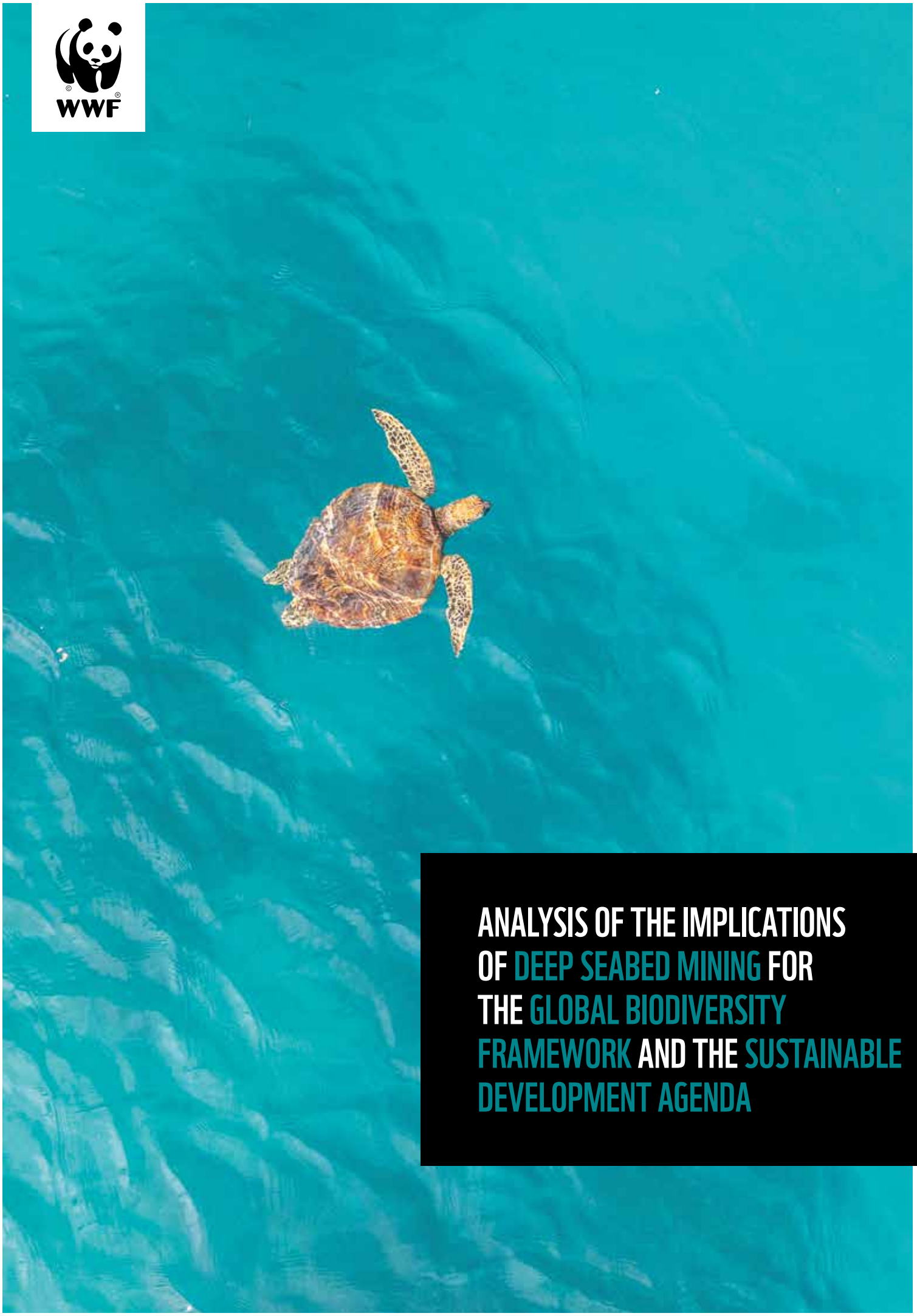

ANALYSIS OF THE IMPLICATIONS OF DEEP SEABED MINING FOR THE GLOBAL BIODIVERSITY FRAMEWORK AND THE SUSTAINABLE DEVELOPMENT AGENDA

World Wide Fund for Nature (WWF)

One of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature by conserving the world's biological diversity, ensuring the sustainable use of renewable natural resources, and promoting the reduction of pollution and wasteful consumption.

Levin Sources

Levin Sources is a B Corporation certified, majority women-led, social venture advisory firm. We have been working since 2010 to realise our Mission to enable governments, companies, investors, and civil society to build sustainable, valuable, and equitable minerals value chains.

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Disclaimer

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EXECUTIVE SUMMARY

The global transition to a low-carbon economy across the energy, digital, and other sectors to meet global climate goals is driving an unprecedented surge in demand for critical minerals. Deep seabed mining (DSM) has emerged as a controversial potential source, raising questions about its economic promise, environmental and socio-economic risks, and alignment with global sustainability goals. This report assesses how DSM could impact on commitments made by Governments to enable sustainable development and the protection of biodiversity in the context of two global frameworks: The Kunming-Montreal Global Biodiversity Framework (GBF) and the 2030 Agenda for Sustainable Development (SDGs). Both frameworks lay out international targets guiding national policies and global efforts toward a more sustainable and equitable world and have already resulted in regional laws, for example in the EU.

Some projections suggest that terrestrial mineral extraction will not meet increasing mineral demands, and concerns over the sector's detrimental environmental and social impacts persist. Thus, proponents promote DSM as a less harmful alternative that could help bridge the resource gap. However, DSM is an untested industry that could cause irreversible damage. The environmental, social, and economic consequences of DSM remain largely unknown, which complicates policy and decision making, and could result in commercial DSM progressing more rapidly than the scientific research needed to assess and regulate the risks effectively.

DSM involves the extraction of minerals from the deep seabed (200 metres or more). The minerals of interest include cobalt, lithium, copper, and nickel, found in three main ore types: seafloor massive sulphides, manganese nodules, and cobalt rich crusts.

Our findings suggest that DSM would have a global impact on several aspects of society, economy and environment. All 4 GBF goals for 2050 and 18 out of the 23 GBF targets for 2030 would be threatened by DSM, as well as 16 out of the 17 SDGs. The destructive methods of DSM would directly impact the seabed, meaning there is a great risk of species loss as many endemic species are found in the deep sea. The indirect impacts may spread throughout the water column, affecting migratory species, carbon sequestration, and ocean acidification. Indigenous communities and small island developing states (SIDS) would be particularly exposed to the impacts that DSM would have on economically important fisheries and tourism industries.

Our conclusions highlight five key findings on the impacts that DSM would have on the realisation of the GBF and SDGs:

1. BIODIVERSITY LOSS

DSM methods of extraction (as currently practiced in exploration) are extremely physically destructive, removing or severely disturbing areas of the deep seafloor which are home to numerous endemic species of ecological significance. Many of these species are highly vulnerable to disturbance due to the low recovery rates in the deep sea. Indeed, it is still unknown how long it would take the deep sea to recover from DSM disturbances, if at all. This habitat destruction and subsequent biodiversity loss would likely have wider impacts on the oceans. These impacts affect GBF targets and SDGs that aim to protect and preserve biodiversity (e.g. GBF targets: 1-4, 7, 9, 11; and SDGs: 14, 15) and enhance nature's contribution to people (e.g. GBF target 9:).

2. DECLINING FISH STOCKS

Pollution and habitat destruction by DSM would tangibly damage fisheries, in turn affecting livelihoods that depend on fisheries for income and economic stability, as well as for food security, such as in Pacific SIDS. These impacts could deepen vulnerabilities to climate change, economic disturbances and intensifed gender disparaties related to climate change. This subsequently affects several GBF targets and SDGs that aim to enhance food security (e.g. GBF targets: 7, 9, 10; and SDG: 2) and reduce poverty (e.g. GBF target: 14 and SDG: 1).

3. EXACERBATED EFFECTS OF CLIMATE CHANGE

With the ocean being the planet's largest carbon sink, DSM is likely to disrupt the ocean's ability to sequester carbon and mitigate against the effects of climate change. This actively undermines the targets and goals aimed at reducing and mitigating against the harmful effects of climate change and ocean acidification (e.g. GBF target: 8; and SDGs: 7, 11, 13, 14).

4. INCREASED DISPARITIES BETWEEN THE GLOBAL NORTH AND GLOBAL SOUTH

Currently, implementation of benefit-sharing regulations remains unclear, putting SIDS in vulnerable financial and legal positions, since they often lack the infrastructure necessary to enforce best practices and manage financial liabilities. Additionally, transparency surrounding governance has already highlighted issues related to accountability and inclusivity. These impacts would likely affect the realisation of goals and targets aimed at reducing poverty and inequalities (e.g. GBF targets: 9, 14, 15, 20, 21; and SDG: 1, 8, 10, 16).

5. CULTURAL INFRINGEMENTS

For many indigenous peoples and other local communities, the ocean holds significant cultural, historic, and spiritual value. By exploiting the ocean's natural resources in a destructive way, DSM threatens the integrity of GBF Targets (e.g. 1, 3, 4, 21, 22) and SDGs (16) that strive to promote inclusive sustainable development and respect the rights of indigenous peoples and local communities.

This report demonstrates the extensive and profound impacts - from irreversible environmental degradation to perpetuating global inequalities - that DSM could have on the GBF's mission to protect biodiversity and the SDGs' vision for global sustainable development, making DSM an unsustainable choice in the green transition.

1. INTRODUCTION

The global transition to a low-carbon economy across the energy, digital, and other sectors to meet global climate goals is driving an unprecedented surge in demand for minerals such as cobalt, lithium, copper, and nickel[1]. The market dynamics of these minerals are shaped by factors including emerging technologies designed to reduce greenhouse gas emissions in the energy sector, such as electric vehicle batteries, wind turbines, and solar panels[2]. While global demand for these critical minerals (minerals that are considered essential for renewable energy technology[3]) rises, deep seabed mining (DSM) has emerged as a potential source. However, there are questions about its economic promise, environmental and socio-economic risks, and alignment with global sustainability goals.

This report assesses how DSM interferes with commitments made by Governments to foster sustainable development and the protection of biodiversity in the context of two global sustainability frameworks: The Kunming-Montreal Global Biodiversity Framework (GBF)[4] and the 2030 Agenda for Sustainable Development (SDGs)[5]. These frameworks set widely adopted international targets guiding national policies and global efforts toward a more sustainable and equitable world. They have also triggered the creation and implementation of regional EU laws, such as the EU Nature Restoration Law[6] and Directive on corporate sustainability due diligence[7].

As projections suggest that terrestrial minerals extraction will not be able to meet some projections of future mineral demand[8], and concerns over the land mining sector's enduring environmental and social impacts persist[9], some companies promote DSM as a less harmful alternative that could help bridge the resource gap[10] [11]. DSM involves the extraction of minerals from the deep seabed, at depths of 200 metres or more[12]. The minerals of interest include cobalt, lithium, copper, and nickel, found in three main ore types: seafloor massive sulphides, manganese nodules, and cobalt rich crusts[13]. The International Seabed Authority (ISA), the regulatory body formed under the United Nations Convention on the Law of the Sea (UNCLOS), has the mandate to "organize and control all mineral resources related activities in the Area [waters outside of national jurisdiction] for the benefit of humankind as a whole", as well as "to ensure the effective protection of the marine environment from harmful effects that may arise from deep seabed related activities"[14]. ISA has thus far awarded 31 exploration contracts around the world, 23 of which are in the Pacific Ocean[15]. These contracts grant exploration rights to various contractors, including Governments and private companies[16].

However, DSM is an untested industry that could cause irreversible ocean damage. Although DSM is still a nascent industry and not yet commercially operational, growing interest — alongside mounting concerns about its potential environmental and socio-economic consequences — makes it increasingly important to assess its full range of impacts. The environmental, social, and economic consequences of DSM remain largely unclear, creating substantial uncertainty for policymakers and stakeholders. This uncertainty complicates policy and decision making and could result in commercial DSM progressing more rapidly than the scientific research needed to assess and regulate their risks effectively.

This report aims to inform decision-makers, researchers, and industry stakeholders, and contribute to a more evidence-based discussion on the future of DSM.

2. KEY TAKEAWAYS

This section introduces a summary of the main findings of the study, presenting the potential ways DSM could infringe on the realisation of each GBF target and SDG. Throughout the report, impacts are referred to as direct or indirect; direct impacts are observable effects on the immediate environment, while indirect impacts are less obvious, with effects that may extend over a wider area.

THE GLOBAL BIODIVERSITY FRAMEWORK

Almost all of the 2030 GBF targets are at risk of being compromised by DSM. In total, 18 out of 23 targets could be negatively impacted (see Figure 1).

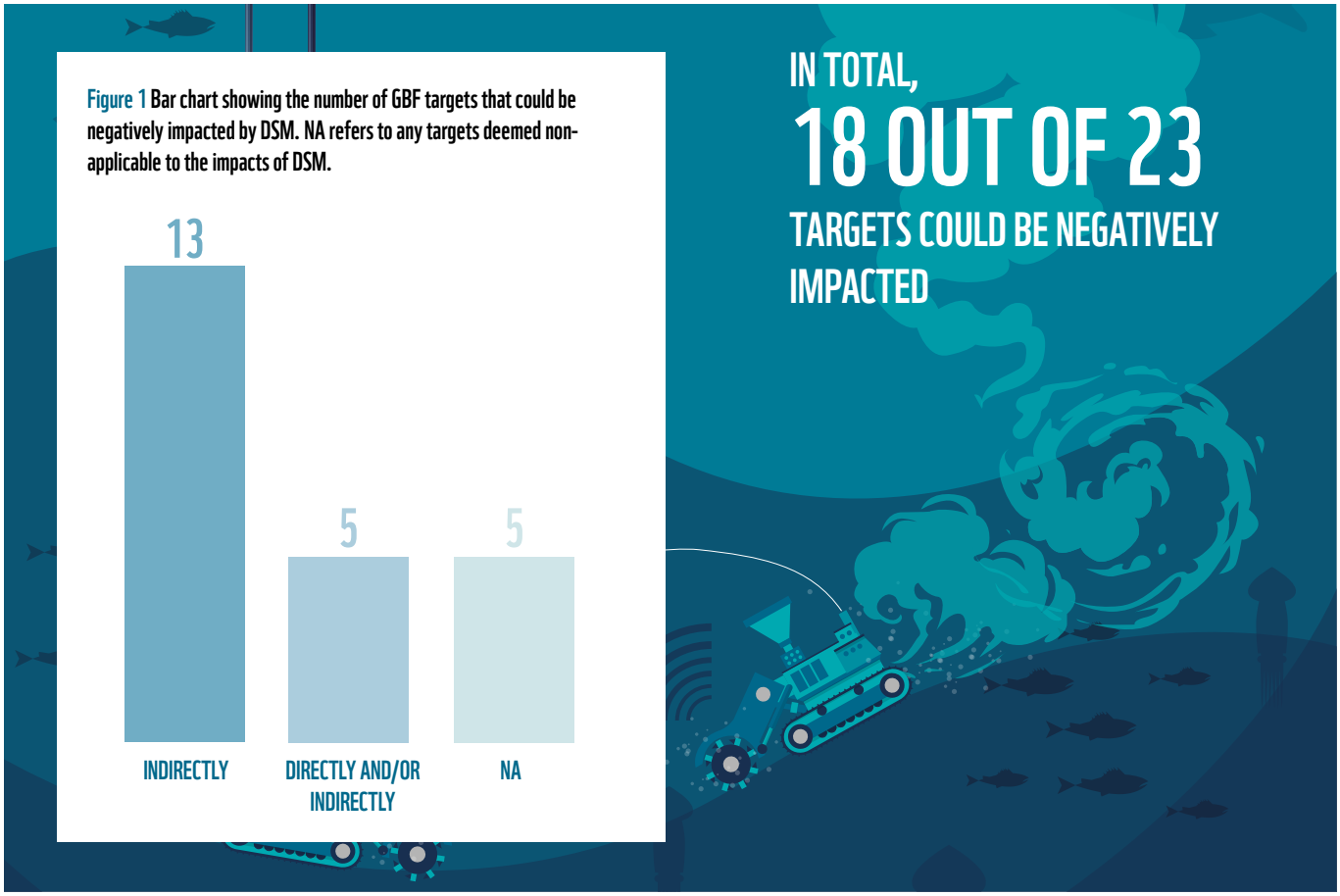


Figure 1 Bar chart showing the number of GBF targets that could be negatively impacted by DSM. NA refers to any targets deemed non-applicable to the impacts of DSM.

Besides the 2030 targets, **the GBF also sets out four goals for 2050, all of which could be negatively impacted by DSM, with two of them directly threatened**. The four goals for 2050 are laid out below, with our response to how they may be negatively impacted by DSM:

Goal A

"The integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050; Human induced extinction of known threatened species is halted, and, by 2050, the extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels; The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential."

DSM poses a risk to this goal by disrupting deep sea ecosystems rather than preserving them. DSM would impact several aspects of the deep sea water column, particularly benthic (sea floor) ecosystems. There is also evidence that suggests DSM exploration activities are already threatening several highly vulnerable deep sea species, many of which are on the IUCN Red List (e.g., scaly foot snails). Migratory species, such as tuna, cetaceans, and sea turtles, who may migrate into DSM exploration areas, are potentially vulnerable to direct and indirect impacts of DSM.

Goal B

"Biodiversity is sustainably used and managed and nature's contributions to people, including ecosystem functions and services, are valued, maintained and enhanced, with those currently in decline being restored, supporting the achievement of sustainable development for the benefit of present and future generations by 2050."

Available information on proposed extraction methods suggests that DSM would extract resources in a manner that does not support biodiversity conservation but instead risks degrading and reducing it.

Goal C

"The monetary and non-monetary benefits from the utilization of genetic resources and digital sequence information on genetic resources, and of traditional knowledge associated with genetic resources, as applicable, are shared fairly and equitably, including, as appropriate with indigenous peoples and local communities, and substantially increased by 2050, while ensuring traditional knowledge associated with genetic resources is appropriately protected, thereby contributing to the conservation and sustainable use of biodiversity, in accordance with internationally agreed access and benefit-sharing instruments."

Pacific communities have a significant spiritual and cultural connection with the ocean. The connection between deep sea biodiversity's genetic resources and traditional knowledge related to these resources remains unclear.

Goal D

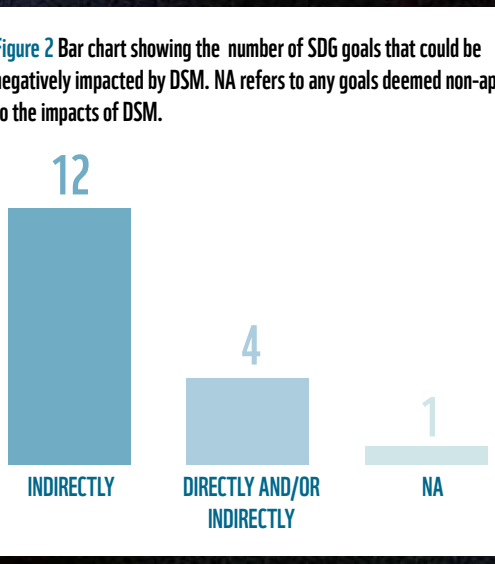
"Adequate means of implementation, including financial resources, capacity-building, technical and scientific cooperation, and access to and transfer of technology to fully implement the Kunming-Montreal Global Biodiversity Framework are secured and equitably accessible to all Parties, especially developing country Parties, in particular the least developed countries and small island developing States, as well as countries with economies in transition, progressively closing the biodiversity finance gap of $700 billion per year, and aligning financial flows with the Kunming-Montreal Global Biodiversity Framework and the 2050 Vision for biodiversity."

Our research suggests that financial gains from DSM are unlikely to be equitably shared with developing states and SIDS. The economic losses DSM may cause in sectors such as fisheries and tourism further risk undermining sustainable development, potentially widening the biodiversity finance gap rather than closing it.

2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Our analysis has shown that DSM could directly and indirectly negatively impact nearly all SDGs. In total, 16 out of the 17 SDGs could potentially be impacted (see Figure 2).

Figure 2 Bar chart showing the number of SDG goals that could be negatively impacted by DSM. NA refers to any goals deemed non-applicable to the impacts of DSM.



IN TOTAL,

16 OUT OF 17

SDGs COULD BE IMPACTED

The SDGs potentially affected by DSM span multiple themes and go beyond exclusively impacting the natural environment.

The 2024 United Nations SDG Annual Progress Report is a stark reminder of how far the global community has yet to go in meeting the SDGs. The report depicts how less than 20% of the SDGs are on track to be met by 2030, while progress of over a third of all SDGs has slowed or regressed since the SDG Agenda's adoption[17]. Initiating commercial DSM could potentially further delay achieving the SDGs.

The following commitments made by the 2030 Agenda for Sustainable Development, People, Planet, Prosperity, Peace, and Partnership, represent the overarching commitments of the SDGs. Below is our response to how DSM could impact each commitment:

People

"We are determined to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality and in a healthy environment."

DSM threatens the health of commercial and small-scale artisanal fish stocks, which in turn threatens to undermine this commitment to end hunger while maintaining a healthy natural environment.

Planet

"We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations."

DSM threatens humanity's ability to protect the planet from degradation. Proposed methods of conducting DSM (such as nodule extraction and removal of cobalt rich crusts[18]) would mean that finite natural resources are not sustainably managed, but rather unsustainably exploited. It could work against urgent action on climate change by disrupting the carbon cycle in the ocean and disturbing significant amounts of carbon stored in the sediment. DSM would threaten the needs of future generations by causing irreparable environmental degradation now. If energy is produced through sourcing mineral resources from the deep seabed, it would not meet the standard of sustainable production.

Prosperity

"We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature."

While DSM proponents highlight its potential for economic and technological progress, its environmental risks — such as threats to biodiversity, ecosystem services, and climate stability —raise concerns about whether this progress could truly be achieved in harmony with nature, and whether any prosperity gains would be maintained in the medium or long term.

Peace

"We are determined to foster peaceful, just and inclusive societies which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development."

The prospect of DSM is already creating divisions where communities, Governments, and stakeholders are divided over its potential benefits and risks, particularly within Small Island Developing States (SIDS) as well as between SIDS and external actors, posing risks to peaceful and inclusive development. Additionally, some DSM companies are framing access to deep sea minerals as meeting the additional demand for military applications, further complicating the link between sustainable development and peace.

Partnership

"We are determined to mobilize the means required to implement this Agenda through a revitalized Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people."

The potential of DSM to drive economic inequities, the exclusion of key stakeholders, and the damage to fragile marine ecosystems threaten to undermine the spirit of global solidarity and the commitment to the shared goals under the UN SDGs.

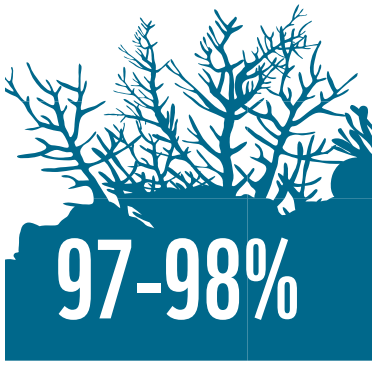
The SDGs and the GBF are interconnected frameworks that not only reinforce each other, but also align with several other international frameworks guiding responsible business conduct. Given these interconnections, failing to uphold SDG and GBF commitments would not only undermine these two frameworks but also conflict with a wider set of global principles governing sustainability, human rights, and corporate responsibility.

The GBF goals and targets are contributing to the realisation of the 2030 Agenda for Sustainable Development, just as the SDGs play a crucial role in achieving GBF objectives. Beyond their mutual reinforcement, the SDGs and GBF are also embedded within a broader network of internationally recognised voluntary and legal frameworks. These include the Universal Declaration of Human Rights[19], the United Nations Guiding Principles on Business and Human Rights (UNGPs)[20], the Paris Agreement[21], Voluntary Sustainability Initiatives[22], and the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)[23].

Limited knowledge and misconceptions about deep sea ecosystems and DSM methods and operational practices create risks of both underestimating and overestimating its impacts.

The deep sea remains vastly unexplored – an estimated 97-98% of the seafloor has never been explored by humanity[24]. A recent study highlights how this lack of understanding of deep sea dynamics, ecological sensitivity, and biodiversity has already led to miscalculations of DSM's potential impacts[25].

However, it is certain that DSM will have negative environmental impacts, both direct and indirect. These would extend beyond mining activities themselves, as well as beyond the marine environment, to include the transporting of machinery, raw materials, fuel and personnel, as well as the processing of extracted raw minerals. However, the full scale and severity of the impacts remains unknown. To reflect the early-stage nature of DSM and the uncertainties surrounding its consequences, this study refers to impacts as "potential".



OF THE SEAFLOOR HAS NEVER BEEN EXPLORED BY HUMANITY

3. GLOBAL BIODIVERSITY FRAMEWORK TARGETS

Table 1 presents how the GBF targets are at risk of being directly or indirectly undermined by DSM. GBF targets 5, 6, 12, 13, and 17[26] were omitted from this analysis as they were deemed non-applicable to the impacts of DSM.

Table 1 Summary of the GBF targets that are at risk of being indirectly (■) or both directly and/or indirectly (■) impacted by DSM.

The Global Biodiversity Framework targets	Impacts of DSM on GBF goals and targets
TARGET 1 Ensure that all areas are under participatory, integrated and biodiversity inclusive spatial planning and/or effective management processes addressing land- and sea-use change, to bring the loss of areas of high biodiversity importance, including ecosystems of high ecological integrity, close to zero by 2030, while respecting the rights of indigenous peoples and local communities.	DSM would cause severe and direct destruction of benthic (seafloor) habitats, with long lasting effects on deep sea communities that recover extremely slowly; studies show that even small-scale disturbances have long-lasting negative impacts on community biomass (abundance of organisms by mass), structure and composition. Many species found in the deep sea are endemic (i.e., not found anywhere else in the world), therefore without careful spatial planning and management, DSM risks endangering them. In 2019, the scaly foot snail became the first hydrothermal vent endemic species to be added to the IUCN Red List of species as endangered, due to the future threat of DSM . There are currently 256 deep sea organisms listed on the IUCN Red List as vulnerable, endangered, or critically endangered. Additionally, DSM would introduce several pollutants. For instance, copper, which would leach into the water column from mine waste, is highly toxic to marine organisms and its effects can be fatal. DSM operation would generate continuous noise and light pollution, which would interfere with phenomena key to survival, such as migration, communication, and hunting. Although proponents argue that DSM could reduce terrestrial mining, the evidence is limited, and the two are likely to operate in parallel. Estimates show that the deep sea is likely as biodiverse as rainforests, making this ecosystem an area of high biodiversity importance. As sea-uses change and DSM is seriously considered, the rights of indigenous peoples must also be considered. For many indigenous communities, the oceans hold significant cultural, spiritual and historical value, for example in Pacific Island cultures. Participatory and integrative spatial planning of DSM must consider the rights of indigenous peoples, as well as preserving areas of high biodiversity.
TARGET 2 Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.	Currently, the deep sea and the deep seabed are considered largely untouched and pristine environments. Therefore, DSM would actively contribute to degrading an untouched ecosystem, rather than preserving it.

The Global Biodiversity Framework targets	Impacts of DSM on GBF goals and targets
TARGET 3 Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.	DSM threatens to directly undermine Target 3 by severely damaging marine ecosystems, in particular benthic habitats. The unique environment of the deep sea, with its extreme high pressure and low temperature and complete darkness, has led to the evolution of many endemic species that would recover extremely slowly if disturbed, with even small-scale disturbances lasting decades. Their destruction would disrupt deep sea integrity, connectivity and specific ecosystem functions and services. Moreover, the deep sea is inextricably linked to the entire ocean and water column, therefore DSM impacts, for instance toxic heavy metal, noise, and light pollution, would have a cascade of effects on wider marine ecology. DSM risks creating long-lasting, potentially irreversible, environmental degradation, directly undermining Target 3. As mentioned in Target 1, the rights of Indigenous peoples and local communities must be considered as part of sustainable sea-use, ensuring traditional territories and cultural heritage is preserved from industrial activities such as DSM. An example of where this target may have already been infringed, is in the Cook Islands, where the main harbour on the main island, Rarotonga has been artificially widened and deepened to accommodate DSM vessels.
TARGET 4 Ensure urgent management actions to halt human induced extinction of known threatened species and for the recovery and conservation of species, in particular threatened species, to significantly reduce extinction risk, as well as to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and effectively manage human-wildlife interactions to minimize human-wildlife conflict for coexistence.	Despite only 2-3% of the deep sea having been discovered (as of 2014), several deep sea species are already on the IUCN Red List of endangered species. This indicates that human industrial activity, such as DSM, could push many more species to extinction before they are even discovered. The loss of these species would not only reduce biodiversity but would erode the genetic diversity critical for their adaptive potential. Thus, DSM would directly impact Target 4.
TARGET 7 Reduce pollution risks and the negative impact of pollution from all sources by 2030, to levels that are not harmful to biodiversity and ecosystem functions and services, considering cumulative effects, including: (a) by reducing excess nutrients lost to the environment by at least half, including through more efficient nutrient cycling and use; (b) by reducing the overall risk from pesticides and highly hazardous chemicals by at least half, including through integrated pest management, based on science, taking into account food security and livelihoods; and (c) by preventing, reducing, and working toward eliminating plastic pollution.	As discussed in Target 1, DSM would contribute high levels of pollution to the marine environment. Mining operations release toxic heavy metals into the water, such as copper, cobalt, cadmium, manganese, nickel and lead, at concentrations up to 15 times higher than the surrounding sea water. DSM requires a lot of heavy infrastructure, which increases the risk of oil spillages and other types of pollution associated with large vessels and increased marine traffic (e.g., noise, light, microplastic, and heavy metal pollution from paint). Additionally, DSM would introduce several pollutants. For instance, copper, which would leach into the water column from mine waste, is highly toxic to marine organisms and its effects can be fatal. DSM operations would generate continuous noise and light pollution, which would interfere with phenomena key to survival, such as migration, communication, and hunting.The cumulative impacts of DSM pollution would undermine Target 7's goal of reducing pollution to levels not harmful to biodiversity.
TARGET 8 Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solutions and/or ecosystem-based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity.	Although proponents argue that DSM presents a solution to meet increased demand for critical minerals and support decarbonisation, the process itself would generate significant GHG emissions. One study suggests that manganese nodule mining could produce between 82,600 and 480,000 tonnes of CO_2 annually, with additional emissions from shipping and mineral processing. Moreover, DSM threatens the ocean's role as a major carbon sink, which stores 25% of carbon emissions. Deep sea sediments sequester carbon for millions of years if left undisturbed. However, DSM vehicles are estimated to disturb approximately 172.5 tons of carbon per km^2 mined, per year, exceeding the natural sequestration rate of about 14 kg per km^2 in the Clarion-Clipperton Zone. To put this into perspective, ISA currently has 31 exploration contracts covering an area of the deep seabed of approximately 1.5 million km^2. DSM thus undermines Target 8 by contributing to climate change rather than minimising it.

The Global Biodiversity Framework targets	Impacts of DSM on GBF goals and targets
TARGET 9 Ensure that the management and use of wild species are sustainable, thereby providing social, economic and environmental benefits for people, especially those in vulnerable situations and those most dependent on biodiversity, including through sustainable biodiversity-based activities, products and services that enhance biodiversity, and protecting and encouraging customary sustainable use by indigenous peoples and local communities.	DSM poses significant risks to the sustainable management of wild species. It threatens small-scale and artisanal fisheries, crucial for Pacific SIDS, where fish account for up to 70% of exports and are vital for food security, as heavy metal contamination may damage economically vital tuna stocks. Tuna fisheries in Pacific SIDS account for approximately 84% of GDP and are therefore heavily reliant on marine biodiversity. Meanwhile, deep sea ecosystems are a promising source of medical innovations , but face degradation from DSM through toxic sediment plumes and habitat destruction, threatening the potential of deep sea biodiversity-based products and services. Pacific SIDS, already vulnerable to climate change with limited adaptation finance, risk further economic and environmental strain if DSM were to become operational. This threatens Target 9's goal of providing economic and environmental benefits for all.
TARGET 10 Ensure that areas under agriculture, aquaculture, fisheries and forestry are managed sustainably, in particular through the sustainable use of biodiversity, including through a substantial increase of the application of biodiversity friendly practices, such as sustainable intensification, agroecological and other innovative approaches, contributing to the resilience and long-term efficiency and productivity of these production systems, and to food security, conserving and restoring biodiversity and maintaining nature's contributions to people, including ecosystem functions and services.	DSM threatens sustainable management of fisheries and thereby food security, particularly in SIDS, by causing damage to marine ecosystems. Small-scale fisheries in Pacific SIDS provide essential nutrition and food security. Additionally, deep sea biodiversity, a valuable resource for medical innovations, faces destruction through pollution and habitat loss from DSM.
TARGET 11 Restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, such as the regulation of air, water and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.	DSM threatens to undermine nature's contributions to people by degrading marine resources that provide essential services. The risks of heavy metal contamination on marine organisms raises concerns about potential health impacts on communities that rely on these fish for consumption, which in the Pacific in particular is notably high. Beyond fisheries, DSM threatens deep sea organisms that have potential medical applications through environmental degradation, habitat destruction, and biodiversity loss. Moreover, toxic sediment plumes and mine waste can disrupt vital biological processes (e.g. photosynthesis), impair desalination processes, and reduce the ocean's capacity as a carbon sink, threatening the ocean's ability to mitigate the impacts of climate change.
TARGET 14 Ensure the full integration of biodiversity and its multiple values into policies, regulations, planning and development processes, poverty eradication strategies, strategic environmental assessments, environmental impact assessments and, as appropriate, national accounting, within and across all levels of government and across all sectors, in particular those with significant impacts on biodiversity, progressively aligning all relevant public and private activities, and fiscal and financial flows with the goals and targets of this framework.	Thus far, DSM has not shown enough evidence of being an honest and transparent industry that aims to completely integrate biodiversity and its multiple values into policies, regulations, planning and development (etc.). Currently there are no legal mechanisms in place for equitable benefit sharing, which appears to show that biodiversity and its multiple values are not being fully integrated. Furthermore, DSM's viability appears to be overstated, contributing only marginally to global mineral supply while having severe ecological impacts. Finally, waste management remains unclear, with potential for severe environmental harm.
TARGET 15 Take legal, administrative or policy measures to encourage and enable business, and in particular to ensure that large and transnational companies and financial institutions … in order to progressively reduce negative impacts on biodiversity, increase positive impacts, reduce biodiversity-related risks to business and financial institutions, and promote actions to ensure sustainable patterns of production.	Currently, DSM lacks the policy and frameworks to keep large corporations and financial institutions accountable. Since ISA currently has no mechanisms in place to regulate equitable profit sharing, and evidence has shown that only a few large corporations would significantly profit from the industry, while exposing SIDS to environmental and financial risks.

The Global Biodiversity Framework targets	Impacts of DSM on GBF goals and targets
TARGET 16 Ensure that people are encouraged and enabled to make sustainable consumption choices, including by establishing supportive policy, legislative or regulatory frameworks, improving education and access to relevant and accurate information and alternatives, and by 2030, reduce the global footprint of consumption in an equitable manner, including through halving global food waste, significantly reducing overconsumption and substantially reducing waste generation, in order for all people to live well in harmony with Mother Earth.	DSM could encourage over-consumption of finite resources, rather than promoting and investing in alternative, more sustainable energy choices for consumers. Rather than reducing waste and overconsumption, DSM would promote increased mineral extraction with unclear waste management systems in place.
TARGET 18 Identify by 2025, and eliminate, phase out or reform incentives, including subsidies, harmful for biodiversity, in a proportionate, just, fair, effective and equitable way, while substantially and progressively reducing them by at least $500 billion per year by 2030, starting with the most harmful incentives, and scale up positive incentives for the conservation and sustainable use of biodiversity.	DSM poses a risk of creating harmful incentives. In many sectors, government subsidies continue to promote unsustainable practices that damage biodiversity. As of 2024, it is estimated that approximately USD 2.4tr in subsidies are actively contributing to environmental destruction. Commercial DSM presents an additional avenue through which environmentally harmful subsidies could flow. The lack of stringent international regulation in DSM means that potentially harmful subsidies may undermine efforts to protect marine ecosystems.
TARGET 19 Substantially and progressively increase the level of financial resources from all sources, in an effective, timely and easily accessible manner, including domestic, international, public and private resources, in accordance with Article 20 of the Convention, to implement national biodiversity strategies and action plans, mobilizing at least $200 billion per year by 2030, including by (...)	Increasing financial resources for biodiversity protection is key to Target 19. DSM activity could divert essential funds that could otherwise be used to sustainably conserve and manage biodiversity. This is linked to Target 18, and to SDG 1, 8, 9, 10.
TARGET 20 Strengthen capacity-building and development, access to and transfer of technology, and promote development of and access to innovation and technical and scientific cooperation, including through South-South, North-South and triangular cooperation, to meet the needs for effective implementation, particularly in developing countries, fostering joint technology development and joint scientific research programmes for the conservation and sustainable use of biodiversity and strengthening scientific research and monitoring capacities, commensurate with the ambition of the goals and targets of the Framework.	DSM would likely primarily benefit multinational corporations from the Global North, leaving local capacity underdeveloped. With DSM projected to supply only about 8% of global cobalt by 2050, questions arise over its profitability and viability. Pacific SIDS—already vulnerable to climate change and constrained by limited legal and institutional frameworks—face heightened risks managing DSM's environmental and economic impacts, as illustrated when Papua New Guinea, was left with a debt of USD 125 million after Canadian mining company Nautilus went bankrupt, having been the first recipient of a DSM exploration licence. Without robust joint scientific research, technology transfer, and capacity-building initiatives, DSM is likely to widen disparities between the Global North and South, hindering the implementation of sustainable, biodiversity-friendly practices.
TARGET 21 Ensure that the best available data, information and knowledge are accessible to decision makers, practitioners and the public to guide effective and equitable governance, integrated and participatory management of biodiversity, and to strengthen communication, awareness-raising, education, monitoring, research and knowledge management and, also in this context, traditional knowledge, innovations, practices and technologies of indigenous peoples and local communities should only be accessed with their free, prior and informed consent, in accordance with national legislation.	Thus far, DSM fails to provide transparent, accessible and integrated data for effective governance. Critical insights from Indigenous peoples and local communities must be considered, and it is unclear whether ISA has yet specifically considered indigenous and cultural rights.
TARGET 22 Ensure the full, equitable, inclusive, effective and gender-responsive representation and participation in decision-making, and access to justice and information related to biodiversity by indigenous peoples and local communities, respecting their cultures and their rights over lands, territories, resources, and traditional knowledge, as well as by women and girls, children and youth, and persons with disabilities and ensure the full protection of environmental human rights defenders.	Diverse perspectives are essential for inclusive, equitable and effective policy and decision making. With many DSM companies being large corporations from the Global North, DSM as an industry risks perpetuating disparities. The values and culture of indigenous peoples and local communities must be recognised in DSM policy and decision making. For many of these groups, the oceans hold significant cultural, spiritual and historic value. For example, parts of the Atlantic Ocean are considered memorials for those who died, and indeed survived, during the transatlantic slave trade. UNCLOS mandates that State Parties are obligated to protect historically significant objects. However, with ISA yet to acknowledge this significance, DSM risks undermining Target 22 by not practicing fully inclusive representation and participation in decision making.

The Global Biodiversity Framework targets	Impacts of DSM on GBF goals and targets
TARGET 23 Ensure gender equality in the implementation of the Framework through a gender-responsive approach, where all women and girls have equal opportunity and capacity to contribute to the three objectives of the Convention, including by recognizing their equal rights and access to land and natural resources and their full, equitable, meaningful and informed participation and leadership at all levels of action, engagement, policy and decision-making related to biodiversity.	DSM risks replicating gender inequalities that persist in terrestrial mining. Within ISA, women held only 10% of positions in the Legal and Technical Commission (LTC), between 2017 and 2022, limiting diverse perspectives in DSM governance. Addressing these imbalances is essential to ensure that women and girls have equal access to policy and decision making related to biodiversity.

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4. SUSTAINABLE DEVELOPMENT GOALS

Table 2 presents how the SDGs are at risk of being directly or indirectly undermined by DSM. SDG 4[27] was omitted from this analysis as it was deemed non-applicable to the impacts of DSM.

Table 2 Summary of SDGs that may be indirectly (■) or both directly and indirectly (■) impacted by DSM.

SDGs	Impacts of DSM on the goals
 **GOAL 1.** End poverty in all its forms everywhere	ISA is required to equitably share profits made by DSM in the Area. However, no legal mechanisms are currently in place that enforce this requirement. As seen in the terrestrial mining sector, DSM is likely to benefit a small number of large corporations, while the mechanisms for equitable benefit-sharing remain unclear. This Goal is linked to Goals 10 and 16.
 **GOAL 2.** End hunger, achieve food security and improved nutrition and promote sustainable agriculture Particularly impacted: sub-goal 2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	DSM poses economic, ecological, and social threats to the fishing industry. As of yet, the scale on which DSM would operate remains unclear, therefore whether DSM would heavily impact large-scale fisheries is unknown. The majority of SIDS close to (or within) current exploration contracts rely on fishing. Fish products account for approximately 70% of the exports of SIDS. In Pacific SIDS in particular, fish make up a significant proportion of diets and are essential to food security. The industry supports many livelihoods, creating permanent employment. However, there are legitimate concerns about the potential impacts of DSM on fisheries in these SIDS, particularly regarding heavy metal contamination of economically vital tuna stocks. Tuna fisheries in Pacific SIDS account for approximately 84% of GDP, making this a critical issue. In Goal 14, we discuss the risks that heavy metal contamination pose to marine organisms. This not only threatens fisheries and food security but also raises concerns about potential health impacts on communities that rely on these fish for consumption. The cumulative effects of climate change (ocean warming and acidification), plus the potential impacts that DSM may have on these fish stocks threatens to severely undermine Goal 2.
 **GOAL 3.** Ensure healthy lives and promote well-being for all at all ages Particularly impacted: sub-goal 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	In recent years, the deep sea has been a valuable source of medical innovation. Deep sea organisms such as sponges, tunicates (sea squirts), and microbes either have already, or have great potential to, contribute to advancements in cancer treatments, painkillers, and even COVID-19 testing. However, DSM poses risks to these vital resources through environmental degradation, habitat destruction, and biodiversity loss, potentially undermining progress toward Goal 3. Sub-goal 3.9 is particularly relevant due to the risks posed by toxic sediment plumes and mine waste in the ocean. As of yet, the management of DSM waste remains unclear, raising concerns about its effects on marine ecosystems. From harming fish stocks, to disrupting light penetration and vital processes such as photosynthesis, such damage to marine ecosystems would also directly impact human health. As the ocean is the world's largest carbon sink (discussed in more detail in Goal 13), DSM could threaten the ocean's ability to mitigate the impacts of climate change, indirectly infringing on this goal.
 **GOAL 5.** Achieve gender equality and empower all women and girls	Gender inequalities persist in terrestrial mining settings, and without proactive measures, DSM risks replicating these disparities. For DSM to contribute meaningfully to gender equality, women must be actively engaged in all levels of DSM from marine science and research, to mineral extraction and processing. However, current governance structures in ISA reflect slow progress towards this goal. Between 2017 and 2022, women held only 10% of positions in the Legal and Technical Commission (LTC), a key ISA body. The underrepresentation of women in decision-making roles not only limits diverse perspectives in DSM governance but also undermines progress toward Goal 5. Addressing these imbalances is essential to ensuring that DSM does not reinforce existing gender disparities in the mining sector. Additionally, the negative impacts of declining ocean health—such as threats to fisheries and coastal livelihoods—often disproportionately affect women and girls, who are more likely to rely on marine resources for subsistence, income, and community well-being. More generally, declining ocean health will likely exacerbate climate change (see SDG 13), which is well known to disproportionately affect women globally. Subsequently, women could potentially be indirectly and disproportionately impacted by the climatic effects of DSM.

SDGs	Impacts of DSM on the goals
 **GOAL 6.** Ensure availability and sustainable management of water and sanitation for all	Little is known about the extent to which DSM pollutants could hamper the efforts of desalination in certain regions. Desalination plants are designed to treat uncontaminated seawater and are vulnerable to changes in the quality of seawater. It is well-documented that oil spills pose significant risks to these facilities, and DSM operations could indirectly contribute to such spills through the transportation of heavy machinery, fuel, and surface vessel activities (see Goal 14).
 **GOAL 7.** Ensure access to affordable, reliable, sustainable and modern energy for all Particularly impacted: sub-goal 7.1:By 2030, ensure universal access to affordable, reliable and modern energy services Particularly impacted: sub-goal 7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	DSM is often promoted as essential for meeting mineral demands required to drive the transitions to renewable energy systems and achieve global climate goals. However, extracting minerals from an undisturbed environment is neither a sustainable nor a reliable solution, particularly when significant mineral resources are already in circulation. Greater investment in recycling infrastructure would provide a more sustainable pathway toward a circular economy (see Goal 9). Integrating DSM-extracted minerals into renewable energy supply chains risks undermining efforts to promote truly sustainable energy infrastructure and investment in clean energy technology (sub-goal 7.a). DSM could infringe on this goal if minerals extracted from the deep seabed were used in the production of renewable energy technologies, such as wind turbines. While energy is considered 'clean' when little to no greenhouse gases are emitted during operation, the manufacturing process of these technologies often involves significant emissions, known as 'embedded emissions'. Additionally, given the high costs associated with both DSM extraction and the subsequent manufacturing processes across the value chain, the affordability of these technologies for SIDS and low-income countries is concerning, potentially limiting equitable access to sustainable energy solutions (sub-goal 7.1).
 **GOAL 8.** Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all Particularly impacted: sub-goal 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead	DSM is estimated to contribute to only a fraction of the predicted global demand for metals . For example, it is estimated that DSM would contribute only 8% of global cobalt production by 2050. This raises questions about the profitability of DSM, which is often overstated by industry proponents. In addition, the environmental cost of DSM could be vast, directly conflicting with Goal 8.4. Proponents of DSM argue that it could create job opportunities, particularly for SIDS. However, DSM is unlikely to contribute significantly or positively to the GDPs of SIDS through the creation of sustainable local employment. Most DSM workers are employed by offshore mining companies, with accommodation and infrastructure built specifically for the workforce, for example in the Cook Islands, where exploration is currently active. The expansion of mining-related infrastructure, as well as potential environmental degradation caused by DSM, could make the area less attractive to tourists, posing a threat to the local tourism industry, on which the Cook Islands greatly depends (it accounts for approximately 70% of the country's GDP).
 **GOAL 9.** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Advancing DSM risks diverting essential investments away from critical recycling infrastructure to ultimately promote a more circular economy. Some proponents argue that increased recycling efforts would not suffice to meet the growing demand for critical minerals. However, currently, less than 20% of e-waste is recycled. Prioritising investment in recycling and circular economy solutions could reduce the need for DSM while minimising environmental harm, aligning more closely with sustainable resource management and long-term economic resilience.

SDGs	Impacts of DSM on the goals
 **GOAL 10.** Reduce inequality within and among countries	DSM risks exacerbating inequalities between the Global South and the Global North. While benefit-sharing mechanisms could reduce these disparities, their implementation and how they would work remains unclear, as discussed in Goal 1. Currently, no clear regulations exist on how this will be enforced. Pacific SIDS, in particular, face disproportionate challenges that DSM could further intensify. These states are already highly vulnerable to climate change, yet they receive inadequate climate finance to support adaptation and protect their fragile island ecosystems . The additional burden of DSM — without sufficient resources for mitigation — risks compounding existing economic and environmental inequalities. Moreover, the long-term cost of rehabilitating deep sea ecosystems post-mining is unknown, raising concerns about whether recovery is even possible. If DSM proceeds without adequate safeguards, it could impose an additional layer of inequity on Pacific SIDS, which already struggle with unfair trade terms, economic constraints, and the cumulative impacts of multiple external pressures. Beyond economic inequalities, power asymmetries and legal imbalances can further exacerbate disparities. Under current regulations, legal liability for DSM activities falls on the sponsoring state of the mining contractor — often a lower-income country or SIDS. The role of a state sponsor is to ensure that the mining contractor complies with the sponsoring state's legal system when operating in the Area and thus helps to protect it . However, these states often face challenges in enforcing best practices and managing financial liabilities due to limited legal and institutional capacity. A notable case study demonstrates the infringement of DSM on the realisation of Goal 10: in 2019, Canadian mining company Nautilus became the first recipient of a DSM exploration licence in the Bismarck Sea, Papua New Guinea (PNG). However, Nautilus went bankrupt before extraction commenced. PNG, once a firm supporter of DSM, had invested significantly in this project and was now left with a debt of USD 125 million — the equivalent of almost one-third of the country's annual healthcare budget.
 **GOAL 11.** Make cities and human settlements inclusive, safe, resilient and sustainable Particularly impacted: sub-goal 11 7b: 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels	Any city that incorporates DSM-sourced material into its infrastructure cannot be considered sustainable under this SDG, given the unsustainable nature of DSM and its infringements on other SDGs. Goal 11.b, which focuses on strengthening climate resilience and adaptation, may be undermined. To credibly claim progress toward mitigating and adapting to climate change, cities and human settlements must prioritise sustainable resource use. Relying on DSM-sourced materials contradicts this objective, as DSM poses significant environmental and socio-economic risks that are inconsistent with long-term sustainability goals.
 **GOAL 12.** Ensure sustainable consumption and production patterns Particularly impacted: sub-goal 12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	Increased mineral extraction, whether terrestrially or through DSM, undermines sustainable consumption and production patterns, as well as slows down the global transition to a more circular economy. Sub-goal 12.4 may be particularly undermined by DSM. Firstly, it is unclear how DSM waste would be managed, however, the impacts of sediment plumes, mine tailing and dewatering ore waste could be severe (see Goal 2, 3 and 14). Secondly, there is the need to manage all wastes throughout their life cycles more effectively, including in order to reduce the need for additional extraction through DSM (see Goal 9).

SDGs	Impacts of DSM on the goals
 **GOAL 13.** Take urgent action to combat climate change and its impacts	Although proponents argue that DSM presents a solution to meet increased demand of critical minerals, to thereby support the decarbonisation of the energy sector and achieve global climate goals, DSM methods and the energy needed to run DSM machinery could generate significant GHG emissions and other pollutants that contribute to global warming. One study suggests that manganese nodule mining could potentially produce between 82,600 and 480,000 tonnes of CO_2 annually. Indirectly, DSM could generate GHG emissions through the shipping process of vessels connecting mining operations with downstream processing facilities, as well as through the mineral processing in itself. Moreover, DSM poses risks to the planet's largest carbon sink, the ocean, which stores 25% of carbon emissions. Deep sea sediments are crucial in carbon sequestration, locking away carbon for millions of years if left undisturbed. DSM vehicles are estimated to disturb approximately 172.5 tons of carbon per km² mined, per year. To put this into perspective, ISA currently has 31 exploration contracts covering an area of the deep seabed of approximately 1.5 million km². However, carbon sequestration is slow, storing approximately only 14kg of carbon per km² per year (specifically in areas currently under contract in the Clarion-Clipperton Zone), emphasising the vulnerability of the deep sea. Therefore, if DSM proceeds on a large scale, it could significantly compromise the ocean's ability to act as a carbon sink, further accelerating climate change rather than mitigating it.
 **GOAL 14.** Conserve and sustainably use the oceans, seas and marine resources for sustainable development Particularly impacted: sub-goal 14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans Particularly impacted: sub-goal 14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels Particularly impacted: sub-goal 14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information Particularly impacted: sub-goal 14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism Particularly impacted: sub-goal 14.b Provide access for small-scale artisanal fishers to marine resources and markets Particularly impacted: sub-goal 14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"	DSM would severely destroy the benthic (seafloor) habitats and result in biodiversity loss. Many of the organisms that live in the deep sea have evolved specifically to function in such a unique habitat, where there is no light, extreme pressure, and extremely low temperatures. Because of this, life in the deep sea is vulnerable to disturbance as regeneration rates are particularly slow. Studies show that even small scale disturbances have long-lasting (several decades), negative impacts on community biomass (abundance of organisms by mass), structure and composition. Many species in the deep sea are endemic (i.e., not found anywhere else in the world), therefore without careful management, DSM risks endangering them. In 2019, the scaly foot snail became the first hydrothermal vent endemic species to be added to the IUCN Red List of species as endangered, due to the future threat of DSM . There are currently 256 deep sea organisms listed on the IUCN Red List as vulnerable, endangered, or critically endangered. The methods of DSM extraction involve the removal and destruction of nodules, crusts or vents, which removes and destroys habitats for numerous species, altering the ecosystem and leading to habitat and biodiversity loss . This is in direct conflict with the goals of SDG 14. Mining manganese nodules releases toxic heavy metals into the water, such as copper, cobalt, cadmium, manganese, nickel and lead. Research suggests that traces of toxic metals released into the water column from dewatered mining waste discharge can be up to approx. 15 times higher than the surrounding seawater. The effects this may have on mesopelagic organisms is yet unknown. However, copper is one of the most toxic metals for marine organisms, leading to reduced physiological function, cell damage and death. Increasing ocean acidification can also exacerbate the harmful effects of copper bioaccumulation in organisms. This concern is linked to Goals 2 and 3, with regards to promoting healthy lives and the fishing industry. There are also concerns related to the infrastructure needed for DSM. With increased infrastructure (i.e., ships and DSM equipment) operating in the oceans, and in some pristine/ untouched environments, there are increased risks of oil spillages and other types of pollution associated with large vessels and increased marine traffic (e.g., noise, light, microplastic, and heavy metal pollution from paint). It is expected that DSM activities and infrastructure would be active 24 hours a day, generating continuous and severely disruptive pollution to marine organisms. Sound travels almost 4 times faster and further in water than air due to the greater density of particles. For organisms that rely on sound for communication or for hunting, the impacts can be detrimental; abundant evidence shows the severe impacts noise pollution has on marine organisms. The light pollution generated by DSM equipment in an environment where organisms have evolved to function in complete darkness and have reduced visual capacity has, at this stage, unknown impacts on the organisms. It would likely cause reduced hunting ability and cause harmful stress, which could be fatal. Surface light pollution from lighting equipment on vessels could disturb light sensitive organisms that rely on natural light cues for phenomena such as diurnal (daily) migration patterns, navigation, synchronised behaviours, and hunting. The potentially harmful effects of DSM on migratory species are recognised in the United Nations Environment Programme (UNEP) Convention on Migratory Species (CMS) Resolution, calling on member Parties and Governments to consider migratory species in DSM decision making. DSM activities may likely undermine this goal and instead of minimising the impacts of ocean acidification, contribute to it. When seafloor massive sulphides are mined, this usually leaves metals exposed to the water and to oxidation, which can leach dissolved sulphide and sulphide particles. The sediment plumes that are released contain these toxic compounds, with the addition of other toxic metals such as copper and arsenic. DSM could contribute to (localised) ocean acidification with the release of toxic plumes.

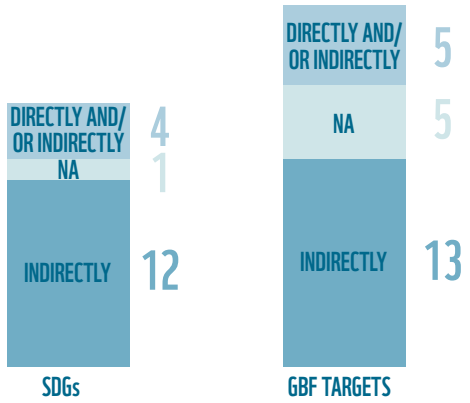
SDGs	Impacts of DSM on the goals
 **GOAL 15.** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	DSM proponents argue that mining the deep sea could shift activity away from terrestrial mining, allow land to recover, and reduce the harmful environmental and climatic effects of terrestrial mining overall. However, there is no evidence to support this claim. In fact, it appears much more likely that DSM would operate in conjunction with terrestrial mining, adding to the total footprint of mining. In addition, some claim that DSM would be less environmentally damaging than terrestrial mining. This claim is made under the assumption that rainforests are the most biodiverse ecosystems on the planet. However, estimates show that the deep sea may be just as biodiverse as our rainforests, being home to more than 10 million species. This report has described the different ways DSM would threaten vulnerable marine biodiversity (see Goals 1-14).
 **GOAL 16.** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Mining has historically been associated with political instability, conflict, and economic volatility, particularly in resource-rich states where dependence on extractive industries can heighten vulnerability to external shocks. DSM would likely reproduce this legacy in an alternative environment - the deep sea. Many leading DSM companies driving exploration are multinational corporations from the Global North, raising concerns about the exploitation of SIDS' vulnerabilities (see Goal 10). The DSM industry has already exhibited governance challenges, with the ISA facing criticism of conflicts of interest — profiting financially from each signed exploration contract — alongside a lack of transparency, as key decisions continue to be largely made behind closed doors, limiting accountability and inclusivity. Additionally, there are indications that DSM-sourced minerals could be used for military applications . This challenges the notion that DSM is solely driven by energy transition technologies. This potential militarisation risks fuelling geopolitical tensions, with broader implications for global peace and security, ultimately undermining progress toward Goal 16. Finally, the ocean holds significant cultural, historical, and spiritual significance for various communities, including those whose ancestors were forcibly taken and endured suffering during the transatlantic slave trade. Parts of the Atlantic Ocean are considered by these communities as memorials for those who died, and indeed survived, during the transatlantic slave trade. According to UNCLOS, State Parties are obligated to protect archaeologically and historically significant objects, however, ISA has not yet acknowledged this significance.
 **GOAL 17.** Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	DSM threatens to undermine partnerships in general, but particularly the global effort for sustainable development. The inequitable distribution of benefits of DSM, lack of transparency and the exploitation of the marine environments in low-income states risks creating divisions, rather than facilitating unity. Moreover, the environmental and social impacts of DSM, as described in the goals above, could undermine global cooperation by exacerbating economic and social disparities. Transparent governance, equitable benefit-sharing, and inclusive decision-making are essential to achieving this goal, yet DSM risks falling short in all these areas, severely undermining Goal 17.

4. CONCLUSIONS

DSM is an avoidable risk that threatens global sustainability objectives, with its potential harms far outweighing any potential benefits. While demand for critical minerals - essential for renewable energy systems - is rising, DSM is not a sustainable solution. Instead, it poses irreversible environmental, social, and economic risks, contradicting international commitments to safeguarding biodiversity and the promotion of sustainable resource use.

Our analysis demonstrates that DSM could negatively impact 16 of the 17 SDGs and 18 of the 23 GBF targets (see Figure 3).

Figure 3: Bar chart showing a side by side comparison of the SDGs and GBF targets that would be negatively impacted by DSM. NA refers to any targets and goals deemed non-applicable to the impacts of DSM.



Key findings show that DSM would cause extensive marine pollution, physical destruction of deep sea habitats and ecosystems, loss of species, unequal access to resources, and further disparities between low- and high-income countries.

The potential impacts of such causes are extensive and interconnected. Our key findings highlight that the following impacts would be particularly felt globally:

1. BIODIVERSITY LOSS

DSM methods of extraction (as currently practiced in exploration) are extremely physically destructive, removing or severely disturbing areas of the deep seafloor which are home to numerous endemic species of ecological significance[28] [29] [30]. Many of these species are highly vulnerable to disturbance due to the low recovery rates in the deep sea. Indeed, it is still unknown how long it would take the deep sea to recover from DSM disturbances, if at all[31]. This habitat destruction and subsequent biodiversity loss would likely have wider impacts on the oceans. These impacts affect GBF targets and SDGs that aim to protect and preserve biodiversity (e.g. GBF targets: 1-4, 7, 9, 11; and SDGs: 14, 15) and enhance nature's contribution to people (e.g. GBF target 9:).

2. DECLINING FISH STOCKS

Pollution and habitat destruction by DSM would tangibly damage fisheries, in turn affecting livelihoods that depend on fisheries for income and economic stability, as well as for food security, such as in Pacific SIDS[32] [33]. these impacts could deepen vulnerabilities[34] to climate change, economic disturbances and intensifed gender disparaties related to climate change[35]. This subsequently affects several GBF targets and SDGs that aim to enhance food security (e.g. GBF targets: 7, 9, 10; and SDG: 2) and reduce poverty (e.g. GBF target: 14 and SDG: 1).

3. EXACERBATED EFFECTS OF CLIMATE CHANGE

With the ocean being the planet's largest carbon sink[36], DSM is likely to disrupt the ocean's ability to sequester carbon and mitigate against the effects of climate change, thereby contributing to the negative effects of climate change[37]. This actively undermines the targets and goals aimed at reducing and mitigating against the harmful effects of climate change and ocean acidification (e.g. GBF target: 8; and SDGs: 7, 11, 13, 14).

4. INCREASED DISPARITIES BETWEEN THE GLOBAL NORTH AND GLOBAL SOUTH

Currently, implementation of benefit-sharing regulations remains unclear, putting SIDS in vulnerable financial and legal positions, since they often lack the infrastructure necessary to enforce best practices and manage financial liabilities[38]. Additionally, transparency surrounding governance has already highlighted issues around accountability and inclusivity[39] [40]. These impacts would likely affect the realisation of goals and targets aimed at reducing poverty and inequalities (e.g. GBF targets: 9, 14, 15, 20, 21; and SDG: 1, 8, 10, 16).

5. CULTURAL INFRINGEMENTS

For many indigenous peoples and other local communities, the ocean holds significant cultural, historic, and spiritual value[41] [42]. By exploiting the ocean's natural resources in a destructive way, DSM threatens to uphold the integrity of GBF Targets (e.g. 1, 3, 4, 21, 22) and SDGs (16) that strive to promote inclusive sustainable development and respect the rights of indigenous peoples and local communities.

The future of DSM remains uncertain, however this report highlights that it poses a profound risk to both the GBF's mission to protect biodiversity and the SDGs' vision for global sustainable development. While proponents argue the need to secure critical minerals for the green transition, the scientific evidence underscores the potential for irreversible environmental damage, social inequities, and economic instability. The far-reaching and interconnected risks associated with DSM demonstrate that it cannot be justified as a viable path towards biodiversity restoration and sustainable development.

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TARGET 6: Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent by 2030, and eradicating or controlling invasive alien species, especially in priority sites, such as islands.

TARGET 12: Significantly increase the area and quality, and connectivity of, access to, and benefits from green and blue spaces in urban and densely populated areas sustainably, by mainstreaming the conservation and sustainable use of biodiversity, and ensure biodiversity-inclusive urban planning, enhancing native biodiversity, ecological connectivity and integrity, and improving human health and well-being and connection to nature, and contributing to inclusive and sustainable urbanization and to the provision of ecosystem functions and services.

TARGET 13: Take effective legal, policy, administrative and capacity-building measures at all levels, as appropriate, to ensure the fair and equitable sharing of benefits that arise from the utilization of genetic resources and from digital sequence information on genetic resources, as well as traditional knowledge associated with genetic resources, and facilitating appropriate access to genetic resources, and by 2030, facilitating a significant increase of the benefits shared, in accordance with applicable international access and benefit-sharing instruments.

TARGET 17: Establish, strengthen capacity for, and implement in all countries, biosafety measures as set out in Article 8(g) of the Convention on Biological Diversity and measures for the handling of biotechnology and distribution of its benefits as set out in Article 19 of the Convention."

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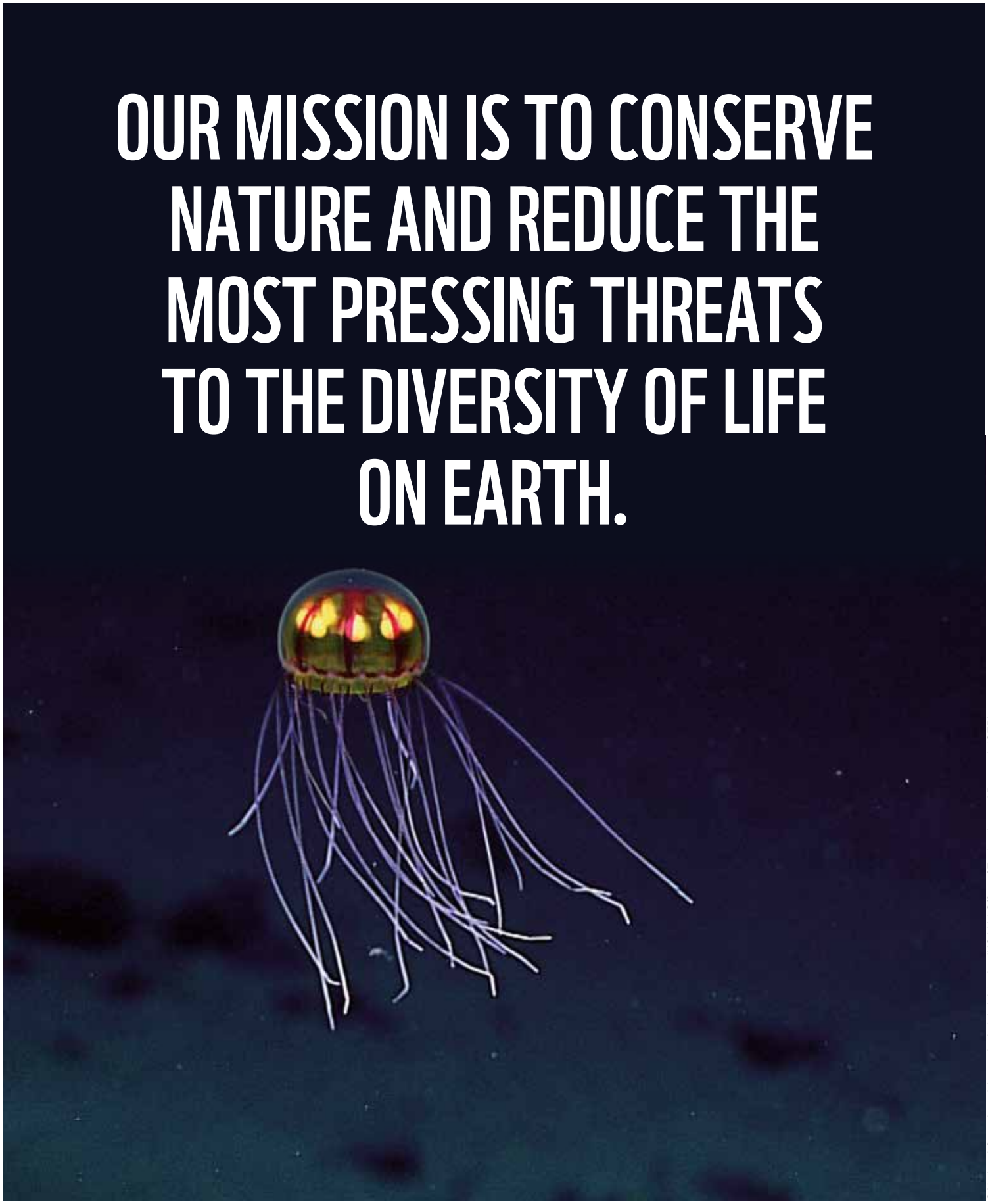
OUR MISSION IS TO CONSERVE NATURE AND REDUCE THE MOST PRESSING THREATS TO THE DIVERSITY OF LIFE ON EARTH.



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