assessment Industry Guide*.[230] This includes assigning accountability for cumulative impacts across stakeholders.

For example, this can be achieved by establishing mechanisms to share data to support landscape-level decision-making, designing impact assessment methodologies and metrics (supported by regional natural capital accounts), sharing infrastructure to limit overall land disturbance, and identifying roles and responsibilities for impact mitigation, restoration and regeneration.

Strengthen rehabilitation and restoration approaches in partnership with local communities

Rehabilitation and restoration of mine sites is a vital part of the sector's contribution to nature-positive outcomes.

For new mines, companies should establish plans for mine closure in line with industry guidelines such as SER's *International Principles and Standards for the Ecological Restoration and Recovery of Mine Sites*[231] and the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development's (IGF) *Relinquishment of Closed Mine Sites: Policy steps for governments*.[232] They should also provide auditable financial assurance based on realistic and publicly available estimates to cover all closure works in the event that the mine operator fails to fulfil its closure obligations because of sudden or temporary closure.[233]

For existing or inactive mines, companies should implement progressive rehabilitation and restoration throughout the mine lifetime as well as upon closure, as extraction in specific areas within the site is completed, and regularly update and reassess closure plans, especially when mining operations are significantly modified or expanded and as planned closure approaches.[234] This includes adapting plans to reflect changes in the state of nature, such as the movement of species or habitats. Companies can also innovate to develop new approaches to address rehabilitation challenges or improve efficacy. For example, Rio Tinto has piloted methods to rehabilitate without topsoil using a mix of organic matter, hydro-mulch and fertilizers to address a lack of topsoil to cap and rehabilitate tailings at remote mines.[235]

Companies should also monitor and evaluate any closed tailings dams to assess risks to the environment, communities and workers, and take adjusted mitigation measures.[236]

For all rehabilitation and restoration efforts, companies should partner with Indigenous Peoples and other local communities to promote their self-determination, identify end-uses for the land, make decisions about rehabilitation, embed Indigenous and traditional knowledge and ensure equitable benefit sharing.[237] For example, Freeport-McMoRan exceeded regulatory requirements at a former mill site in Arizona and co-designed the 87-acre "Man in the Maze Trails" park with the town of Sahuarita and the local tribe, focused on conservation and STEM education. This four-year project included implementing formal reclamation, establishing nearly 2 miles of trails, sowing 8 acres of pollinator habitat, transplanting plants considered culturally significant by the Tohono O'odham Nation, constructing traditional Wa:tos (shade structures), and more. By increasing the overall project budget by 2.5% and deeding the park over to the town, it was possible to achieve greater community and conservation benefits and facilitate use by schools and the public.[238]

Compensate for unavoidable residual impacts

When companies have taken steps to rigorously apply the mitigation hierarchy, they should compensate for unavoidable residual impacts as a last resort after all other attempts at preventing or reducing impacts have been considered.[239,240] Efforts should be aligned with an NNL or BNG goal for each project.[241] It is important to note that there are certain cases where compensation is not appropriate and should not be used. Compensation efforts should follow specific principles, such as those outlined by The Nature Conservancy,[242] UN Environmental Programme (UNEP), [243] IUCN,[244] and the Business and Biodiversity Offsets Programme (BBOP),[245] including additionality, equivalency, location and temporal considerations.

In many regions, compensation is supported by government policies, where the number of countries with biodiversity offset policies doubled from 60 to 115 from 2001 to 2017. Currently, 43 countries make offsets a regulatory requirement for mining developments in at least some scenarios, while 63 countries enable and facilitate voluntary offsetting, and 26 countries are undertaking initial research, discussions or exploration of policy options. Analysis by the Global Inventory on Biodiversity Offset Policy indicates that most countries that are both biodiversity-rich and highly mining-dependent tend to have advanced offset policies, such as Peru and Colombia. However, there are still regions where more regulatory development is needed or where compliance is weak, and companies can work with governments to strengthen policies, policy compliance and implementation.[246]

Priority action 2

3.2 Improve water stewardship

Avoid, then reduce, water abstraction in mining operations and improve water stewardship across landscapes.

Alongside addressing the other nature impacts of mining operations, companies need to improve water stewardship across landscapes, reducing the sector's impact on water availability and quality, as well as its dependency on water.

To address local shared water challenges, companies should conduct site-level water audits and risk assessments with a catchment-based approach and establish strategies to sustainably and responsibly manage water supplies, prioritizing basins facing water stress. Company strategies should be supported by robust enterprise-level water targets, including minimum ecological thresholds for water use.

For example, Rio Tinto publicly discloses site-by-site surface water allocation, annual water use and associated average catchment rainfall runoff for their operations.[247] BHP have set asset-level context-based water targets for many of their operated assets. These are informed by BHP's view of catchment-level water-related risks and the shared water challenges identified through the *Water Resource Situational Analysis*.[248]

Several resources and tools are available to support company risk assessment and target-setting, including:

- World Wide Fund for Nature's (WWF) Water Risk Filter[249]
- SBTN's Freshwater Technical Guidance[250]
- WRI's Toolbox for Setting Enterprise Water Targets[251]
- ICMM's *Water Stewardship: Position Statement*[252] and *Water Stewardship Maturity Framework*[253]
- MAC's *Towards Sustainable Mining: Water Stewardship Protocol*[254]

In order to avoid and reduce water abstraction, use and pollution, and work towards achieving water-neutral operations, businesses can use a number of existing practices and technologies alongside harnessing innovation opportunities:

- **Adopt less water-intensive processes**, including new methods for extraction (e.g. switching from lithium evaporation to direct lithium extraction to remove the need for evaporation ponds) and dust suppression (e.g. Bind-X uses a powder containing biological and nutrient components for dust control instead of water).[255]
- **Upgrade manufacturing operations to reduce reliance on water**, such as switching from water-cooled to air-cooled processes.
- **Innovate to develop minimal water or dry mining and processing techniques**. For example, Metso has developed an elliptical motion screen that reduces water use by increasing throughput and efficiency in dry screening applications.[256] FLSmidth is currently co-developing a dry stack tailings system that can be applied to larger tonnage mines.[257]
- **Promote water circularity** by establishing integrated water systems and closed-loop recycling systems at production sites.
- **Switch to alternative water sources**, including harvesting rainwater, treating wastewater or replacing freshwater with non-freshwater sources (e.g. through reverse osmosis or desalinating seawater). For example, Antofagasta Minerals has converted to 100% seawater use at the Minera Centinela mine in Los Pelambres, Chile, by acquiring and operating a 144 km water pipeline. They have also recently signed a consortium contract with Almar Water Solutions and Transelec, representing a $1.5 billion investment to double the current water supply.[258] When switching water sources, companies should conduct a risk assessment of other potential environmental impacts, such as the impact of seawater abstraction on marine life or of discharged processed water on groundwater salinity.
- **Sustainably manage natural water flow regimes** by avoiding abstraction in periods when the water supply is low and developing solutions to store water in periods of surplus.
- **Deploy effective wastewater treatment** by investing in new microbial technologies to remove toxins from wastewater,[259] for example, creating artificial wetlands or recycling treated wastewater into mining operations.

"To avoid and reduce water abstraction, use and pollution, and work towards achieving water neutral operations, businesses can use a number of existing practices and technologies.

> Companies should also partner with environmental NGOs, local governments, Indigenous Peoples and communities to improve water stewardship and strive for water replenishment across landscapes.

Companies should also partner with environmental non-governmental organizations (NGOs), local governments, Indigenous Peoples and communities to improve water stewardship and strive for water replenishment[260] across landscapes. For example, they could collaboratively monitor water quality across water basins, establish systems to treat local wastewater and actively improve and secure access to water for people and livelihoods.

Several companies have already implemented initiatives in support of these objectives, such as:[261]

- Barrick Gold entered into a partnership model with the Community Development Committee local to their Kibali gold mine in the Democratic Republic of the Congo to invest in a water distribution project to pump and purify water to a network of 40 water fountains in the local city of Durba.
- Anglo American has partnered with Peruvian communities near its Quellaveco mine for over a decade to improve the quality and availability of water for more than 6,000 local farmers.
- BHP partnered with over 20 organizations in the Fitzroy Basin in Australia as part of a participatory approach to comprehensively assess river health in the region.

Priority action 3

3.3 Expand circularity and source responsibly

Expand circularity across the value chain, embrace standards and transparency, engage with suppliers and source responsibly, and collaborate with customers.

Expand circularity across the value chain

Companies can minimize the nature-related impacts of metals by investing in circularity and adopting new business models to reduce demand for newly mined raw materials. This includes investing in providing re-use, remanufacturing and recycling services at scale and collaborating across the value chain:

- Invest in new technologies for reuse and remanufacturing, automated processes, and large-scale facilities to increase cost-competitiveness, including enhanced scrap treatment facilities to better manage the increased volume and diversity of scrap.
- Develop improved waste collection and sorting systems in factories for process scrap and end-of-life (EOL) materials to increase process efficiency and enable higher-value recovery.
- Collaborate with customers to co-design low-impact, longer-life, recyclable metals and define requirements for EOL material processing to reduce downcycling.
- Establish alliances to ensure quality scrap and EOL materials, such as battery metals, are tracked and returned without contamination and available for reuse.

For example, Teck Resources is reusing rubber from old haul truck tyres, adding it into asphalt while paving to improve performance wear and prevent cracking.[262]

> To de-risk nature commitments and support nature-related investments, companies can form strategic partnerships with downstream customers.

Embrace standards and transparency

To improve traceability and transparency, companies should identify, assess and disclose their nature-related impacts, dependencies, risks and opportunities across the supply chain (see Table 1), incorporating environmental data from suppliers where possible. Where sourcing location data is available, companies can also use other available resources to screen supply chain risks, such as the Integrated Biodiversity Assessment Tool (IBAT),[263] WWF's Biodiversity Risk Filter[264] and Global Forest Watch.[265]

Companies should work to improve access to and quality of data and enable data sharing across the value chain by engaging and collaborating with others, such as upstream and downstream companies, traders and distributors, financial institutions, industry associations and NGOs:

- **Engage with suppliers on environmental data requirements and develop common data requests**, supporting capacity-building and using collective buying power to drive transparency.
- **Establish data needs of downstream customers** and collectively develop solutions to address these needs.
- **Develop environmental data management and sharing technologies**. For example, several mining companies are piloting blockchain technologies to improve traceability through the value chain, such as Teck Resources's digital product passport pilot with germanium,[266] Rio Tinto's START sustainability label for aluminium,[267] and De Beers Group's Tracr diamond blockchain solution.[268]

To improve the credibility of transparency efforts and provide a guarantee of the implementation of responsible mining and production standards, companies can engage in robust third-party auditing of sustainability efforts, including engagement with relevant external stakeholders and rightsholders. This includes using assurance frameworks such as IRMA,[269] The Copper Mark[270] and the Aluminium Stewardship Initiative,[271] and aligning practices for priority assets that have material impacts and dependencies on nature.

Engage with suppliers and source responsibly

In addition to improving access to and quality of data from suppliers, companies can:

- **Strategically engage with vendors to drive nature action** by joining forces with other purchasers to call on suppliers to set carbon reduction targets.
- **Incorporate nature-related performance criteria into the supplier due diligence and management processes** by establishing restrictions such as deforestation-free,[272] setting clear environmental controls on materials sourced from ASM and eliminating sourcing from illegal miners.

Efforts to source responsibly should be taken within the context of avoiding and preventing leakage of impacts. Companies should prioritize collaborating with existing vendors to reduce their nature impacts, given that switching to alternative suppliers in the same region or sourcing from different countries altogether can lead to re-routing of original impacts through less discriminating purchasers.[273]

Collaborate with and support customers

To de-risk nature commitments and support nature-related investments, companies can form strategic partnerships with downstream customers to reduce the environmental impacts of products, starting with a flagship initiative and drawing learnings from climate collaboration. For example:

- Hydro has established three environmental partner package models for customers[274] and launched a strategic partnership with Volvo Group to enable the global transport manufacturer to reach its 2040 climate target of delivering net-zero vehicles as part of the Forum's First Movers Coalition (FMC).[275]
- Anglo American Platinum has signed a collaboration agreement with BMW and Sasol to bring hydrogen fuel cell vehicles (FCEVs) to South Africa, providing the platinum group metals required for FCEVs.[276]
- Rio Tinto and Alcoa have launched a joint venture, Elysis, to scale up and commercialize the world's first carbon-free aluminium smelting process;[277] investments from Apple have also supported the technology's development.[278]

Beyond enabling existing operations, companies can also collaborate with downstream customers to transition their product portfolio in alignment with the nature-positive transition. This includes investing in the scale-up of critical minerals supply to support the clean energy transition and scaling down supply of products that are incompatible with a nature-positive future, such as coal for power generation.

BOX 7 | **Applying natural capital accounting in the mining sector**

To better understand and manage the value of nature to their businesses and to the communities where they operate, BHP is one of the first companies to trial natural capital accounting within the mining industry.[279]

After developing an initial natural capital accounting case study at the Beenup site in Western Australia in 2023, piloting has been extended to the Olympic Dam operation in South Australia as part of a broader collaboration with the Cooperative Research Centre for Transformations in Mining Economies, Commonwealth Scientific and Industrial Research Organisation (CSIRO), the University of South Australia and the Australian Government Department of Climate Change, Energy, the Environment and Water.

Following these two pilots, the organization has developed a preliminary natural capital metrics framework. The framework considers the ecological status and socioeconomic value of the natural capital assets that BHP impacts and depends on. It was applied in FY2024 (financial year 2024) to establish the initial metrics that are intended to measure the impact of BHP's nature-positive management practices.

Priority action 4

3.4 Restore and regenerate landscapes

Support nature conservation and restoration with local communities, both across and beyond own value chains, and invest in innovative nature financing mechanisms.

Support nature conservation and restoration

In pursuing conservation and restoration efforts, companies should first start by following the mitigation hierarchy at the site level and addressing the impacts of their own activities, including compensating for unavoidable residual impacts to meet NNL or BNG goals.

However, **companies are also encouraged to contribute to systems-wide conservation and restoration within and beyond their own value chains**,[280] and target investments towards contributing to government targets under their National Biodiversity Strategies and Action Plans (NBSAPs). Companies should adopt holistic, ecosystem-wide approaches, incorporating Indigenous ecological knowledge that promotes balance and sustainability. This includes investing in credible and effective nature-based solutions (through place-based conservation and restoration or landscape and jurisdictional approaches), and partnering with environmental NGOs, local governments, Indigenous Peoples and other local communities, such as through the World Economic Forum's 1t.org initiative. As supporting guidance, companies can refer to the *Global Standard for Nature-based Solutions* published by IUCN, which proposes eight criteria and 28 indicators to deliver results that are "environmentally sound, socially just and economically feasible".

Companies in the sector are already investing in and supporting conservation and restoration initiatives. For example, Vale, in collaboration with Itaú Unibanco, Marfrig, Santander, Suzano and Rabobank, formed a new company, Biomas, to restore and protect 4 million hectares of native forests in biomes such as the Amazon, Atlantic Forest and Cerrado over 20 years.[281] In addition, BHP Foundation, in collaboration with Nature United (an affiliate of The Nature Conservancy), is working with First Nations to create a new model for shared resource management on a 9 million-hectare commercial forest tenure in the Canadian Boreal, implementing conservation in support of economic and community well-being.[282]

Invest in innovative biodiversity financing mechanisms

A 2020 report estimated there is an average global biodiversity financing gap of $711 billion per year required for the protection, restoration and enhancement of nature,[283] where the private sector has a key role to play in helping bridge this gap by investing in a nature-positive transition.

Target 19 of the Global Biodiversity Framework proposes several innovative ways to mobilize public- and private-sector resources. For example, companies could consider investing in payment for ecosystem services, green or blue bonds, nature restoration funds and voluntary biodiversity certificates or credit markets. Through careful assessment of the advantages and disadvantages of available products, companies can contribute to meaningful long-term biodiversity conservation that is aligned with both their internal values and targets as well as national objectives. The Forum has published a *Private Sector Roadmap to Finance and Act on Nature*.

Priority action 5

3.5 Transform policy systems and collaborate across sectors

Advocate for policy systems that protect nature and catalyse cross-sector and cross-industry collaboration.

Call on governments to strengthen nature-related policy

Mining and metals companies have a role to play in collectively calling for more progressive policies and regulations that set the minimum standards for the sector. Indeed, companies can advocate for governments to:[284]

- **Implement a resource governance framework**, such as UNEP's Sustainable Development Licence to Operate,[285] which promotes sustainable development and supports equitable benefit sharing for all stakeholders.
- **Develop and implement ambitious national biodiversity strategy and action plans (NBSAPs)**, including a national mining sector transition pathway.[286]
- **Support operationalization of nature-related targets** (including site-level NNL and BNG targets) **and adherence to the mitigation hierarchy** – for example, governments can provide guidelines on metrics (e.g. habitat classification for equivalency) and build supporting infrastructure for companies (e.g. regulated biodiversity offset markets).
- **Develop comprehensive landscape-level management plans that clearly delineate no-go areas** (that strictly ban any commercial and/or industrial land use conversion or resource extraction) **from mining areas** in collaboration with mining companies. These plans should include a strong bias towards banning exploration or mining in IUCN categories I-IV Protected Areas[287] or equivalent and ensuring exploration and mining in KBAs[288] and other areas of high ecological, cultural or community significance are avoided wherever possible (e.g. including areas where Indigenous Peoples live in voluntary isolation and initial contact[289]). In addition, avoid downgrading, downsizing or degazetting Protected Areas. Where mining is permitted in such areas, establish safeguards to minimize negative nature impacts, such as robust permitting and licensing systems.

- **Require that mining companies comply with FPIC** of Indigenous, tribal and traditional communities with collective land and resource rights, throughout all stages of exploration and extraction.
- **Require that mining companies identify potential and actual risks and impacts to biodiversity before, during and after mining** as part of the environmental and social impact assessment (ESIA) process and permit conditions; integrate biodiversity into environmental and social management plans (ESMPs).
- **Require that mining companies submit performance assessments to governments** and publish regular public reports, disclosing environmental and social impacts and actions.
- **Strengthen pollution policy to promote innovation**, for example, in line with the EU's "best available techniques" regulation.[290]
- **Set stronger requirements for restoration and relinquishment in closure planning**,[291] including limiting large-scale developments following a mining action and requiring robust stakeholder engagement processes to determine post-mining land uses.
- **Tackle the legacy of abandoned mines** in collaboration with mining companies, including assigning responsibility and rehabilitation requirements.
- **Establish mechanisms, platforms and requirements for information sharing and reporting** in collaboration with companies across the value chain and civil society.
- **Support the scale-up of circular materials production and development of advanced recycling and sorting technologies** to reduce demand for primary materials, e.g. electric vehicle battery metals.[292]
- **Improve governance to support artisanal and small-scale mining and tackle illegal mining** (see Box 8).

As well as supporting the development of more progressive policies to reduce nature impacts, companies should embed nature in all advocacy efforts and avoid advocating for policies that negatively impact nature.

BOX 8 **Policy asks to support increased capabilities of artisanal and small-scale miners**

Artisanal and small-scale mining is a complex and diversified sector, and companies can collaboratively call on governments to strengthen policies in order to reduce this sub-sector's impacts on nature and enhance the quality of life of workers.[293] This includes:

- **Integrating ASM into the formal economy and legal system**, for example, by developing specific legal frameworks to manage operations, supporting operators to meet regulatory requirements, and establishing robust mechanisms for monitoring and enforcement of sanctions when practices are unacceptable.
- **Integrating ASM into the economic system**, for example, by providing technical training, facilitating access to the financial system and improving finance literacy, and supporting the development of associations and responsible supply-chain initiatives.
- **Developing environmental and social protections in ASM,** for example, by establishing and enforcing regulations to safeguard water sources, minimize habitat loss, manage tailings and rehabilitate sites; taking steps to reduce and, where possible, eliminate the use of mercury and other toxic substances; and strengthening the capacity of women working in ASM.

Support cross-sector and cross-industry collaboration

Mining and metals companies can collaborate within the sector and beyond to encourage sustainability, innovation and responsibility across the industry. For example, businesses can:

- **Support knowledge sharing**, including disclosure requirements, between junior and major companies or leading and lagging regions.
- **Engage with legitimate ASM producers**, alongside national and local governments and environmental NGOs, in the spirit of progressive improvement, providing technical and financial support to help ASM actors implement correction action plans.[294]
- **Collaborate across industrial sectors to harness process efficiencies**, for example, by developing industrial hubs, clusters or parks to share infrastructure and services and trial innovative new technologies (e.g. sharing waste management facilities, CCUS facilities or transport and trialling hydrogen technologies).[295]

4 Get started

The imperatives to tackle carbon emissions and nature loss are interdependent. Companies should integrate their nature-positive and net-zero strategies.

Making transformative changes to business models by 2030 demands significant time and resource investments from companies.

While many companies in the mining and metals sector have already embarked on their nature journey and embraced the five priority actions, making transformative changes to business models by 2030 demands significant time and resource investments from companies.

Delivering net-zero emissions and tackling nature loss are highly interdependent goals. Climate change is a main driver of biodiversity loss, and efforts to tackle climate change cannot succeed without safeguarding nature. Therzefore, the nature-positive transition aligns closely with companies' net-zero commitments and should be integrated into their climate transition plans. Likewise, companies should ensure that social objectives are integrated for a just and equitable nature-positive transition.

Guidance is emerging on how to develop nature transition plans or adapt net-zero transition plans to include nature and biodiversity commitments and objectives supported by several institutions. For example:

- **It's Now for Nature's** *Nature Strategy Handbook* is a practical guide to support businesses across sectors in developing a nature strategy.
- **TNFD** will publish new guidance in 2025 on recommendations for nature transition plans for real-economy companies and financial institutions. This document was launched for public consultation in October 2024.
- **CDP and WWF** are developing transition planning recommendations, including practical guidance on tools and methodology.
- **Glasgow Financial Alliance for Net Zero (GFANZ)** has published a framework for net-zero transition planning for financial institutions and will release guidance on integrating nature into these plans in early 2025.[296] This document was launched for public consultation in October 2024.

4.1 Align strategy with organizational maturity

Assessing organizational readiness and maturity can help a company understand its performance on the nature-positive journey and identify the most suitable guidance and tools to drive action. Table 5 details recommended actions to deliver a nature-positive strategy mapped to an organization's level of readiness and maturity.

TABLE 5 **Mapping the components of a nature-positive strategy against organizational maturity**

Components of a nature-positive strategy	Organizational maturity	
	Starting and developing	Advanced and leading
Summary	– Identify nature-related issues. – Set a high-level ambition and/or targets for nature. – Present stand-alone actions on nature.	– Integrate nature into strategy and governance. – Assess impacts and dependencies for all potentially relevant realms. – Set measurable and science-based targets for nature. – Implement strategic action, redefine industry business models and mobilize the whole value chain.
Foundations	– Employ sectoral averages for high-level screening to discern priority effects on nature. – Use secondary data for materiality assessments to gauge priority impacts and nature dependencies, considering factors like environmental pollution. – Use tools and guidance such as ENCORE,[297] SBTN's guidance for businesses, Aqueduct from WRI,[298] TNFD's upcoming transition planning guidance, WWF's biodiversity risk filter and water risk filter,[299] UN Environmental Programme Finance Initiative (UNEP-FI)'s report on high-risk sectors[300] and the Integrated Biodiversity Assessment Tool (IBAT).[301]	– Refine materiality assessment by measuring impacts and dependencies on nature using primary operations data and environmental indicators, and undertake an in-depth analysis of significant risks and opportunities, understanding their influence on financial statements. – Maintain a comprehensive grasp of organizational resilience with an actionable plan for managing nature risks and opportunities. – Perform thorough valuations of all priority areas, considering trade-offs, using value chain data and recognizing the mutual benefits for business and society. – Use tools and guidance such as ENCORE, SBTN's step 1 – assess, step 2 – prioritize and TNFD's LEAP approach, Aqueduct from WRI, WWF's biodiversity risk filter and water risk filter, UNEP-FI's report on high-risk sectors and the IBAT.

TABLE 5 **Mapping the components of a nature-positive strategy against organizational maturity** (continued)

Components of a nature-positive strategy	Organizational maturity	
	Starting and developing	Advanced and leading
Implementation strategy and engagement strategy	– Develop sustainable procurement policies with suppliers that have nature-focused elements. – Prioritize actions to avoid and reduce negative impacts in the company's direct operations and upstream supply chain. – Implement initial traceability for primary suppliers. – Be aware of NBSAPs and recognize the interdependence of nature and climate in advocacy efforts.	– Adopt a circular strategy and embrace regenerative principles by linking capital to nature-positive outcomes and by involving all stakeholders, including employees, clients and customers. – Establish advanced traceability for key materials and ensure supplier alignment, expand traceability throughout product life cycle and encourage innovative supplier collaborations. – Engage actively in NBSAPs, champion nature-positive outcomes and advocate for integrated reforms benefiting nature, climate and society.
Metrics and targets	– Set nature-positive goals on a timeline using the SMART (specific, measurable, achievable, relevant and time-bound) approach. – Validate commitments using third-party stakeholders.	– Detail and report on targets for nature-related risks and opportunities based on TNFD's *Recommendations*.[302] – Prepare for science-based targets on land and freshwater by using SBTN's step 3 – set targets.
Governance	– Assign a management member for nature-based risks, ideally overseeing both climate and nature. – Incorporate nature into environmental risk management, especially within enterprise risk management (ERM), environmental, social and governance (ESG) and sustainability teams. – Train governance roles on the connection between nature and wider ESG risks.	– Ensure board or senior management ownership of nature actions. – Tie performance on nature and climate to leadership incentives. – Set up governance structures for managing, reporting and overseeing nature-based risks and actions on nature across the organization, including informing relevant board-level committees.

4.2 A deeper look at metrics to support decision-making

Companies need to track and publicly report on their actions against relevant metrics to strengthen their credibility and ensure they deliver an effective transition.

TNFD's LEAP approach

TNFD offers sector-specific and sector-agnostic guidance on metrics, which should be the first port of call. A good place to start within TNFD's resources is the *Guidance for corporates on science-based targets for nature,* published jointly by TNFD and SBTN.[303] TNFD differentiates between assessment metrics and disclosure metrics along the four phases of the LEAP approach[304] (see Figure 9):

- **L**ocate interface with nature
- **E**valuate dependencies and impacts
- **A**ssess material risks and opportunities
- **P**repare to respond and report

FIGURE 9 **Types of metrics in TNFD's LEAP approach**

Types of metrics	Assessment metrics				Disclosure metrics
	Location prioritization metrics – Ecosystem integrity – Biodiversity importance – Physical water risks – Other corporate data	**Impact and dependency metrics** – Impact drivers – State of nature – Ecosystem services/ dependencies	**Risk and opportunity metrics** – Physical risks – Transition risks – Systemic risks – Nature-related opportunities	**Response metrics** – Governance – Strategy – Management actions	**Disclosure metrics** – Core global metrics – Core sector metrics – Additional metrics
LEAP approach	**Locate** interface with nature	**Evaluate** dependencies and impacts on nature	**Assess** material risks and opportunities	**Prepare** to respond and report	

Source: Adapted from Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Recommendations*.

Guidance on nature measurability is fast developing:

- The Capital Coalition's Align Project has issued a suite of publications on measuring and valuing biodiversity.[305]
- CSRD, Global Reporting Initiative (GRI) and TNFD's disclosures are organized around a series of metrics that can be used to anchor company assessments and support disclosure. These should be complemented with what the TNFD LEAP approach calls "response metrics" – the internal reporting on an organization's actions, policies, commitments, plans and targets to manage its nature strategy.
- CDP's corporate questionnaire also enables companies to disclose on climate change, deforestation, water security, plastics and biodiversity. CDP is partially aligned with the TNFD disclosure recommendations and is working towards full alignment.
- WBCSD has developed sector-specific metrics to measure the state of nature, and pressures and responses of the forestry, agri-food, built environment and energy sectors. In 2025, it plans to develop additional metrics for the pharma and chemicals sectors.
- The Nature Positive Initiative is developing indicators and metrics to define the state of nature and contributions to "nature-positive" outcomes. It will be launched in January 2025.

Differentiating between input and output indicators

There are a number of dimensions to indicators and metrics. They should be both qualitative and quantitative. They should also measure inputs and processes and – importantly – outputs and outcomes (see Table 6).

Companies should define a set of indicators and metrics according to the mitigation hierarchy (avoid, reduce, restore, compensate) to assess their activities and the impacts achieved.[306] For the mining and metals sector, TNFD's metals and mining sector guidance[307] can help business leaders identify indicators and metrics as they start to develop their approaches for monitoring and measuring priority actions.

TABLE 6 **Input and output indicators and examples**

Indicator type	Example
Input and process indicators	Resources and activities that are deployed by a business in service of a certain priority action, for example: – Investment in water management systems – Number of knowledge products/research projects conducted by a company
Output and outcome indicators	Tangible results stemming from undertaking a priority action, for example: – Commitment to no conversion of natural ecosystems – Percentage of reusable, recyclable or compostable plastic packaging – Percentage of raw material certified by commodity-specific certifications in the supply chain (that are identified as critical suppliers based on materiality assessment and volume)

4.3 Map the transition on to business functions

Mapping the nature-positive transition on to distinct company functions requires a holistic approach to ensure that every division synchronizes its strategies with nature-positive aspirations.

TABLE 7 **Mapping strategies and actions by business function**

Business function	Potential strategies and actions required for a nature-positive transition
Sustainability	Develop the nature-positive transition plan for the business (together with the strategy function). Obtain a holistic understanding of impacts and dependencies of the firm's operations and products. Collaborate with other functions to drive the wider transition of the business. Drive nature conservation and restoration initiatives (such as wetlands for wastewater purification). Promote collective sector-wide positive action, such as sustainable raw material sourcing or collaboration on bio-based or recyclable material research. Monitor sustainable sourcing practices and raw material certification. Support and enable collaborations with NGOs as well as industry initiatives.
Strategy and corporate development	Develop the nature-positive transition plan for the company (together with the sustainability function). Conduct horizon scanning and comprehensive market research for new opportunities related to the nature-positive transition (e.g. markets, products, processes, technologies). Evaluate the risks and returns associated with more disruptive opportunities (e.g. circularity approaches, new products) and identify business cases in new nature-positive economies. Drive necessary organizational changes to align business operations with the requirements of the new nature-positive economy (e.g. establish cross-functional teams to address both climate and nature challenges internally and across your supply chain).

TABLE 7 | **Mapping strategies and actions by business function** (continued)

Business function	Potential strategies and actions required for a nature-positive transition
Finance and risk management	**Financial management** Revise capital planning assumptions for nature-positive related businesses cases (e.g. pay-off periods for investments may increase versus traditional capital expenditures). Consider impacts of nature-positive transition on balance sheet (e.g. high-polluting assets might have to be written off prematurely or written down on an accelerated timeline). **Investments** Increase capital spending on projects enabling the nature-positive transition of the business (e.g. retrofitting plants, supporting other nature-based solutions). – In particular, allocate funding to improve water stewardship measures, including water audits, wastewater recycling and water basin restoration. Allocate budget for innovation spending, such as for circular innovations and research into bio-based or recycled material for feedstocks. – Plan for the financial implications of incorporating circularity and sustainable product development. Commit to investments in nature conservation, restoration and nature-based solutions in collaboration with NGOs and local communities. **Financing** Consider that the cost of capital for high-polluting operations could increase. Consider that availability of capital may become contingent on credible nature-positive strategies. Use new sources of funding, such as green bonds and sustainability loans, nature-focused impact funds, blended funding and partnership with NGOs. **Risk management and disclosure** Consider that new nature-related risks may emerge that need to be managed (see TNFD framework), for example: – Physical and supply chain risks, such as decreased water availability or quality in the supply chain – Transition risks including demand shifts, regulatory risks and reputational risks Prepare required nature-related disclosures for audited statements for CSRD (and potentially under forthcoming requirements of the ISSB).
Procurement	Ensure procurement decisions are aligned with sustainability imperatives and strategy. Engage closely with upstream suppliers to discuss impacts and dependencies, as well as priority actions, and co-develop implementation strategies. Develop innovative working models or partnerships with suppliers to support the transition (e.g. upfront payments or co-financing).
Research and development (R&D)	Invest in research for new nature-positive products and production techniques. Introduce new metrics to track the effect of R&D spending related to the nature-positive transition of the business, in addition to financial returns from R&D spending.
Operations (own)	Identify relevant indicators and establish applicable metrics as well as define the respective target ambition and baseline for each and subsequently report publicly on progress. Enhance efficiency of production processes (e.g. improved water management, including water recycling systems and close-loop systems in manufacturing; digitalization and automation in manufacturing processes; energy efficiency measures). Track water impacts (including use and recycling). Engage in conservation and restoration initiatives.
Operations (supply chain management)	Identify relevant indicators, establish applicable metrics, define the respective target ambition and baseline for each and subsequently report publicly on progress made. Collaborate with suppliers for sustainable sourcing and improved traceability. Support suppliers (where possible) in taking nature-positive actions for their own operations.

TABLE 7 | **Mapping strategies and actions by business function** (continued)

Business function	Potential strategies and actions required for a nature-positive transition
Human resources	Upskill workforce on nature and biodiversity topics (where relevant). Hire relevant external expertise (e.g. additional human resources might be required to prepare for upcoming nature-related reporting and disclosure requirements).
Sales and marketing	Promote products that have minimal impacts on nature and biodiversity and develop solutions that both reduce nature impact and offer additional utility or benefits to consumers. Provide disclosure on impacts and dependencies of products, especially as customers may expect more information on nature footprint, which requires transparent and traceable supply chains. Develop a holistic understanding of customer segments and willingness to pay for greener products.
Investor relations	Disclose nature-positive initiatives and their impact on company performance (e.g. company commitments to water stewardship, sustainable sourcing and circular economy practices). Highlight contributions to global frameworks like the Kunming-Montreal Global Biodiversity Framework. Manage investor engagement on nature topics to ensure transparency on priorities from both sides.
Public affairs	Advocate nature-positive action in the public space. Collaborate with policy-makers, regulators and other standard-setters to develop effective, progressive policies, regulations and standards supporting the transition of the sector (e.g. the United Nation's global plastics treaty).

Source: Adapted from McKinsey & Company. (2022). *The net-zero transition: What it would cost, what it could bring.*

Conclusion

The mining and metals sector plays a pivotal role in the global economy, supplying materials that are fundamental to almost all other sectors. However, the sector also faces significant environmental and social challenges, where activities can contribute to biodiversity loss and violate the rights of Indigenous Peoples. As demand for critical minerals intensifies, driven by the clean energy transition, it is essential that companies balance this growth with robust sustainability practices.

To mitigate risks and build long-term resilience, businesses in this sector must take decisive actions. This includes prioritizing avoiding and reducing the impacts of mining operations, expanding circularity and sourcing responsibly, and restoring and regenerating landscapes.

Through collaboration with companies across the sector, suppliers and customers, other industries, regulators, civil society, Indigenous Peoples and local communities, the mining and metals industry can champion a transformative shift that aligns with global biodiversity goals, securing a sustainable future for both business and the planet.

Appendix

Impacts and dependencies analysis

The sector-average assessment of the top drivers of nature loss shown in Table 2 is mostly based on ENCORE,[308] and follows a four-step process.

First, the relevant sub-industries were identified at an ISIC class level[309] for each stage of the value chain. After initially shortlisting the ISIC classes for the midstream section of the value chain (direct operations), the ENCORE upstream and downstream "links" were used to map each midstream ISIC class to relevant upstream and downstream ones. A manual review was also conducted to identify any other relevant categories, resulting in a total of 68 ISIC classes mapped to the value chain stages for the mining and metals sector.

Second, the ENCORE "pressures" were mapped to the five IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) drivers of biodiversity and ecosystem change.[310] Note, "Resource exploitation" was mapped solely to "Volume of water use", as the other pressures ("Other biotic resource extraction (e.g. fish, timber)" and "Other abiotic resource extraction") were not material for the mining and metals sector, and "Introduction of invasive species" was similarly excluded given the materiality was mostly low or below for all ISIC classes where a value was assigned. See Table 8 for the complete mapping.

Third, for each stage of the value chain and IPBES driver, an average of the ENCORE "pressure materiality rating" was computed across all the ISIC classes where a materiality value was assigned (i.e. not N/A or ND). This was summarized in Table 2 for those with medium, high or very high materiality.

Finally, this output was tested with business, civil society and academic industry experts via interviews and consultation workshops, and the final ratings were adapted based on the feedback provided. For the mining and metals sector specifically, this involved updating the "midstream, land-use change and ecosystem disturbance" from medium to high materiality, and the "downstream, greenhouse gas emissions" from low to medium materiality.

The impact and dependency descriptions in Chapter 2 also use the ENCORE "pressure materiality ratings", "pressure links", "dependency materiality ratings" and "dependency links" datasets alongside several other sources. These include CDP Water Watch, WWF Water and Biodiversity Risk Filters, academic papers, civil society reviews, company-specific insights and assessments, analysis by the World Economic Forum and industry expert interviews and consultation workshops. The results of this analysis were then used to inform the development of the priority actions.

TABLE 8 **Mapping from ENCORE "pressures" to five IPBES drivers**

IPBES drivers of biodiversity and ecosystem change	Relevant ENCORE "pressures"
Land-use change and ecosystem disturbance	– Area of land use – Area of freshwater use – Area of seabed use
Pollution	– Emissions of toxic soil and water pollutants – Emissions of nutrient soil and water pollutants – Emissions of non-GHG air pollutants – Generation and release of solid waste – Disturbances (e.g. noise, light)
Resource exploitation (water abstraction)	– Volume of water use
GHG emissions	– Emissions of GHGs

Opportunity sizing

The Forum's *Future of Nature and Business* report,[311] published in 2020, identifies about 60 major business opportunities in the nature-positive economy and estimates their respective market sizes (defined as concentrated shifts in profit pools that generate specific opportunities for business). The sizing reflects the annual additional opportunity in 2030 based on estimated savings (e.g. value of land saved through restoration) or revenue upside (e.g. new market potential for new products). For each opportunity, the incremental size of the opportunity in a nature-positive versus a business-as-usual scenario is measured. The opportunities selected are based on existing, commercialized technologies. A detailed overview of this sizing can be found in the methodology note for the *Future of Nature and Business* report.[312]

Identifying the business opportunity potential of the priority actions for the mining and metals sector followed a two-step approach. First, relevant opportunities were selected from the *Future of Nature and Business* report and mapped to the priority actions identified in this report (see Table 3). Second, the market potential for the mining and metals sector was estimated across each selected opportunity, using relevant adjustment factors such as the sector's share of global GDP for sector-agnostic opportunities or the mining and metals revenue share excluding coal for opportunities specifically related to the extractives sector.

This sizing approach may not cover the entire set of business opportunities for the sector. For example, the market potential of new technologies under development was not considered in the original 2020 report and is, therefore, not covered in this report. Similarly, the 2020 report did not aspire to exhaustively cover all present opportunities.

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1. Global Footprint Network. (n.d.). *Home.* https://www.footprintnetwork.org.
2. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (n.d.). *Models of drivers of biodiversity and ecosystem change*. https://www.ipbes.net/models-drivers-biodiversity-ecosystem-change.
3. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2021). *IPBES-IPCC Co-sponsored Workshop: Biodiversity and Climate Change – Scientific outcome*. https://www.ipbes.net/sites/default/files/2021-06/2021_IPCC-IPBES_scientific_outcome_20210612.pdf.
4. London School of Economics and Political Science and Grantham Research Institute on Climate Change and the Environment. (2023). *What is the role of deforestation in climate change and how can 'Reducing Emissions from Deforestation and Degradation' (REDD+) help?.* https://www.lse.ac.uk/granthaminstitute/explainers/whats-redd-and-will-it-help-tackle-climate-change.
5. The Nature Conservancy (TNC). (2017). *Nature's Make or Break Potential for Climate Change*. https://www.nature.org/en-us/what-we-do/our-insights/perspectives/natures-make-or-break-potential-for-climate-change/?src=social.multiple.site_globsol.cam_ncs.link_initative.d_oct2017.info_ncs3.
6. Science Based Targets initiative (SBTi). (n.d.). *Forest, Land and Agriculture (FLAG): Key requirements of the SBTi FLAG Guidance*. https://sciencebasedtargets.org/sectors/forest-land-and-agriculture.
7. Science Based Targets Network (SBTN). (n.d.). *Step 3: Measure, Set & Disclose Freshwater Targets.* https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/freshwater-targets/; Science Based Targets Network (SBTN). (n.d.). *Step 3: Measure, Set & Disclose Land Targets*. https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/land-targets/; Science Based Targets Network (SBTN). (n.d.). *Step 3: Biodiversity within SBTs for Nature*. https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/biodiversity-targets/.
8. Caesar, L. et al. (2024). *Planetary Health Check: A Scientific Assessment of the State of the Planet*. https://www.planetaryhealthcheck.org/storyblok-cdn/f/301438/x/a4efc3f6d5/planetaryhealthcheck2024_report.pdf.
9. World Economic Forum. (2025). *Global Risks Report 2025*. https://www.weforum.org/publications/global-risks-report-2025/.
10. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Recommendations*. https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/.
11. Convention on Biological Diversity. (2022). *Kunming-Montreal Global Biodiversity Framework*. https://www.cbd.int/gbf/.
12. European Financial Reporting Advisory Group (EFRAG). (2022, 23 November). *EFRAG delivers the first set of draft ESRS to the European Commission* [Press release]. https://www.efrag.org/sites/default/files/sites/webpublishing/SiteAssets/EFRAG%20Press%20release%20First%20Set%20of%20draft%20ESRS.pdf.
13. European Commission. (n.d.). *EU taxonomy for sustainable activities*. https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en.
14. Ramos, J. & Sedilekova, Z. (2023). *Biodiversity Risk: Legal Implications for Companies and their Directors, Commonwealth Climate and Law Initiative (CCLI)*. https://commonwealthclimatelaw.org/wp-content/uploads/2022/12/CCLI_Biodiversity_risk_paper_2022.pdf.
15. Linklaters. (2024). *China's stock exchanges release for public consultation mandatory sustainability reporting requirements for listed companies.* https://sustainablefutures.linklaters.com/post/102j12k/chinas-stock-exchanges-release-for-public-consultation-mandatory-sustainability.
16. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Recommendations*. https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/.
17. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Over 500 organisations and $17.7 trillion AUM now committed to TNFD-aligned risk management and corporate reporting*. https://tnfd.global/over-500-organisations-and-17-7-trillion-aum-now-committed-to-tnfd-aligned-risk-management-and-corporate-reporting/.
18. DeNederlandscheBank. (2020). *Indebted to nature: Exploring biodiversity risks for the Dutch financial sector.* https://www.dnb.nl/media/4c3fqawd/indebted-to-nature.pdf.
19. Finance for Biodiversity Foundation. (2022). *Global investors developing new collaborative engagement initiative to drive nature action*. https://www.financeforbiodiversity.org/global-investors-developing-new-collaborative-engagement-initiative-to-drive-nature-action/.
20. United Nations Environment Programme (UNEP). (2023). *State of Finance for Nature 2023*. https://www.unep.org/resources/state-finance-nature-2023.
21. Hughes, M. (2021). *Biodiversity Net Gain – more than just a number.* Government of the UK. https://naturalengland.blog.gov.uk/2021/09/21/biodiversity-net-gain-more-than-just-a-number/.
22. Australian Government Department of Climate Change, Energy, the Environment and Water. (n.d.). *Nature Repair Market*. https://www.dcceew.gov.au/environment/environmental-markets/nature-repair-market.

23. Kucher, S. (2021, 25 October). *Recent study reveals more than a third of global consumers are willing to pay more for sustainability as demand grows for environmentally-friendly alternatives.* https://www.simon-kucher.com/en/who-we-are/newsroom/recent-study-reveals-more-third-global-consumers-are-willing-pay-more.

24. Deloitte. (2022). *The Deloitte Global 2022 Gen Z and Millennial Survey: Striving for balance, advocating for change*. https://www2.deloitte.com/content/dam/Deloitte/at/Documents/human-capital/at-gen-z-millennial-survey-2022.pdf.

25. McKinsey Sustainability. (2024). *Corporate commitments to nature have evolved since 2022*. https://www.mckinsey.com/industries/agriculture/our-insights/corporate-commitments-to-nature-have-evolved-since-2022.

26. World Benchmarking Alliance. (2022). *Nature is a blind spot for major companies despite its importance for their operations and people*. https://www.worldbenchmarkingalliance.org/news/nature-benchmark-press-release-2022/.

27. Nature Positive Initiative. (2023). *The Definition of Nature Positive*. https://www.naturepositive.org/app/uploads/2024/02/The-Definition-of-Nature-Positive.pdf.

28. These actions have been developed in collaboration with leading organizations. They build on existing action frameworks and guidance, including the Natural Capital Protocol, the Science Based Targets Network's Initial Guidance for Business, the World Business Council for Sustainable Development's (WBCSD's) building blocks on what nature-positive means to business, Business for Nature's steps to become nature-positive and the Taskforce on Nature-related Financial Disclosures' (TNFD) framework: Business for Nature. (n.d.). *High-level Business Actions on Nature.* https://www.businessfornature.org/high-level-business-actions-on-nature.

29. Science Based Targets Network (SBTN). (n.d.). *Unlocking insights and changing mindsets: what it is like to pioneer science-based targets for nature.* https://sciencebasedtargetsnetwork.org/case-studies/initial-corporate-insights/.

30. Includes iron, aluminium, copper and other non-ferrous metals, estimated based on the Global Material Flow Database.

31. United Nations Environment Programme (UNEP). (2024). *Global Resources Outlook 2024.* https://www.unep.org/resources/Global-Resource-Outlook-2024.

32. World Economic Forum. (2023, 29 November). *4 breakthrough actions to decarbonize steelmaking.* https://www.weforum.org/agenda/2023/11/4-breakthrough-actions-to-decarbonize-steelmaking/.

33. Concentrated in less developed regions, primarily Africa and Asia. World Resources Institute (WRI) and UK Aid Direct. (2021). *World Resources Report: Seven Transformations for More Equitable and Sustainable Cities.* https://publications.wri.org/transformations-equitable-sustainable-cities/current-urbanization-global-south-realities.

34. United Nations Environment Programme (UNEP). (2024). *Global Resources Outlook 2024.* https://www.unep.org/resources/Global-Resource-Outlook-2024.

35. Ranging from Sustainable Development Scenario to Net-Zero by 2050 Scenario.

36. International Energy Agency (IEA). (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

37. Mining surface area estimate includes open cuts, tailings dams, waste rock dumps, water ponds, processing plants and other ground features related to the mining activities: Maus, V., Giljum, S., da Silva, D.M. *et al*. (2022). An update on global mining land use. *Scientific Data*, vol. 9, no. 433. https://www.nature.com/articles/s41597-022-01547-4; Wikipedia. (n.d.). *Earth*. https://en.wikipedia.org/wiki/Earth.

38. Organisation for Economic Co-operation and Development (OECD). (n.d.). *Compare your country: Trade in Raw Materials – 2022 Edition*. https://www.compareyourcountry.org/trade-in-raw-materials/en/0/ALL/all/default.

39. South African Government. (2022). *Trade, Industry and Competition hosts Platinum Group Metals colloquium, 20 Oct.* https://www.gov.za/news/media-advisories/government-activities/trade-industry-and-competition-hosts-platinum-group.

40. International Energy Agency (IEA). (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

41. International Energy Agency (IEA). (2024). *Share of top three producing countries in mining of selected minerals, 2022.* https://www.iea.org/data-and-statistics/charts/share-of-top-three-producing-countries-in-mining-of-selected-minerals-2022.

42. International Energy Agency (IEA). (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

43. International Energy Agency (IEA). (2024). *Geographical distribution of refined material production for key energy transition minerals in the base case, 2023-2040.* https://www.iea.org/data-and-statistics/charts/geographical-distribution-of-refined-material-production-for-key-energy-transition-minerals-in-the-base-case-2023-2040-2.

44. Luckeneder, S. et al. (2021). Surge in global metal mining threatens vulnerable ecosystems. *Global Environmental Change*, vol. 69. https://www.sciencedirect.com/science/article/pii/S0959378021000820.

45. International Financial Reporting Standard (IFRS) Foundation's International Sustainability Standards Board (ISSB). (n.d.). *SASB Sustainable Industry Classification System (SICS).* https://sasb.org/standards/download/.

46. International Union for Conservation of Nature (IUCN). (2024). *The impact of deep-sea mining on biodiversity, climate and human cultures.* https://www.iucn.nl/en/news/the-impact-of-deep-sea-mining-on-biodiversity-climate-and-human-cultures/#note17574512. World Economic Forum. (2022). *Decision-Making on Deep-Sea Mineral Stewardship: A Supply Chain Perspective.* https://www.weforum.org/publications/decision-making-on-deep-sea-mineral-stewardship-a-supply-chain-perspective/.

47. World Economic Forum. (2023). *Mining and Metals: Trends, Challenges and the Way Forwards*. https://www.weforum.org/publications/mining-and-metals-trends-challenges-and-the-way-forward/.

48. International Energy Agency (IEA). (2022). *Critical Minerals Policy Tracker*. https://www.iea.org/reports/introducing-the-critical-minerals-policy-tracker/key-findings.

49. Natural Resources Canada. (2022, 12 December). *Countries Commit to the Sustainable Development and Sourcing of Critical Minerals.* [Press release]. https://www.canada.ca/en/natural-resources-canada/news/2022/12/countries-commit-to-the-sustainable-development-and-sourcing-of-critical-minerals.html.

50. World Economic Forum. (2024). *Translating Critical Raw Material Trade into Development Benefits*. https://www.weforum.org/publications/translating-critical-raw-material-trade-into-development-benefits/.

51. World Economic Forum. (2023). *Mining and Metals: Trends, Challenges and the Way Forwards*. https://www.weforum.org/publications/mining-and-metals-trends-challenges-and-the-way-forward/.

52. World Economic Forum. (2024). *Translating Critical Raw Material Trade into Development Benefits*. https://www.weforum.org/publications/translating-critical-raw-material-trade-into-development-benefits/.

53. Includes a 10 km buffer around mining projects and Indigenous Peoples' territories to account for errors, then applies 20 km and 100 km buffers to approximate average population densities and focus the analysis on the least populated and industrialised areas. For peasant land, a 20 km buffer was applied: Owen, J. R. *et al.* (2023). Energy transition minerals and their intersection with land-connected peoples. *Nature Sustainability*, vol. 6. https://www.nature.com/articles/s41893-022-00994-6.

54. Government of Canada. (2022). *The Canadian Critical Minerals Strategy*. https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html.

55. International Labour Organization (ILO). (2015). *Mining: a hazardous work.* https://www.ilo.org/resource/mining-hazardous-work.

56. International Energy Agency (IEA). (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

57. World Wide Fund for Nature (WWF). (2023). *Extracted Forests.* https://wwfint.awsassets.panda.org/downloads/wwf_studie_extracted_forests_1_1.pdf.

58. World Bank. (2019). *Forest-Smart Mining: Identifying Good and Bad Practices and Policy Responses for Artisanal & Small-Scale Mining in Forest Landscapes.* https://documents1.worldbank.org/curated/en/620501560322517491/pdf/Forest-Smart-Mining-Identifying-Good-and-Bad-Practices-and-Policy-Responses-for-Artisanal-and-Small-Scale-Mining-in-Forest-Landscapes.pdf.

59. World Bank. (2019). *Forest-Smart Mining: Identifying Factors Associated with the Impacts of Large-Scale Mining in Forest Landscapes.* https://documents1.worldbank.org/curated/fr/104271560321150518/pdf/Forest-Smart-Mining-Identifying-Factors-Associated-with-the-Impacts-of-Large-Scale-Mining-on-Forests.pdf.

60. Laing, T. & Pinto, A. N. (2023). Artisanal and small-scale mining and the low-carbon transition: Challenges and opportunities. *Environmental Science & Policy,* vol. 149, no. 103563. https://doi.org/10.1016/j.envsci.2023.103563.

61. Minerals Council of South Africa. (n.d.). *Illegal Mining*. https://www.mineralscouncil.org.za/work/illegal-mining.

62. ICMM. (2024). *Mining leaders make landmark commitments to support a nature positive future.* https://www.icmm.com/en-gb/news/2024/landmark-commitments-nature-positive.

63. ICMM. (2024). *Nature: Position Statement.* https://nature.icmm.com/position-statement.

64. ICMM. (n.d.). *Climate Change.* https://www.icmm.com/en-gb/our-work/environmental-resilience/climate-change.

65. ICMM. (2017). *Water Stewardship: Position Statement.* https://www.icmm.com/en-gb/our-principles/position-statements/water-stewardship.

66. The Mining Association of Canada (MAC). (n.d.). *Towards Sustainable Mining.* https://mining.ca/towards-sustainable-mining/.

67. Minerals Council of Australia (MCA). (n.d.). *Australia is moving Towards Sustainable Mining.* https://tsmining.com.au/.

68. ICMM. (2023). *Collaboration underway to develop consolidated standard for responsible mining.* https://www.icmm.com/en-gb/news/2023/convergence.

69. Teck Resources. (2021). *Biodiversity and Reclamation*. https://www.teck.com/media/2021-Sustainability-Report-BiodiversityAndReclamation.pdf.

70. Anglo American. (n.d.). *Biodiversity*. https://www.angloamerican.com/sustainable-mining-plan/healthy-environment/biodiversity.

71. ICMM. (2024). *Nature: Position Statement.* https://nature.icmm.com/position-statement.

72. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *TNFD Adopters.* https://tnfd.global/engage/tnfd-adopters-list/.

73. CDP. (2024). *Forest Declaration Assessment Analysis: Mining*. https://www.cdp.net/en/.

74. World Economic Forum. (2023). *UpLink and Prospect Innovation partner to unearth sustainable mining solutions.* https://uplink.weforum.org/uplink/s/news/partnership-in-sustainable-mining.

75. International Resource Panel. (2024). *Intentionally designing sustainable consumption and production policies and practices to reduce inequalities.* https://www.resourcepanel.org/reports/intentionally-designing-SCP.

76. Circle Economy Foundation. (2024). *The Circularity Gap Report 2024*. https://www.circularity-gap.world/2024.

77. International Resource Panel. (2024). *Intentionally designing sustainable consumption and production policies and practices to reduce inequalities.* https://www.resourcepanel.org/reports/intentionally-designing-SCP.

78. United Nations Environment Programme (UNEP). (2024). *Global Resources Outlook 2024.* https://www.unep.org/resources/Global-Resource-Outlook-2024.

79. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Additional sector guidance – Metals and mining.* https://tnfd.global/publication/additional-sector-guidance-metals-and-mining/.

80. Science Based Targets Network (SBTN). (n.d.). *Step 1: Assess*. https://sciencebasedtargetsnetwork.org/companies/take-action/assess/.

81. Science Based Targets Network (SBTN). (n.d.). *Step 2: Prioritize*. https://sciencebasedtargetsnetwork.org/companies/take-action/prioritize/.

82. Organisation for Economic Co-operation and Development (OECD). (2023). *Handbook on Environmental Due Diligence in Mineral Supply Chains.* https://www.oecd-ilibrary.org/finance-and-investment/handbook-on-environmental-due-diligence-in-mineral-supply-chains_cef843bf-en; Organisation for Economic Co-operation and Development (OECD). (2016). *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.* https://www.oecd-ilibrary.org/governance/oecd-due-diligence-guidance-for-responsible-supply-chains-of-minerals-from-conflict-affected-and-high-risk-areas_9789264252479-en.

83. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

84. International Union for Conservation of Nature (IUCN). (2023). *Measuring Nature-Positive: Setting and implementing verified, robust targets for species and ecosystems*. https://iucn.org/sites/default/files/2023-11/iucn-nature-positive-contribution-v1.0.pdf.

85. Science Based Targets Network (SBTN). (n.d.). *Step 3: Measure, Set & Disclose Freshwater Targets.* https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/freshwater-targets/; Science Based Targets Network (SBTN). (n.d.). *Step 3: Measure, Set & Disclose Land Targets*. https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/land-targets/; Science Based Targets Network (SBTN). (n.d.). *Step 3: Biodiversity within SBTs for Nature*. https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/biodiversity-targets/.

86. World Economic Forum. (n.d.). *Sector Transitions to Nature Positive website*. https://initiatives.weforum.org/sector-transitions-to-nature-positive/home.

87. Business for Nature. (n.d.). *Sector Actions Towards a Nature-Positive Future.* https://www.businessfornature.org/sector-actions.

88. Initiative for Responsible Mining Assurance (IRMA). (n.d.). *Resources: Full documentation and guidance*. https://responsiblemining.net/resources/#full-documentation-and-guidance.

89. The Copper Mark. (n.d.). *Core Documents*. https://coppermark.org/standards/core-documents/.

90. Aluminium Stewardship Initiative (ASI). (n.d.). *ASI Performance Standard.* https://aluminium-stewardship.org/asi-standards/performance-standard.

91. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

92. Cross-Sector Biodiversity Initiative (CSBI). (2015). *Cross-sector Guide for Implementing the Mitigation Hierarchy.* http://www.csbi.org.uk/our-work/mitigation-hierarchy-guide/.

93. The Nature Conservancy (TNC). (2015). *Achieving Conservation and Development: 10 Principles for Applying the Mitigation Hierarchy.* https://www.conservationgateway.org/Documents/TNCApplyingTheMitigationHierarchy.pdf.

94. United Nations Environment Programme (UNEP). (2012). *Biodiversity offsets: voluntary and compliance regimes.* https://files.ctctcdn.com/b3b328ed001/7b1aaa64-234c-4918-abb8-27a30c51ac03.pdf.

95. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Recommendations of the Taskforce on Nature-Related Financial Disclosures*. https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/#publication-content.

96. International Sustainability Standards Board (ISSB). (2023). *IFRS S1 and IFRS S2*. https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/.

97. CDP. (n.d.). *Guidance for companies.* https://www.cdp.net/en/guidance/guidance-for-companies.

98. Global Reporting Initiative (GRI). (2024). *Sector Standard for Mining*. https://www.globalreporting.org/standards/standards-development/sector-standard-for-mining/.

99. Includes high and very high materiality dependencies from ENCORE across the value chain – the full methodology for this assessment can be found in the Appendix: United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

100. Includes iron ore mining, precious metals mining, other non-ferrous ore mining and other non-metallic minerals mining: CDP. (2018). *Global Water Report 2018.* https://www.cdp.net/en/research/global-reports/global-water-report-2018#671b3beee69d9180412202b6528ec8f7.

101. Green infrastructure has been defined as "a strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity": European Commission. (n.d.). *Green infrastructure*. https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en.

102. World Economic Forum. (2020). *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*. https://www.weforum.org/reports/nature-risk-rising-why-the-crisis-engulfing-nature-matters-for-business-and-the-economy/.

103. Díaz, S. et al. (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). https://www.ipbes.net/global-assessment.

104. Taskforce on Nature-related Financial Disclosures (TNFD). (2023). *Guidance on the identification and assessment of nature-related issues: the LEAP approach*. https://tnfd.global/publication/additional-guidance-on-assessment-of-nature-related-issues-the-leap-approach/.

105. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Additional sector guidance – Metals and mining.* https://tnfd.global/publication/additional-sector-guidance-metals-and-mining/.

106. Science Based Targets Network (SBTN). (n.d.). *Step 1: Assess*. https://sciencebasedtargetsnetwork.org/companies/take-action/assess/.

107. Science Based Targets Network (SBTN). (n.d.). *Step 2: Prioritize*. https://sciencebasedtargetsnetwork.org/companies/take-action/prioritize/.

108. Includes high and very high materiality dependencies from ENCORE across the value chain – the full methodology for this assessment can be found in the Appendix: United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

109. Coincidence analysis was based on global extent of areas potentially influenced by mining, allocating a 50 km radius around 62,000 mining properties. This includes known mining properties only sourced from S&P Global Market Intelligence: Sonter, L. J. *et al*. (2020). Renewable energy production will exacerbate mining threats to biodiversity. *Nature Communications*, vol.11, no.4174. https://www.nature.com/articles/s41467-020-17928-5.

110. Of disclosed tailings facilities, 9% were within declared protected areas and 20% were within 5 km: The University of Queensland, Australia. (2023, 28 November). *Sensitive ecosystems at risk from mine waste*. https://www.uq.edu.au/news/article/2023/11/sensitive-ecosystems-risk-mine-waste.

111. Hansen, M. C. et al. (2013). High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science*, vol. 342, no.6160. https://www.science.org/doi/10.1126/science.1244693.

112. The approach assumes that deforestation in buffer zones of up to 50 km around mining areas can be partially attributed to mining activities, to reflect light on the indirect impacts of mining. However, indirect influence may vary significantly, influenced by other factors, such as geography, proximity to urban settlements and watershed boundaries. This includes coal: World Wide Fund for Nature (WWF). (2023). *Extracted Forests.* https://wwfint.awsassets.panda.org/downloads/wwf_studie_extracted_forests_1_1.pdf.

113. World Wide Fund for Nature (WWF). (2023). *Extracted Forests.* https://wwfint.awsassets.panda.org/downloads/wwf_studie_extracted_forests_1_1.pdf.

114. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Additional sector guidance – Metals and mining.* https://tnfd.global/publication/additional-sector-guidance-metals-and-mining/.

115. Sonter, L. J. et al. (2018). Mining and biodiversity: key issues and research needs in conservation science. *Proc. R. Soc. B,* vol 286. http://dx.doi.org/10.1098/rspb.2018.1926.

116. Society for Ecological Restoration (SER). (2022). *International Principles and Standards for the Ecological Restoration and Recovery of Mine Sites.* https://www.ser.org/page/mining.

117. European Environment Agency. (2024). *Best available techniques (BAT) to cut the use and impact of hazardous chemicals (Signal).* https://www.eea.europa.eu/en/european-zero-pollution-dashboards/indicators/best-available-techniques-bat-to-cut-the-use-and-impact-of-hazardous-chemicals.

118. World Wide Fund for Nature (WWF). (2023). *Extracted Forests.* https://wwfint.awsassets.panda.org/downloads/wwf_studie_extracted_forests_1_1.pdf.

119. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2017). *Global Trends in Artisanal and Small-Scale Mining (ASM): A Review of Key Numbers and Issues.* https://www.iisd.org/system/files/publications/igf-asm-global-trends.pdf.

120. United Nations Environment Programme (UNEP). (2023). *Ending the toxic trail of small-scale gold mining.* https://www.unep.org/news-and-stories/story/ending-toxic-trail-small-scale-gold-mining.

121. United Nations Environment Programme (UNEP). (2022). *How countries are reducing anthropogenic mercury pollution.* https://www.unep.org/technical-highlight/how-countries-are-reducing-anthropogenic-mercury-pollution.

122. Includes high and very high materiality dependencies from ENCORE across the value chain – the full methodology for this assessment can be found in the Appendix: United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

123. Baeten, J., Langston, N. & Lafreniere, D. (2017). A spatial evaluation of historic iron mining impacts on current impaired waters in Lake Superior's Mesabi Range. *Ambio*, vol. 27, no. 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5794688/.

124. Laker, M. C. (2023). Environmental Impacts of Gold Mining – With Special Reference to South Africa. *Mining 2023*, vol. 3, no. 2. https://doi.org/10.3390/mining3020012.

125. UN Environment Programme (UNEP). (2001). *Abandoned mines: Problems, Issues and Policy Challenges for Decision Makers.* https://www.unep.org/resources/report/abandoned-mines-problems-issues-and-policy-challenges-decision-makers.

126. Farjana, S. H., Huda, N. & Mahmud, M. A. P. (2019). Life cycle assessment of cobalt extraction process. *Journal of Sustainable Mining*, vol. 18, no. 3. https://doi.org/10.1016/j.jsm.2019.03.002.

127. Gbedzi, D. D. et al. (2022). Impact of mining on land use land cover change and water quality in the Asutifi North District of Ghana, West Africa. *Environmental Challenges*, vol. 5. https://doi.org/10.1016/j.envc.2022.100441.

128. Abdullah, N. H. et al. (2016). Potential Health Impacts of Bauxite Mining in Kuantan. *The Malaysian Journal of Medical Sciences*, vol. 23, no. 3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934713/.

129. BBC. (2023, 22 September). *Metal-mining pollution impacts 23 million people worldwide.* https://www.bbc.com/news/science-environment-66880697.

130. Tayebi-Khorami, M., Edraki, M., Corder, G. & Golev, A. (2019). Re-Thinking Mining Waste through an Integrative Approach Led by Circular Economy Aspirations. *Minerals*, vol. 9, no. 5. https://doi.org/10.3390/min9050286.

131. Mining Watch, Canada. (2024). *A decade after disastrous breach, Mount Polley mine tailings dam could get even bigger.* https://www.miningwatch.ca/news/2024/7/31/decade-after-disastrous-breach-mount-polley-mine-tailings-dam-could-get-even-bigger.

132. United Nations Environment Programme (UNEP). (2020). *Global Industry Standard on Tailings Management.* https://www.unep.org/resources/report/global-industry-standard-tailings-management.

133. The Church of England. (n.d.). *The Investor Mining and Tailings Safety Initiative.* https://www.churchofengland.org/about/leadership-and-governance/national-church-institutions/church-england-pensions-board/pensions.

134. United Nations Environment Programme (UNEP). (24 January 2023). *New Independent Global Tailings Management Institute announced to drive mining industry safety standard.* [Press release]. https://www.unep.org/news-and-stories/press-release/new-independent-global-tailings-management-institute-announced-drive.

135. Earthworks, MiningWatch Canada and London Mining Network. (2022). *Safety First: Guidelines for Responsible Mine Tailings Management*. https://earthworks.org/resources/safety-first.

136. CDP. (2023). *Water Watch: Water Impact Index.* https://www.cdp.net/en/investor/water-watch-cdp-water-impact-index/water-watch-download.

137. International Energy Agency (IEA). (2021). *The Role of Critical Minerals in Clean Energy Transitions*. https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

138. Where the "volume of water use" or "area of freshwater use" has a medium to high materiality: UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

139. Equivalent to 10-25% of global industry freshwater withdrawals, with agriculture accounting for roughly 70% of water freshwater withdrawals, industry accounting for just under 20% and domestic accounts for about 12%: United Nations Educational, Scientific and Cultural Organization (UNESCO). (2024). *UN World Water Development Report. Water for Prosperity and Peace: Statistics.* https://www.unesco.org/reports/wwdr/en/2024/s.

140. Meißner, S. (2021). The Impact of Metal Mining on Global Water Stress and Regional Carrying Capacities – A GIS-Based Water Impact Assessment. *Resources 2021*, vol.10, no.12. https://www.mdpi.com/2079-9276/10/12/120.

141. World Economic Forum. (2023). *Lithium: Here's why Latin America is key to the global energy transition.* https://www.weforum.org/agenda/2023/01/lithium-latin-america-energy-transition/.

142. World Resources Institute (WRI). (2024). *More Critical Minerals Mining Could Strain Water Supplies in Stressed Regions.* https://www.wri.org/insights/critical-minerals-mining-water-impacts.

143. Liu, W., Agusdinata, D. B. & Myint, S. W. (2019). Spatiotemporal patterns of lithium mining and environmental degradation in the Atacama Salt Flat, Chile*. International Journal of Applied Earth Observation and Geoinformation,* vol. 80. https://www.sciencedirect.com/science/article/abs/pii/S0303243419300996.

144. CDP. (2018). *Global Water Report 2018.* https://www.cdp.net/en/research/global-reports/global-water-report-2018#671b3beee69d9180412202b6528ec8f7.

145. Anglo American. (n.d.). *Water*. https://www.angloamerican.com/sustainable-mining-plan/healthy-environment/water.

146. Teck Resources. (n.d.). *Water*. https://www.teck.com/sustainability/sustainability-topics/water/.

147. SKARN Associates. (2023). *Water Focus in Mexico's Mining Law.* https://www.skarnassociates.com/insights/water-focus-mexico-mining.

148. McKinsey & Company. (2021). *Creating the zero-carbon mine.* https://www.mckinsey.com/industries/metals-and-mining/our-insights/creating-the-zero-carbon-mine.

149. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *The impacts of climate change on the mining sector*. https://www.iisd.org/system/files/2023-09/impacts-climate-change-mining-sector.pdf.

150. International Energy Agency (IEA). (2021). *Average GHG emissions intensity for production of selected commodities.* https://www.iea.org/data-and-statistics/charts/average-ghg-emissions-intensity-for-production-of-selected-commodities.

151. McKinsey & Company. (2021). *Creating the zero-carbon mine.* https://www.mckinsey.com/industries/metals-and-mining/our-insights/creating-the-zero-carbon-mine.

152. Ibid.

153. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *The impacts of climate change on the mining sector*. https://www.iisd.org/system/files/2023-09/impacts-climate-change-mining-sector.pdf.

154. International Energy Agency (IEA). (n.d.). *Iron and Steel Technology Roadmap*. https://www.iea.org/reports/iron-and-steel-technology-roadmap.

155. BHP. (2019). *Metallurgical coal: Properties, facts, uses and production.* https://www.bhp.com/-/media/documents/business/2019/191119_whatismetcoal.pdf.

156. International Energy Agency (IEA). (n.d.). *International Shipping*. https://www.iea.org/energy-system/transport/international-shipping.

157. Calculation based on 2021 data, taking total metals and minerals loaded in international maritime trade (iron ore = 1,517 million tons loaded, metals and minerals = 984 million tons loaded) as a share of total maritime trade (10,985 million tons loaded): United Nations (UN). (2022). *Review of Maritime Transport: Navigating Stormy Waters*. https://unctad.org/system/files/official-document/rmt2022_en.pdf.

158. International Council on Mining and Metals (ICMM). (n.d.). *Climate Change.* https://www.icmm.com/en-gb/our-work/environmental-resilience/climate-change.

159. Rio Tinto. (2023). *Climate change*. https://www.riotinto.com/sustainability/climate-change.

160. Minerals Council of Australia (MCA). (2022). *Climate Action Plan: Progress Report.* https://minerals.org.au/wp-content/uploads/2022/12/MCA-Climate-Action-Plan_Progress-Report-2022.pdf.

161. World Steel Association. (2023). *Sustainability Indicators: 2023 report.* https://worldsteel.org/steel-topics/sustainability/sustainability-indicators-2023-report/.

162. While "compensation" can be treated as synonymous with "offsetting", as aligned with IUCN's approach, in this report "compensation" is a more general term of which biodiversity offsets are just one subset. Compensation may achieve NNL or BNG (in which case it is an offset), but in other cases, compensation can involve reparation that falls short of achieving NNL (and is therefore not an offset).

163. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

164. Cross-Sector Biodiversity Initiative (CSBI). (2015). *Cross-sector Guide for Implementing the Mitigation Hierarchy.* http://www.csbi.org.uk/our-work/mitigation-hierarchy-guide/.

165. The Nature Conservancy (TNC). (2015). *Achieving Conservation and Development: 10 Principles for Applying the Mitigation Hierarchy.* https://www.conservationgateway.org/Documents/TNCApplyingTheMitigationHierarchy.pdf.

166. United Nations Environment Programme (UNEP). (2012). *Biodiversity offsets: voluntary and compliance regimes.* https://files.ctctcdn.com/b3b328ed001/7b1aaa64-234c-4918-abb8-27a30c51ac03.pdf.

167. The steps of the mitigation hierarchy can be expressed differently in various policies, but the core steps remain the same.

168. International Union for Conservation of Nature (IUCN). (2023). *Nature positive for business.* https://portals.iucn.org/library/sites/library/files/documents/2023-023-En.pdf.

169. For all new operations and significant expansions, NNL or net gain should be measured against a pre-operation or pre-expansion baseline respectively. For existing operations and future acquisitions, this should align with an estimated pre-operation baseline where possible. Alternatively, for existing operations, this should be measured against a 2020 or earlier baseline, and for future acquisitions, the baseline should be the date of takeover or earlier: International Council on Mining and Metals (ICMM). (2024). *Nature: Position Statement.* https://nature.icmm.com/position-statement.

170. The Nature Conservancy (TNC). (2015). *Achieving Conservation and Development: 10 Principles for Applying the Mitigation Hierarchy.* https://www.conservationgateway.org/Documents/TNCApplyingTheMitigationHierarchy.pdf.

171. The Biodiversity Consultancy. (2016). *Government policies on biodiversity offsets*. https://www.thebiodiversityconsultancy.com/fileadmin/uploads/tbc/Documents/Resources/Government-policy-2.pdf.

172. International Union for Conservation of Nature (IUCN). (2016). *Policy on Biodiversity Offsets*. https://iucn.org/sites/default/files/2022-06/iucn_biodiversity_offsets_policy_jan_29_2016_0.pdf.

173. International Union for Conservation of Nature (IUCN). (2013). *Guidelines for Applying Protected Area Management Categories.* https://portals.iucn.org/library/sites/library/files/documents/PAG-021.pdf.

174. Alliance for Zero Extinction. (n.d.). *Homepage*. https://zeroextinction.org/.

175. United Nations Educational, Scientific and Cultural Organization (UNESCO). (n.d.). *World Heritage List.* https://whc.unesco.org/en/list/.

176. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

177. International Union for Conservation of Nature (IUCN). (2013). *Guidelines for Applying Protected Area Management Categories.* https://portals.iucn.org/library/sites/library/files/documents/PAG-021.pdf.

178. Key Biodiversity Areas (KBAs). (n.d.). *Homepage.* https://www.keybiodiversityareas.org/.

179. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

180. International Finance Corporation (IFC). (2012). *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-6.

181. NatureMetrics. (2024). *Nature Tech's Role in Mining's Nature Positive Future.* https://www.naturemetrics.com/news/nature-techs-role-in-minings-nature-positive-future.

182. Securing Indigenous Peoples' Rights in the Green Economy (SIRGE) Coalition. (2023). *FPIC Protocol Guide*. https://www.sirgecoalition.org/fpic-guide.

183. United Nations (UN). (2013). Human Rights, Office of the High Commissioner: Free, Prior and Informed Consent of Indigenous Peoples. https://www.ohchr.org/sites/default/files/Documents/Issues/IPeoples/FreePriorandInformedConsent.pdf.

184. International Finance Corporation (IFC). (2012). *Performance Standard 7: Indigenous Peoples.* https://www.ifc.org/en/insights-reports/2012/ifc-performance-standard-7.

185. United Nations (UN). (2007). *Declaration on the Rights of Indigenous Peoples.* https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP_E_web.pdf.

186. United Nations (UN). (2011). *Guiding Principles on Business and Human Rights.* https://www.ohchr.org/sites/default/files/documents/publications/guidingprinciplesbusinesshr_en.pdf.

187. International Labour Organization (ILO). (n.d.). *Indigenous peoples: Consultation and participation.* https://www.ilo.org/media/279381/download.

188. Securing Indigenous Peoples' Rights in the Green Economy (SIRGE) Coalition. (2023). *FPIC Protocol Guide*. https://www.sirgecoalition.org/fpic-guide.

189. Forest People's Programme. (2008). *Key Elements to the Initiation, Performance and Maintenance of Good Faith Consultations and Negotiations with Indigenous and Tribal Peoples and Communities.* https://www.forestpeoples.org/sites/fpp/files/publication/2010/09/fppkeyelementsgoodfaithdec08eng.pdf.

190. Asia Indigenous Peoples Pact's (AIPP). (2019). *Handbook: Extractive Industries and Free, Prior and Informed Consent of Indigenous Peoples.* https://aippnet.org/wp-content/uploads/2020/05/AIPP-Handbook-on-Extractive-Industries-and-FPIC-of-Indigenous-Peoples_web.pdf.

191. Organisation for Economic Co-operation and Development (OECD). (2017). *Due Diligence Guidance for Meaningful Stakeholder Engagement in the Extractive Sector.* https://www.oecd-ilibrary.org/governance/oecd-due-diligence-guidance-for-meaningful-stakeholder-engagement-in-the-extractive-sector_9789264252462-en.

192. Taskforce on Nature-related Financial Disclosures (TNFD). (2023). *Guidance on engagement with Indigenous Peoples, Local Communities and affected stakeholders.* https://tnfd.global/publication/guidance-on-engagement-with-indigenous-peoples-local-communities-and-affected-stakeholders/.

193. Science Based Targets Network (SBTN). (2023). *Stakeholder Engagement Guidance.* https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Stakeholder-Engagement-Guidance-beta.pdf.

194. Initiative for Responsible Mining Assurance (IRMA). (2018). *Chapter 2.2: Free, Prior and Informed Consent (FPIC).* https://responsiblemining.net/wp-content/uploads/2018/08/Chapter_2.2_FPIC.pdf. *Chapter 4.6: Biodiversity, Ecosystem Services and Protected Areas.* https://responsiblemining.net/wp-content/uploads/2018/08/Chapter_4.6_Biodiversity_EServices_PAs.pdf.

195. Indigenous Peoples' and community conserved territories and areas (ICCAs). (n.d.). *Homepage.* https://www.iccaconsortium.org/.

196. Global Land Governance Index. (n.d.). *LANDex: People's Data on Land.* https://www.landexglobal.org/en/.

197. World Resources Institute (WRI). (n.d.). *LandMark*. https://www.wri.org/initiatives/landmark.

198. Indigenous Navigator. (n.d.). *Homepage.* https://indigenousnavigator.org/.

199. McKinsey Sustainability. (2020). *Climate risk and decarbonization: What every mining CEO needs to know.* https://www.mckinsey.com/capabilities/sustainability/our-insights/climate-risk-and-decarbonization-what-every-mining-ceo-needs-to-know.

200. World Economic Forum. (n.d.). *Clean Power, Grids and Electrification*. https://initiatives.weforum.org/clean-power-and-electrification/clean-power.

201. Clean Energy Buyers Institute. (n.d.). *Beyond the Megawatt.* https://cebi.org/programs/beyond-the-megawatt/.

202. Rivian and The Nature Conservancy (TNC). (2023). *Power with Purpose: Driving Change Through Clean Energy Procurement.* https://www.nature.org/content/dam/tnc/nature/en/documents/Power-With-Purpose-Rivian-TNC-White-Paper-2023-HiRes.pdf.

203. Antofagasta Minerals. (2022). *Sustainability Report 2022.* https://www.antofagasta.co.uk/media/4527/am_rs_2022_ingles_06.pdf.

204. World Economic Forum. (2023). *Mining and Metals: Trends, Challenges and the Way Forwards*. https://www3.weforum.org/docs/WEF_Mining_and_Metals_2023.pdf.

205. World Economic Forum. (n.d.). *First Movers Coalition: Home*. https://initiatives.weforum.org/first-movers-coalition/home.

206. World Economic Forum. (n.d.). *First Movers Coalition: Commitments*. https://initiatives.weforum.org/first-movers-coalition/commitments.

207. Fortescue. (2022, 24 January). *Fortescue to acquire Williams Advanced Engineering in race to net zero.* [Press release]. https://fortescue.com/news-and-media/news/2023/07/24/fortescue-to-acquire-williams-advanced-engineering-in-race-to-net-zero.

208. World Economic Forum. (2023). *The "No-Excuse" Framework to Accelerate the Path to Net-Zero Manufacturing and Value Chains.* https://www.weforum.org/publications/the-no-excuse-framework-to-accelerate-the-path-to-net-zero-manufacturing-and-value-chains/.

209. World Economic Forum. (2023). *The "No-Excuse" Framework to Accelerate the Path to Net-Zero Manufacturing and Value Chains.* https://www.weforum.org/publications/the-no-excuse-framework-to-accelerate-the-path-to-net-zero-manufacturing-and-value-chains/.

210. Green Gravity. (n.d.). *Homepage.* https://greengravity.com/.

211. TerraEye. (n.d.). *Homepage.* https://terraeye.co/.

212. Datarock. (n.d.). *Unearth possibility.* https://datarock.com.au/.

213. Palden, T. *et al.* (2019). Methanesulfonic acid: a sustainable acidic solvent for recovering metals from the jarosite residue of the zinc industry. *Green Chemistry*, vol. 19. https://pubs.rsc.org/en/content/articlelanding/2019/gc/c9gc02238d.

214. Quijada-Maldonado, E. et al. (2020). Possibilities and challenges for ionic liquids in hydrometallurgy. *Separation and Purification Technology*, vol. 251. https://doi.org/10.1016/j.seppur.2020.117289.

215. Endolith. (n.d.). *Homepage.* https://www.endolithmining.com/.

216. The University of Queensland, Australia. (n.d.). *Ore-sand: A circular economy solution to reduce mineral wastes and improve global sand sustainability.* https://smi.uq.edu.au/gcms/research/ore-sand-circular-economy-solution-reduce-mineral-wastes-and-improve-global-sand-sustainability; Mining. (2023). *Is ore-sand the solution to the mining industry's waste problem?* https://miningmagazine.com.au/is-ore-sand-the-solution-circular-economy-to-the-mining-industrys-waste-problem/.

217. Norsk Hydro. (2021). *Novel bauxite tailings concept a success in full operation.* https://www.hydro.com/en/global/about-hydro/stories-by-hydro/novel-bauxite-tailings-concept-a-success-in-full-operation/.

218. ArcelorMittal. (n.d.). *Tailings management*. https://corporate.arcelormittal.com/industries/tailings-management#.

219. Envicore. (n.d.). *Homepage.* https://www.envicoreinc.com/.

220. Rio Tinto. (2023). *Turning slime into solar panels*. https://www.riotinto.com/en/news/stories/slime-into-solar; Rio Tinto. (2023). *Extracting scandium from waste*. https://www.riotinto.com/en/news/stories/extracting-scandium-from-waste; Rio Tinto. (2022). *Mining waste is fertile ground.* https://www.riotinto.com/en/news/stories/mining-waste-is-fertile-ground.

221. Genomines. (n.d.). *Homepage.* https://www.genomines.com/.

222. World Economic Forum. (2023). *The "No-Excuse" Framework to Accelerate the Path to Net-Zero Manufacturing and Value Chains.* https://www.weforum.org/publications/the-no-excuse-framework-to-accelerate-the-path-to-net-zero-manufacturing-and-value-chains/.

223. Vale. (n.d.). *Vale Ventures.* https://vale.com/de/vale-ventures.

224. Expande. (n.d.). *Homepage.* https://expandemineria.cl/?lang=en.

225. Unearthed. (n.d.). *Homepage*. https://unearthed.solutions/.

226. mininghub. (n.d.). *Homepage.* https://mininghub.com.br/pb.

227. ReThink Mining. (n.d.). *Homepage.* https://www.rethinkmining.org/.

228. United Nations Environment Programme (UNEP). (2020). *Global Industry Standard on Tailings Management.* https://www.unep.org/resources/report/global-industry-standard-tailings-management.

229. Earthworks, MiningWatch Canada & London Mining Network. (2022). *Safety First: Guidelines for Responsible Mine Tailings Management*. https://earthworks.org/resources/safety-first.

230. Minerals Council of Australia (MCA). (2015). *Cumulative Environment Impact Assessment Industry Guide.* https://minerals.org.au/resources/cumulative-environmental-impact-assessment-industry-guide/.

231. Society for Ecological Restoration (SER). (2022). *International Principles and Standards for the Ecological Restoration and Recovery of Mine Sites.* https://www.ser.org/page/mining.

232. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *Relinquishment of Closed Mine Sites: Policy steps for governments.* https://www.iisd.org/system/files/2023-09/relinquishment-closed-mines-policy-steps-for-governments-en.pdf.

233. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *Mining Policy Framework: Mining and sustainable development.* https://www.iisd.org/system/files/2023-12/igf-mining-policy-framework-en.pdf.

234. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *Relinquishment of Closed Mine Sites: Policy steps for governments.* https://www.iisd.org/system/files/2023-09/relinquishment-closed-mines-policy-steps-for-governments-en.pdf.

235. Rio Tinto. (2022). *Re-planting and ecosystem without topsoil.* https://www.riotinto.com/en/news/stories/replanting-an-ecosystem.

236. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *The impacts of climate change on the mining sector*. https://www.iisd.org/system/files/2023-09/impacts-climate-change-mining-sector.pdf.

237. World Economic Forum. (2023). *Embedding Indigenous Knowledge in the Conservation and Restoration of Landscapes.* https://www.weforum.org/publications/embedding-indigenous-knowledge-in-the-conservation-and-restoration-of-landscapes/.

238. Freeport-McMoRan. (2024). *Unique Recreational Space Emerges from Former Milling Site.* https://www.fcx.com/freeport-features/050324.

239. While "compensation" can be treated as synonymous with "offsetting", as aligned with IUCN's approach, in this report "compensation" is a more general term of which biodiversity offsets are just one subset. Compensation may achieve NNL or BNG (in which case it is an offset), but in other cases, compensation can involve reparation that falls short of achieving NNL (and is therefore not an offset).

240. International Union for Conservation of Nature (IUCN). (2016). *Issue Brief: Biodiversity Offsets*. https://iucn.org/sites/default/files/2022-04/biodiversity_offset_issues_briefs_final_0.pdf.

241. International Union for Conservation of Nature (IUCN). (2023). *Nature positive for business.* https://portals.iucn.org/library/sites/library/files/documents/2023-023-En.pdf.

242. The Nature Conservancy (TNC). (2015). *Achieving Conservation and Development: 10 Principles for Applying the Mitigation Hierarchy.* https://www.conservationgateway.org/Documents/TNCApplyingTheMitigationHierarchy.pdf.

243. United Nations Environment Programme (UNEP). (2012). *Biodiversity offsets: voluntary and compliance regimes.* https://files.ctctcdn.com/b3b328ed001/7b1aaa64-234c-4918-abb8-27a30c51ac03.pdf.

244. International Union for Conservation of Nature (IUCN). (2016). *Policy on Biodiversity Offsets*. https://iucn.org/sites/default/files/2022-06/iucn_biodiversity_offsets_policy_jan_29_2016_0.pdf.

245. The Business and Biodiversity Offset Programme (BBOP). (2018). *The BBOP Principles on Biodiversity Offsets*. https://www.forest-trends.org/wp-content/uploads/2018/10/The-BBOP-Principles_20181023.pdf.

246. International Union for Conservation of Nature (IUCN), The Biodiversity Consultancy and the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2017). *Understanding Government Biodiversity Offset Policies in the Mining Sector.* https://iucn.org/sites/default/files/2022-06/understanding_government_biodiversity_offset_policies_in_the_mining_sector_november_2017.pdf.

247. Rio Tinto. (2023, 22 March). *Rio Tinto becomes first major mining company to publish site-by-site water usage data*. [Press release]. https://www.riotinto.com/en/news/releases/2023/rio-tinto-becomes-first-major-mining-company-to-publish-site-by-site-water-usage-data.

248. Broken Hill Proprietary (BHP). (2023). *World Environment Day: Announcement of new water targets.* https://www.bhp.com/news/articles/2023/06/world-environment-day-announcement-of-new-water-targets.

249. World Wide Fund for Nature (WWF). (n.d.). *Water Risk Filter*. https://riskfilter.org/water/home.

250. Science Based Targets Network (SBTN). (n.d.). *Step 3: Measure, Set & Disclose Freshwater Targets.* https://sciencebasedtargetsnetwork.org/companies/take-action/set-targets/freshwater-targets/.

251. World Resources Institute (WRI). (n.d.). *Toolbox for Setting Enterprise Water Targets.* https://www.wri.org/toolbox/setting-enterprise-water-targets.

252. ICMM. (2017). *Water Stewardship: Position Statement.* https://www.icmm.com/en-gb/our-principles/position-statements/water-stewardship.

253. ICMM. (2023). *Water Stewardship Maturity Framework.* https://www.icmm.com/en-gb/guidance/environmental-stewardship/2023/water-stewardship-maturity-framework.

254. The Mining Association of Canada (MAC). (2019). *Towards Sustainable Mining: Water Stewardship Protocol.* https://mining.ca/resources/guides-manuals/tsm-water-stewardship-protocol/.

255. BIND-X. (n.d.). *Homepage.* https://bind-x.com/.

256. Metso. (2021). *The challenge of minimizing water usage in the mining process*. https://www.metso.com/insights/blog/mining-and-metals/the-challenge-of-minimizing-water-usage-in-the-mining-process/.

257. FLSmidth. (n.d.). *Healthier economy in tailings management.* https://www.flsmidth.com/en-gb/discover/healthier-economy-in-tailings-management.

258. International Mining. (2023). *Minera Centinela achieves goal of 100% operation with seawater*. https://im-mining.com/2023/01/03/minera-centinela-achieves-goal-of-100-operation-with-seawater/; Almar Water Solutions. (2024). *Antofagasta Minerals and Almar Water Solutions / Transelec consortium sign contract for water supply to Centinela*. https://almarwater.com/antofagasta-minerals-and-almar-water-solutions-transelec-consortium-sign-contract-for-water-supply-to-centinela/.

259. World Resources Institute (WRI). (2024). *More Critical Minerals Mining Could Strain Water Supplies in Stressed Regions.* https://www.wri.org/insights/critical-minerals-mining-water-impacts.

260. Returning water to ecosystems and communities within a local catchment area. UN Global Compact CEO Water Mandate. (2023). *Volumetric Water Benefit Accounting (VWBA): A Practical Guide to Implementing Water Replenishment Targets.* https://ceowatermandate.org/posts/water-replenishment-guide/.

261. ICMM. (2023). *World Water Day 2023.* https://www.icmm.com/en-gb/stories/2023/world-water-day-2023.

262. Teck Resources. (2024). *Where The Rubber Meets The Road — Tire Recycling For Rubberized Asphalt*. https://www.teck.com/news/stories/2024/where-the-rubber-meets-the-road-%E2%80%94-tire-recycling-for-rubberized-asphalt.

263. Integrated Biodiversity Assessment Tool (IBAT). (n.d.). *Homepage.* https://www.ibat-alliance.org/.

264. World Wide Fund for Nature (WWF). (n.d.). *Biodiversity Risk Filter.* https://riskfilter.org/biodiversity/home.

265. Global Forest Watch. (n.d.). *Homepage.* https://www.globalforestwatch.org/.

266. Teck Resources. (2022). *Teck And DLT Partner To Pilot Traceability For Critical Minerals With Blockchain.* https://www.teck.com/news/news-releases/2022/teck-and-dlt-partner-to-pilot-traceability-for-critical-minerals-with-blockchain.

267. Rio Tinto. (3 February 2021). *Rio Tinto launches START: the first sustainability label for aluminium using blockchain technology*. [Press release]. https://www.riotinto.com/news/releases/2021/Rio-Tinto-launches-START-the-first-sustainability-label-for-aluminium-using-blockchain-technology.

268. De Beers Group. (n.d.). *Tracr*. https://www.debeersgroup.com/sustainability-and-ethics/leading-ethical-practices-across-the-industry/tracr.

269. Initiative for Responsible Mining Assurance (IRMA). (n.d.). *Resources: Full documentation and guidance*. https://responsiblemining.net/resources/#full-documentation-and-guidance.

270. The Copper Mark. (n.d.). *Core Documents*. https://coppermark.org/standards/core-documents/.

271. Aluminium Stewardship Initiative (ASI). (n.d.). *ASI Performance Standard.* https://aluminium-stewardship.org/asi-standards/performance-standard.

272. The sustainable palm oil choice. (n.d.). *No Deforestation, Peat, and Exploitation, NDPE Commitment.* https://www.sustainablepalmoilchoice.eu/ndpe-commitment/.

273. International Union for Conservation of Nature (IUCN). (2023). *Measuring Nature-Positive: Consultation Draft.* https://iucn.org/sites/default/files/2023-11/iucn-nature-positive-contribution-v1.0.pdf.

274. Norsk Hydro. (n.d.). *Hydro Extrusions Partnership for a more sustainable future*. https://www.hydro.com/gb/global/aluminium/products/extruded-profiles/hydro-extrusions-partner-packages/.

275. Norsk Hydro. (2023, 2 December). *Hydro and Volvo Group join forces to accelerate net zero transportation.* [Press release]. https://www.hydro.com/en/global/media/news/2023/hydro-and-volvo-group-join-forces-to-accelerate-net-zero-transportation/.

276. BMW Group. (2023, 16 October). *BMW Group, Anglo American Platinum and Sasol announce collaboration to drive the green hydrogen economy with the launch of a pilot fleet of hydrogen vehicles in South Africa.* [Press release]. https://www.press.bmwgroup.com/south-africa/article/detail/T0437706EN/bmw-group-anglo-american-platinum-and-sasol-announce-collaboration-to-drive-the-green-hydrogen-economy-with-the-launch-of-a-pilot-fleet-of-hydrogen-vehicles-in-south-africa?language=en.

277. Rio Tinto. (2018, 10 May). *Rio Tinto and Alcoa announce world's first carbon-free aluminum smelting process*. [Press release]. https://www.riotinto.com/fr-CA/can/news/releases/First-carbon-free-aluminium-smelting.

278. Apple. (2022, 24 March). *Apple's $4.7B in Green Bonds support innovative green technology.* [Press release]. https://www.apple.com/ci/newsroom/2022/03/apples-four-point-seven-billion-in-green-bonds-support-innovative-green-technology/.

279. BHP. (2024). *Annual Report 2024.* https://www.bhp.com/-/media/documents/investors/annual-reports/2024/240827_bhpannualreport2024.pdf.

280. There is lively debate about whether voluntary within- and out-of-value chain conservation and restoration could be used to take responsibility for unmitigated biodiversity impacts, which is out of the scope of this report. For more information on the concerns and guardrails to be put in place for corporates considering investing in biodiversity credits specifically: World Economic Forum. (2023). *Biodiversity Credits: A Guide to Support Early Use with High Integrity.* https://www3.weforum.org/docs/WEF_Biodiversity_Credits_A_Guide_to_Support_Early_Use_with_High_Integrity_2023.pdf.

281. Vale. (2022). *Integrated Report 2022.* https://vale.com/documents/d/guest/vale_relatointegrado2022-en-final-1.

282. BHP Foundation. (2020). *Forest Conservation in the Canadian Boreal.* https://www.bhp.com/es/-/media/project/bhp1ip/bhp-com-en/documents/sustainability/communities/bhp-foundation/environmental-resilence/190606_bhpfoundation_forestconservationinthecanadianboreal.pdf.

283. The Paulson Institute, The Nature Conservancy, Cornell Atkinson Center for Sustainability. (2020). *Financing Nature: Closing the Global Biodiversity Financing Gap.* https://www.paulsoninstitute.org/wp-content/uploads/2020/10/FINANCING-NATURE_Full-Report_Final-with-endorsements_101420.pdf.

284. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2021). *Guidance for Governments: Environmental Management and Mining Governance.* https://www.iisd.org/system/files/2021-05/igf-guidance-governments-environmental-management-mining-en.pdf.

285. United Nations Environment Programme (UNEP). (2020). *Mineral Resource Governance in the 21st Century*. https://www.unep.org/resources/report/mineral-resource-governance-21st-century.

286. Convention on Biological Diversity. (n.d.). *National Biodiversity Strategies and Action Plans (NBSAPs).* https://www.cbd.int/nbsap/introduction.shtml.

287. International Union for Conservation of Nature (IUCN). (2013). *Guidelines for Applying Protected Area Management Categories.* https://portals.iucn.org/library/sites/library/files/documents/PAG-021.pdf.

288. Key Biodiversity Areas (KBAs). (n.d.). *Homepage.* https://www.keybiodiversityareas.org/.

289. Inter-American Commission on Human Rights (IACHR). (2013). *Indigenous Peoples in Voluntary Isolation and Initial Contact in the Americas.* https://www.oas.org/en/iachr/indigenous/docs/pdf/report-indigenous-peoples-voluntary-isolation.pdf.

290. European Environment Agency. (2024). *Best available techniques (BAT) to cut the use and impact of hazardous chemicals (Signal).* https://www.eea.europa.eu/en/european-zero-pollution-dashboards/indicators/best-available-techniques-bat-to-cut-the-use-and-impact-of-hazardous-chemicals.

291. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *Relinquishment of Closed Mine Sites: Policy steps for governments.* https://www.iisd.org/system/files/2023-09/relinquishment-closed-mines-policy-steps-for-governments-en.pdf.

292. Institute for Sustainable Futures, prepared for Earthworks. (2021). *Reducing new mining for electric vehicle battery metals: responsible sourcing through demand reduction strategies and recycling.* https://earthworks.org/wp-content/uploads/2021/09/UTS-EV-battery-metals-sourcing-20210419-FINAL.pdf.

293. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF). (2023). *Mining Policy Framework: Mining and sustainable development.* https://www.iisd.org/system/files/2023-12/igf-mining-policy-framework-en.pdf.

294. Organisation for Economic Co-operation and Development (OECD). (2023). *Handbook on Environmental Due Diligence in Mineral Supply Chains.* https://www.oecd-ilibrary.org/finance-and-investment/handbook-on-environmental-due-diligence-in-mineral-supply-chains_cef843bf-en; Organisation for Economic Co-operation and Development (OECD). (2016). *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.* https://www.oecd-ilibrary.org/governance/oecd-due-diligence-guidance-for-responsible-supply-chains-of-minerals-from-conflict-affected-and-high-risk-areas_9789264252479-en.

295. World Economic Forum. (2023). *The "No-Excuse" Framework to Accelerate the Path to Net-Zero Manufacturing and Value Chains.* https://www.weforum.org/publications/the-no-excuse-framework-to-accelerate-the-path-to-net-zero-manufacturing-and-value-chains/.

296. GFANZ's framework is primarily aimed at financial institutions but can also be applied to firms in the real economy: Glasgow Financial Alliance for Net Zero (GFANZ). (2022). *Financial Institution Net-zero Transition Plans: Fundamentals, Recommendations, and Guidance, Final Report*. https://assets.bbhub.io/company/sites/63/2022/09/Recommendations-and-Guidance-on-Financial-Institution-Net-zero-Transition-Plans-November-2022.pdf.

297. United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

298. World Resources Institute (WRI). (n.d.). *Aqueduct*. https://www.wri.org/aqueduct.

299. World Wide Fund for Nature (WWF). (n.d.). *Biodiversity Risk Filter.* https://riskfilter.org/biodiversity/home; World Wide Fund for Nature (WWF). (n.d.). *Water Risk Filter.* https://riskfilter.org/water/explore/introduction.

300. United Nations Environment Programme Finance Initiative (UNEP-FI). (2022). *Prioritising nature-related disclosures: considerations for high-risk sectors.* https://www.unepfi.org/publications/prioritising-nature-related-disclosures-considerations-for-high-risk-sectors/.

301. Integrated Biodiversity Assessment Tool (IBAT). (n.d.). *Homepage*. https://www.ibat-alliance.org/.

302. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Recommendations*. https://tnfd.global/publication/recommendations-of-the-taskforce-on-nature-related-financial-disclosures/.

303. Taskforce on Nature-related Financial Disclosures (TNFD) & Science Based Targets Network (SBTN). (2023). *Guidance for corporates on science-based targets for nature.* https://tnfd.global/wp-content/uploads/2023/09/Guidance_for_corporates_on_science_based_targets_for_nature_v1.pdf?v=1695138398.

304. Taskforce on Nature-related Financial Disclosures (TNFD). (2023). *Guidance on the identification and assessment of nature-related issues: the LEAP approach.* https://tnfd.global/publication/additional-guidance-on-assessment-of-nature-related-issues-the-leap-approach/.

305. Capitals Coalition. (n.d.). *Aligning Accounting Approaches for Nature*. https://capitalscoalition.org/project/align/.

306. The Organisation for Economic Co-operation and Development (OECD) defines an indicator as a: "Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor": Organisation for Economic Co-operation and Development (OECD). (n.d.) *Development co-operation peer reviews and learning.* https://www.oecd.org/dac/peer-reviews/Development-Results-Note.pdf.

307. Taskforce on Nature-related Financial Disclosures (TNFD). (2024). *Additional sector guidance – Metals and mining.* https://tnfd.global/publication/additional-sector-guidance-metals-and-mining/.

308. United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). (2024). *Exploring Natural Capital Opportunities, Risks and Exposure.* https://encorenature.org/en.

309. United Nations (UN). (2008). *International Standard Industrial Classification of All Economic Activities (ISIC), Rev.4*. https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf.

310. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (n.d.). *Models of drivers of biodiversity and ecosystem change*. https://www.ipbes.net/models-drivers-biodiversity-ecosystem-change.

311. World Economic Forum. (2020). *New Nature Economy Report II: The Future of Nature and Business*. https://www.weforum.org/publications/new-nature-economy-report-ii-the-future-of-nature-and-business/.

312. Alpha Beta. (2020). *Identifying Biodiversity Threats and Sizing Business Opportunities: Methodological Note to the New Nature Economy Report II: The Future of Nature and Business.* https://accesspartnership.com/wp-content/uploads/2023/01/200715-nner-ii-methodology-note_final.pdf.

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