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How to fuel an energy transition with ecologically responsible mining

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Iron ore exploration in the Pilbara region of Western Australia. Considering the biodiversity threats of mining in the early phases of mineral exploration activities can make an enormous difference to the overall biodiversity impacts that will result from supplying energy transition minerals. Image credit: iStock/ Adrian Wojcik.

The most recent United Nations conferences on Climate Change (COP27) and Biodiversity (COP15) reemphasized the need for strong links between their respective agendas (1, 2). A renewable energy transition is essential for climate action (3). It will also help to address the biodiversity losses driven by climate change and fossil fuel extraction and use, and, thus, contribute toward achieving global goals for nature recovery (2). However, little is known about the biodiversity impacts of mining the 3 billion tons of raw materials needed for a clean energy future (4). And, while many mining companies are making "Nature Positive" commitments to contribute toward halting and reversing global biodiversity loss (5), clear guidance is needed around when, how, and who is responsible for managing the likely trade-offs between biodiversity loss and climate action.

Future mining to supply energy transition minerals doesn't need to have a big impact on the environment - more responsible options exist. We propose four actions essential to aligning global climate and conservation goals when considering mining's biodiversity impact. Clearly, there is an urgent need for science and policy innovation to optimize outcomes for nature.

Growing Threats

Mining currently threatens a similar number of species as climate change (11,314 species vs. 12,260 species, respectively). Given that only 1,179 species (5%) are threatened by both (6), minimizing the harm from mining and climate change

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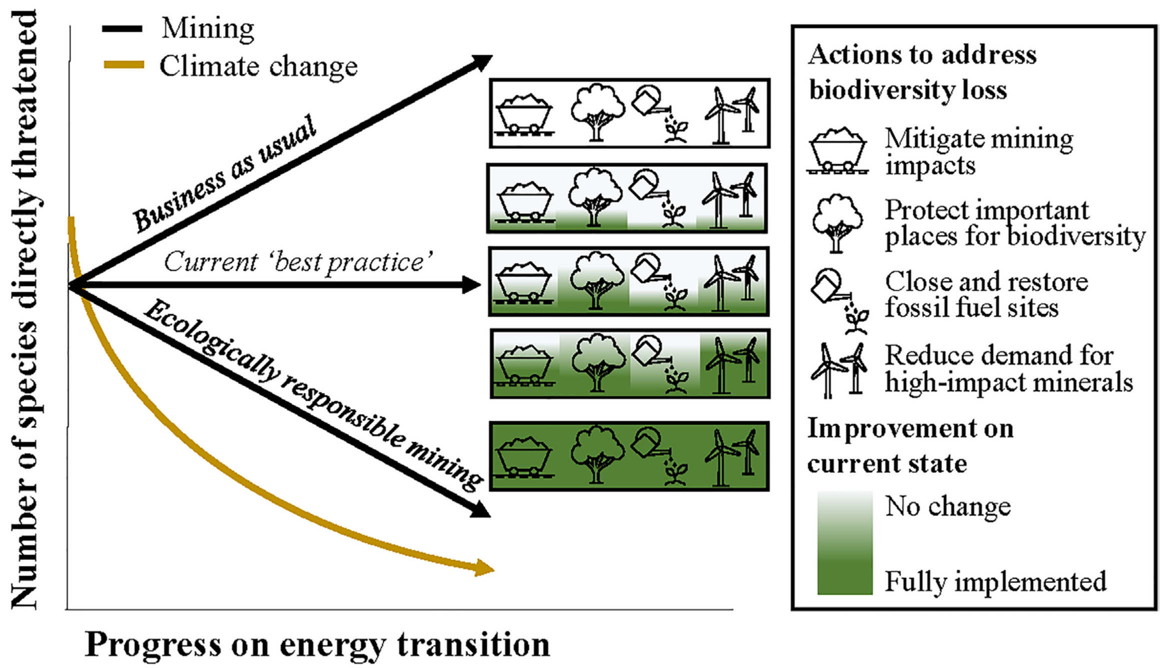

Fig. 1. Biodiversity threatened by climate change and mining due to a renewable energy transition over time. Threats are approximated by the number of species listed by the International Union for Conservation of Nature Red List as threatened (6). Here, an energy transition limits global warming to 1.5 degrees Celsius and halts fossil fuel extraction. This will reduce threats from climate change. Three hypothetical trajectories for changes in threats by mining are shown. Business-as-usual represents growth in ETM demand and mining, growth in the biodiversity loss per ton of ore, and failure to close, restore, and relinquish coal mines and oil and gas fields. Current "best practice" represents a case where new mines achieve no-net-loss in biodiversity, through progress on a combination of actions. Ecologically responsible mining achieves no-net-loss of biodiversity, while also restoring closed or abandoned coal mines to avert their threats.

together would be a huge win for conservation (Fig. 1). However, we are far from this trajectory. If we assume that future mines will cause similar biodiversity losses to current mines, threats will likely increase as demand grows by 500–900% by 2050 for some energy transition materials (ETMs), like cobalt and lithium (7). However, worryingly, biodiversity loss per ton of ore mined is more likely to grow, given declining grades (leading to larger mines, with more waste; ref. 8), ongoing mining and mineral exploration activities within protected areas (9), and a trend toward sourcing ETMs from more vulnerable ecoregions (9) with weaker governance (10). The importance of fully mitigating impacts in the future is therefore even greater. Unfortunately, this task is rarely achieved at present (11), and we have no measure of progress on prevention of ongoing biodiversity losses at historic sites extracting fossil fuels of coal, oil, and gas.

Ongoing or increasing rates of biodiversity loss would render unachievable the international commitments made by 196 nations party to the Convention on Biological Diversity in December 2022 (2). Residual biodiversity impacts also create significant risks to business operations, including the mining industry, and human society more broadly, given nature's contributions to people (12). However, since climate action is essential for all life on Earth and because an energy transition is dependent on more mining (at least in the short term; ref. 13), the challenge will be to find the least harmful path forward. The four actions described below embody a novel take on the concept of ecologically responsible mining (14), where the goal would be to avert threats to biodiversity. While these actions could provide a broad range of other environmental and social benefits (7, 10, 13), implementing them collectively is essential to shift away from our current trajectory of long-term biodiversity loss (Fig. 1).

Key Steps

First, applying the Mitigation Hierarchy (MH; avoid, minimize, restore, offset) to mine sites is international best practice and a requirement by governments and investors, yet often fails to achieve no-net-loss of biodiversity (11). The approach needs several improvements, three of which are essential to addressing impacts of ETMs. The MH must extend to address indirect and cumulative impacts on biodiversity, through strategic environmental assessments, particularly in regions where demand will cause rapid development of infrastructure and industry. Further, biodiversity losses and gains must be monitored and reported across the entire MH to enable transparent and adaptive management and mainstream biodiversity into mine planning and investor decisions at earlier stages. Finally, impacts and mitigation requirements must be mapped and shared equitably across entire value chains. This would help to address the geopolitical disparities in biodiversity losses and gains between areas of ETM supply and demand (10).

Second, since threats and impacts of mining vary geographically, avoiding development in biodiverse places that are important for conservation could have a huge impact on outcomes. Mining nickel outside of the world's remaining old-growth tropical forests, for example, could reduce total biodiversity losses 10-fold (15). However, incorporating biodiversity into ETM sourcing and exploration activities is not the norm. To make the necessary progress, the conservation community must prioritize development of new tools to identify the sites most important for biodiversity conservation, including irreplaceable sites that cannot be recovered (e.g., old-growth forests) and the facets of biodiversity that we cannot afford to lose (e.g., habitat critical for species persistence)—if, indeed, the goal is to meet international commitments to conservation (2). We also require an understanding of how current and future mining activities pose threats to these priorities, through enhancing publicly available data on prospectivity, exploration, impacts, and mitigation. Such tools would enable industry and investors to improve environmental commitments, which, at present, narrowly focus on avoiding World Heritage Areas and respecting legally designated protected areas (16).

Careful planning now could make a huge difference for global conservation outcomes.

Third, reducing fossil fuel dependence will cause fewer new coal mines and oil and gas fields to open and may also reduce or halt production at current operations. However, unless coupled with effective ecological restoration activities, threats to biodiversity may persist or, in some cases, intensify (8). The global extent of land requiring restoration is significant; more than 335,000 hectares are currently occupied by coal mining (17). Mine closure planning and efforts to rehabilitate land to some postmining use is improving, but only recently. In Australia, for example, only a small fraction of inactive mines (4% of a total of 84,794) have undergone any form of rehabilitation and relinquishment, and very rarely do these activities represent ecological restoration to address biodiversity loss. In combination, this represents an enormous financial burden to land custodians, including Indigenous Peoples, and consequences of degraded land for nature and people. Mine site restoration is a slow, uncertain, and expensive process. Governments must strengthen requirements for restoration in closure planning and ensure that responsibility sits with the proponents. For legacy sites, identifying restoration priorities would support government investments in conservation and could also provide a tool for industry to act beyond compliance and demonstrate progress toward their Nature Positive commitments.

Fourth, biodiversity impacts of ETM mining will also depend on the energy transition pathway that society ultimately chooses to take. Managing demand for ETMs could improve outcomes, particularly if opportunities exist to curb mining of high-impact ETMs. This could be achieved by factoring biodiversity risks into corporate, national, and global assessments of metal criticality and strategies to address supply risks; or by creating incentives for mining investors and ETM end users to reduce their biodiversity footprints through supply chain standards and mineral certification schemes (14). Yet, while the appetite for this approach exists, such plans are hindered by inadequate data and knowledge. While some progress has been made since the last knowledge synthesis (8), we need new ways to quantify the biodiversity intensity of ETMs—including robust global-scale metrics that are responsive to mining—and knowledge of how net impacts (losses and gains) differ among supply options, along energy supply chains, and among development trajectories.

Tradeoffs between climate action and other societal goals are inevitable. Failing to recognize and address them will result in suboptimal outcomes and unresolved conflicts between sustainable development goals (7, 13), including conservation. In terms of biodiversity, the impacts of mining could vary by orders of magnitude, depending on the demand for ETMs and how and where they are mined and managed along energy supply chains (Fig. 1). Careful planning now could make a huge difference for global conservation outcomes. In addition to progress on the actions above, society must engage in a broader discussion around which trade-offs are acceptable and who gets to decide when new mines should be approved for their shared climate benefit. Ecologically responsible mining ensures that by addressing one environmental problem, we don't create others.

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