

Why we should protect the high seas from all extractive uses, forever

Exploitation of the high seas risks doing irreversible damage to biodiversity, climate stability and ocean equity. A consensus must be built now to save them.

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Species in the high seas are at risk because of climate warming and the depletion of nutrients and oxygen. Credit: Alex Mustard

International waters, also known as the high seas, make up 61% of the ocean and cover 43% of Earth's surface — amounting to two-thirds of the biosphere by volume. They have been exploited since the seventeenth century for whales, and from the mid-twentieth century for fish, sharks and squid, depleting wildlife. Now, climate change is reducing the productivity of the high seas through warming and through depletion of nutrients and oxygen. Proposals to fish for species at greater depths and mine the sea bed threaten to wreak yet more

damage, putting the ocean's crucial role in maintaining the stability of Earth's biosphere at risk.

Less than 1% of the area of the high seas is protected, however. This is because there has been no globally accepted mechanism to do so beyond Antarctica. The United Nations High Seas Treaty was agreed in 2023 to fill this governance gap and expand the number of marine protected areas in international waters. It is crucial to protect at least 30% of the world's oceans by 2030, as agreed under the Global Biodiversity Framework in 2022.

But the High Seas Treaty could take years to come into force. Sixty countries are required to ratify it; as this article was published, only 28 had done so. Processes and mechanisms are yet to be set up. And its implementation is likely to be hampered by a lack of data, disagreements about divisions of responsibilities and the perennial problems associated with multilateralism.

Given the urgency of addressing the climate and biodiversity crises, the world can't wait another decade to fix the problems humans have created. Ocean life is too precious and important to lose, and shifts in the chemical and physical environments of the sea, once made, will be irreversible on timescales of centuries to millennia.

As world ocean specialists and policymakers convene this week at the UN Ocean Conference in Nice, France, we make a case for permanent protection of all international ocean waters from fishing, sea-bed mining, and oil and gas exploitation.

Oceans store carbon and nutrients

The high seas are home to an immense diversity of wildlife, including megafauna, such as cetaceans, turtles, tuna and sharks that migrate over vast distances. They also play a crucial part in Earth's carbon cycle, which is essential for life and the balance of gases in the atmosphere. Indeed, with an average depth of 4,100 metres, the high seas are the planet's largest and most secure carbon sink.

The crucial role of marine life in the high seas influences the global carbon cycle through two mechanisms: the biological pump and the nutrient pump. In the

biological pump, fish and invertebrates living in the twilight 'mesopelagic' zone (at depths of 200–1,000 metres) comprise billions of tonnes of biomass and undertake daily vertical migrations, feeding by night near the surface and returning by day to the deep, where they deposit carbon-rich faeces. Without this cycle, atmospheric carbon dioxide levels could be 200 parts per million higher, and Earth possibly 3 °C warmer, than under pre-industrial conditions¹.

The nutrient pump is important because dead plants, animals and their faeces sink from shallower to deeper layers of the ocean. Much of the high seas experiences limited mixing — warmer surface waters float on top of colder, denser and darker water — so marine life in the sunlit upper 200 metres is limited by low nutrients. Marine megafauna, such as bigeye tuna (*Thunnus obesus*), sperm whales (*Physeter macrocephalus*) and leatherback turtles (*Dermochelys coriacea*), dive deep to feed and return to the surface to breathe, thermoregulate or digest their prey. Faeces and urine produced near the surface transfer nutrients from deep to shallow water, boosting production of biomass, which takes up dissolved CO₂².



Krill fishing in the Southern Ocean. Credit: Associated Press/Alamy

This upward nutrient pump has been slowed by centuries of intensive exploitation, beginning with the whaling industry, which resulted in the collapse of cetacean populations across the entire ocean by the mid-twentieth century. Fishing of the high seas came later, beginning with Japanese long-distance tuna fisheries in the 1930s, expanding to longline fishing for billfish (Istiophoridae) and sharks in the 1950s, deep-sea bottom trawling of seamounts and continental slopes from the 1960s and 1970s, and squid ‘jigging’ (using lights to attract squid) from the 1990s/90s.

Encouraged by government subsidies³, fishing in the high seas has intensified — involving an estimated 3,500 boats in 2018⁴. This has depleted many fished species and caused serious collateral damage to wildlife and habitats, driving iconic and vulnerable species, such as some albatrosses (Diomedidae), oceanic whitetip sharks (*Carcharhinus longimanus*) and leatherback turtles, to become critically endangered.

Pressure is now mounting to fish at greater depths, despite very limited understanding of the structure and function of deep-sea ecosystems. Although mesopelagic species are mostly small and unsuitable for direct human consumption, government- and industry-sponsored researchers are looking for new sources of fishmeal and oil to supply the burgeoning aquaculture industry.

Expansion of fisheries to deeper waters could reduce the amount of carbon that the oceans take up and deplete a key source of food for species such as tuna, sharks and dolphins. For these reasons, conservationists have argued for a moratorium on fishing in the mesopelagic zone⁵, helping to safeguard the estimated 59% of ocean carbon sequestration that happens in the high seas.

No need to fish in the high seas

High-seas fisheries occur from the poles (for species such as krill, cod, Antarctic icefish and toothfish) to the tropics (for tuna, billfish, sharks and opah, for example). The devastating and poorly managed impacts of fishing were among the main motivations for the High Seas Treaty (formally known as the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction Agreement). Closing the high seas to fishing has been proposed before by academics^{7,8} and by a high-level panel made up of former

heads of state, government ministers and policy experts⁹. There are compelling reasons to do so (see ‘Fishery gains’).

FISHERY GAINS

Closing the high seas to fishing entirely will benefit many nations by boosting catches in national waters.

Most high-seas fish swim in national waters, too

A mere 0.03% of the average annual high-seas catch of 10 million tonnes consists of species that occur only in the high seas.

■ High seas only ■ Both EEZs* and high seas ■ EEZs only

1.4% of taxa are caught only in the high seas[†]



<0.1% of global catch is from taxa caught only in the high seas^{††}

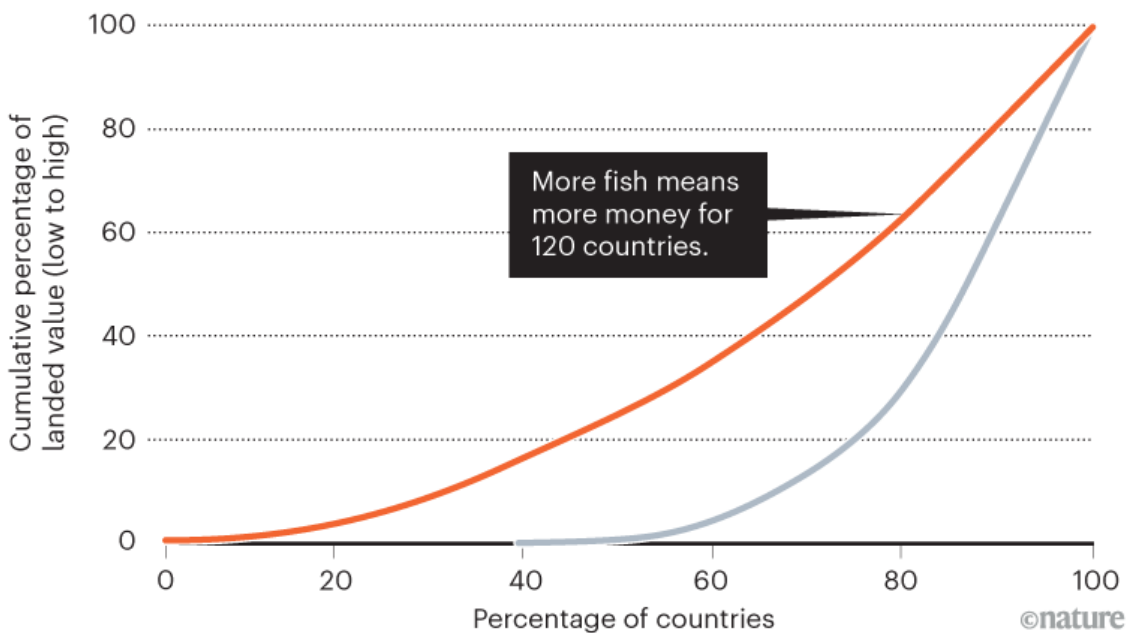


*Exclusive economic zones. [†]Total = 1,406 species; ^{††}Total = 80 million tonnes; both based on global catch statistics 2000–10.

More countries gain than lose from ending high-seas fishing

Closing the high seas would boost catches of fish elsewhere by at least 18% on average.

— Closed high seas — Now



Source: Ref. 8

High-seas catches and profits are constrained by the sparseness of biomass in these remote regions¹⁰. This means that little of the global fish catch (less than 6%) comes from the high seas³, and most of this is destined for consumption in the high-income world. Food-security arguments, therefore, do not apply. Few countries have the capital to invest in high-seas fishing. Around 80% of the high-seas catch is landed by only six regions: the Chinese mainland, Taiwan, Japan, Indonesia, Spain and South Korea³.

Many of these fisheries are economically viable only because they are propped up by government subsidies. High-seas fishing generated profits of between US\$3.8 billion and \$5.6 billion in 2014, but with subsidies of \$4.2 billion³. Costs are further 'subsidized' by low wages, and sometimes by forced or slave labour, with human-rights abuses prevalent.

Not fishing these remote waters would save taxpayer money and prevent publicly funded declines in endangered, threatened and protected species, as well as immense damage to the sea bed and open-water habitats. High-seas species are currently fished using destructive and polluting methods, with limited oversight, little enforcement and weak governance under international law by regional fisheries management organizations (RFMOs).

By-catch, by-kill and pollution problems are often extreme. Each year, pelagic longline fisheries kill hundreds of thousands of seabirds, thousands of turtles and millions of high-seas sharks.

In the 1990s, in addition to pursuing free-swimming tuna schools, 'purse seine' fisheries adopted satellite-tracked drifting fish aggregation devices (dFADs), which are rafts with a net or rope structure hanging beneath. As well as tuna (mostly juveniles), the large wall of netting collects other wildlife, such as turtles, dolphins, whale sharks and manta rays, which are often killed.

Between 2007 and 2021, upwards of 120,000 dFADs were deployed annually and drifted across 37% of the ocean¹¹. Depending on the fishery, up to 90% of dFADs are lost or abandoned at sea¹². Many RFMOs have taken steps to regulate their use, but the regulations are insufficient and poorly enforced¹².



Frozen tuna for sale at a fish market in Tokyo. Credit: Kazuhiro Nogi/AFP via Getty

The sustainability of high-seas fishing is being placed at further risk by deoxygenation from warming and stratification. The global ocean has lost around 2% of its oxygen content over the past 50–60 years¹³. Deep-water deoxygenation is reducing the habitat volume for oxygen-demanding species, such as sharks and tuna, pushing them closer to the surface, where they are more easily caught. Lower levels of dissolved oxygen also lead to slower growth and smaller body size, reducing productivity and reproduction¹⁴ — effects that will be amplified by interactions between fisheries, deep-sea mining, climate change and habitat destruction.

Closing the high seas to fishing would support population recoveries of targeted species⁷. Fishers would have access to healthier, more productive stocks that spill into national waters, where they could be exploited with better governance and oversight — 98.6% of exploited high-seas fish straddle national waters⁸. Remote regions such as the high seas, when highly protected, generate greater conservation benefits for ocean wildlife relative to areas that are closer to humans¹⁵.

Deep-sea mining is unnecessary

Oil and gas exploitation in the high seas has not yet been licensed and there is no justification for it to be. There are known reserves on land and in national waters that vastly exceed the remaining safe carbon-emissions limit to avoid the worst effects of climate change, and exceed need, given the expansion of renewable energy.

Nor has mining started commercially in the high seas, although there are more than 30 active exploration contracts. Discussions have been pushed aggressively by a few supportive governments and commercial interests, and accepted by a compliant International Seabed Authority (ISA). The regulatory process is being rushed, lacks transparency and accountability, and is beset by conflicts of interest. For example, the ISA acts as both promoter and potential regulator of deep-sea mining. A new ISA secretary-general, who was appointed in 2024, has promised to restore trust but — in a concerning recent twist — US President Donald Trump signed an executive order in April calling on US entities to begin deep-sea mining outside the international legal framework.

Doubts are growing, too, about the mining industry's narrative: that the world needs the resources for green technology, that there will be little environmental impact underwater and that deep-sea mining will lessen the need for damaging terrestrial mining.

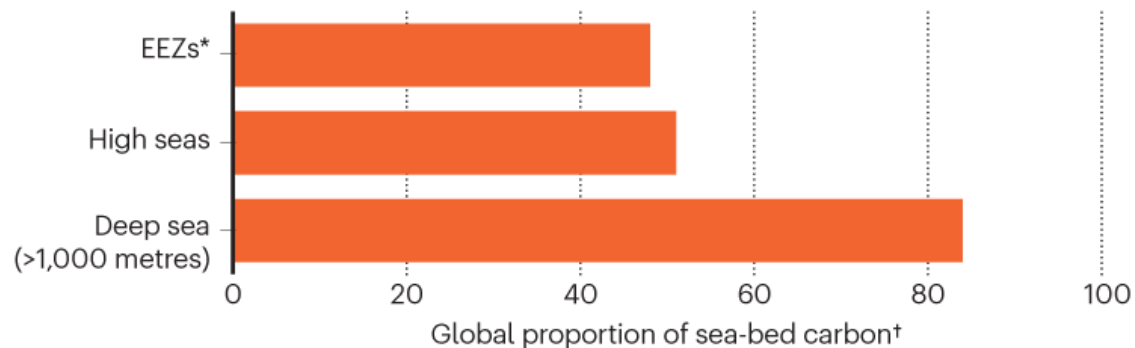
Green technologies are emerging with alternative mineral requirements. There are ample terrestrial sources of critical minerals, and although land-based mining has environmental impacts, they are easier to control, monitor and verify than those in the deep sea¹⁶. Deep-sea resources are smaller and typically lower grade than are terrestrial ones; they are also thinly spread, so would come with more extensive impacts for the same yields¹⁶.

Worryingly, many studies show that deep-sea mining impacts, although hard to predict with accuracy, will be uncontrollable and irreversible with many adverse effects, such as habitat removal and vast areas of sedimentation and deoxygenation. For example, mining the top 10–15 centimetres of the sea floor

for polymetallic nodules would liberate organic carbon stored over millennia, affecting ocean life and the climate system (see 'Climate gains').

CLIMATE GAINS

The sea bed stores vast quantities of carbon that should be left undisturbed to protect the climate system.



*Exclusive economic zones. *Ocean sediment stores. In EEZs and high seas jurisdictions = 2,322 gigatonnes; in deep sea = 1,962 Gt (shallow sea not shown).

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Source: T. B. Atwood *et al. Front. Mar. Sci.* **7**, 165 (2020)

In light of these risks — and the current lack of governance, high environmental uncertainty and absence of recovery mechanisms in the deep ocean — deep-sea mining must meet the same stringent environmental, regulatory and social standards as terrestrial mining. These include rigorous impact assessments; free, prior and informed consent; mitigation and rehabilitation measures; and transparency and audit mechanisms. Meeting such standards is impossible with the tools and technologies of today and will remain so for the foreseeable future.

That is why, we argue, the precautionary principle must be applied. The processes that this immense volume of biosphere supports are too important to the habitability of Earth to gamble with for the narrow and uncertain rewards of deep-sea mining. Many scientists, conservationists and 33 countries (so far) agree, and back a global ban or moratorium on deep-sea mining.

Act before it is too late

Through most of human history, people have damaged the environment before they understood the consequences. In the high seas, we still have an opportunity to avoid disaster. It is possible to reverse the devastating effects of

poorly managed overfishing using destructive methods and gear, and to avoid future harms from drilling and mining.

Declines of ocean megafauna happen fast — the 95% loss of Pacific leatherback turtles took only 25 years. Endless tinkering with fisheries management, governance reforms and working out how fisheries fit into the High Seas Treaty will lead to further losses of megafauna, perhaps irreversibly.

The message is clear. We should act now to avoid severe consequences, rather than wait until the situation becomes irretrievable.

Protecting the high seas from extractive uses would not interfere with international shipping, recreation, legitimate scientific research (including bioprospecting) or other non-consumptive uses. However, it would provide planet-wide benefits at a time of growing peril for the climate.

We recognize that there is currently no clear path by which this proposal could be implemented. But it has a precedent in the way the world came together in the 1950s to protect the Antarctic continent. We should do it again for the high seas in support of all life on Earth.

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