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Annual Review of Environment and Resources
Governance of the High Seas

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Keywords

marine genetic resources, biodiversity in areas beyond national jurisdiction, marine protected areas, multilateralism, ocean equity, private governance

Abstract

Covering two-thirds of the ocean and half of the planet's surface, the high seas are increasingly the focus of commercial activity and conservation ambitions. Contrary to narratives of a lawless frontier, they are governed by a dense network of sectoral institutions for shipping, fisheries, and other industries, although these collectively deal with conservation and sustainable use of biodiversity in a fragmented and uneven manner. These gaps were the subject of nearly 20 years of negotiation, resulting in the adoption of the Agreement on Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction in June 2023. The Agreement was designed to address access and benefit sharing associated with marine genetic resources; the establishment of area-based management tools such as marine protected areas, Environmental Impact Assessments, and capacity building; and the transfer of marine technology. Achieving coherence across public and private governance mechanisms will be a significant challenge as human activity increases on the high seas, but it is key to achieving ocean sustainability goals.

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1. INTRODUCTION

Just as the ocean has always been crucial to the functioning of the climate and Earth's systems, so too has it been inextricably tied to the history and trajectories of humanity. Covering 71% of the Earth's surface, the ocean has been a vast connector—of continents, of civilizations, of cultures (1, pp. 177–218). Life in the ocean gave rise to life on Earth and has existed for 3.7 billion years, resulting in unique biodiversity, much of which remains to be described by science (2, 3). Its currents and upwelling zones shape the productivity of coastal ecosystems, and its vast open waters seed storms and weather systems that carry traces of the ocean's influence to even the most distant corners of the world (4).

The majority of humanity's interactions with the ocean are limited to coastal areas, rendering most of the ocean remote from people's daily consciousness (5). As a result, in the popular imagination, these vast and distant expanses of the ocean are a lawless frontier of mystery and possibility. Yet the high seas are increasingly being used and influenced by human activity, with virtually no part of the ocean unaffected by these cumulative impacts (6). Sustainable management of the high seas will rest on understanding these activities and impacts and creating appropriate instruments of governance to address them, but an ad hoc approach that has lagged behind the pace and expansion of human use (7) has resulted in a patchwork of governance: legal obligations, rights, and responsibilities that extend across the ocean, often on a sector-by-sector basis (8). In 2023, a final patch was added, an agreement on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction—known formally as the Agreement on Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (BBNJ Agreement) and colloquially as the High Seas Treaty (9, 10).

To understand the gaps the BBNJ Agreement intends to fill and its prospects for resulting in greater coherence rather than increased fragmentation, one must first consider how governance of the high seas has evolved over time. It is also useful to consider the technological and scientific

advances that have enabled humanity to increasingly engage in activities—both commercial and noncommercial—in more remote, distant, and deep parts of the ocean. Finally, one cannot consider these topics without drawing attention to the persistent inequities in use and sharing of benefits from this vast global commons.

2. THE SEA AND THE HIGH SEAS

A useful starting point in understanding the high seas today is the year 1608, when the 25-year-old Dutch legal scholar Hugo Grotius (11) wrote and published *Mare liberum* (“The Freedom of the Seas”). At the time, crucial maritime trade routes were connecting Europe to what were then called the East Indies (the coasts of Southeast Asia and archipelagoes of the Philippines, Indonesia, and Papua New Guinea). With the Portuguese seeking a monopoly over the trade route and asserting a *mare clausum* (“closed sea”) claim, Grotius was assigned on behalf of the Dutch East India Company to challenge this assertion. His resulting *Mare liberum* argued that the sea was inherently open and free to all and that no one had a right to restrict the access of others to travel and trade as they saw fit (12).

Three hundred and fifty years later, Grotius’s arguments were at the core of the 1958 Convention on the High Seas (13), which recognized the following four freedoms of all states, both coastal and noncoastal: (a) freedom of navigation, (b) freedom of fishing, (c) freedom to lay submarine cables and pipelines, and (d) freedom to fly over the high seas. These same norms echo through the subsequent 1982 United Nations Convention on the Law of the Sea (UNCLOS) (14) and into the 2023 BBNJ Agreement (15).

While general norms have remained in place, both the extent of the high seas and the scope of these freedoms have become more tightly defined. In 1958, the high seas included “all parts of the sea that are not included in the territorial sea or in the internal waters of a state” (13). The territorial sea, generally a swath of ocean extending 12 nautical miles (~22 km) from the coastal baseline, has been defined as a given country’s sovereign territorial waters, beyond which lay the high seas (Figure 1). The formalization of the Exclusive Economic Zone (EEZ) in 1982 under UNCLOS generally pushed the start of the high seas from 12 nautical miles to 200 nautical miles

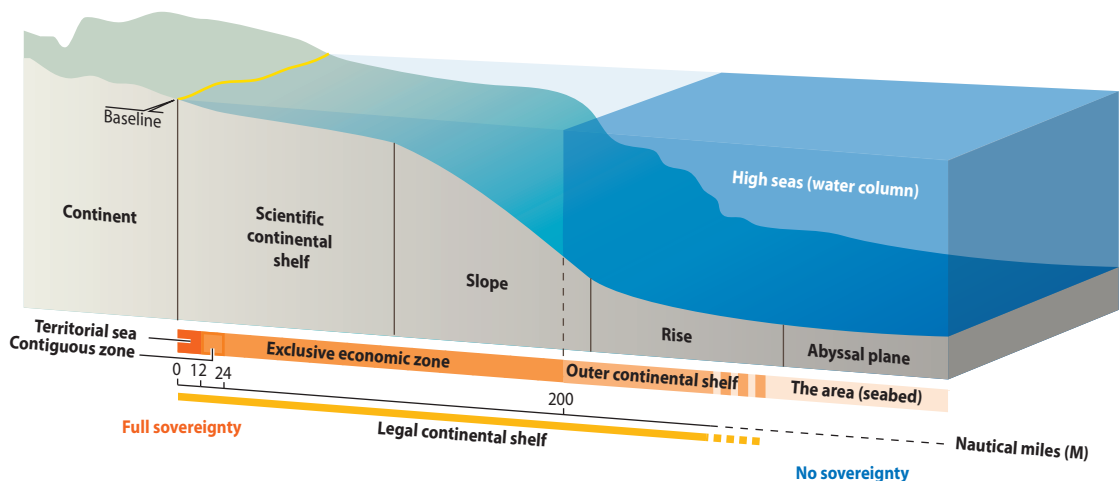


Figure 1

Maritime zones and boundaries. Figure adapted from an image by Riccardo Pravettoni with permission from GRID-Arendal (<https://www.grida.no/resources/7923>; CC BY-NC-SA 4.0).

PRINCIPLES OF FREEDOM OF THE HIGH SEAS AND THE COMMON HERITAGE OF HUMANKIND

The principles of a common heritage of humankind and freedom of the high seas (14) are central to how the space and resources of the ocean are understood and managed. While the principle of freedom of the high seas suggests a liberal regime with minimal restrictions on access and use, the common heritage of humankind principle implies a shared good, the benefits from which should be shared equitably among states. UNCLOS includes both principles (14, art. 87, 136) and states that “the Area and its resources are the common heritage of [hu]mankind” and that “resources” are “all solid, liquid or gaseous mineral resources. . .including polymetallic nodules” (art. 133). Whether marine genetic resources (MGRs) from the Area also fell under a common heritage of humankind regime, or rather a freedom of the high seas principle, was a point of continuous contention throughout the BBNJ Agreement negotiations. Some participants argued that the “resources” of the Area were specifically limited to mineral resources, while others noted the recent advent of modern biotechnology, pointed to the limited knowledge about genetic resources at the time UNCLOS was negotiated, and argued that MGRs should be subject to a similar regime as mineral resources in the Area. According to UNCLOS, the “financial and other economic benefits derived from activities in the Area” should be equitably shared (art. 40).

from the coastline (14). It also resulted in countries—particularly states composed of dispersed archipelagoes or with overseas territories—formally gaining vast maritime territories. The countries with the three largest EEZs are the United States, France, and Australia. At the same time, a number of small island developing states became self-proclaimed big ocean states or large ocean states. For example, Kiribati, Tuvalu, and Micronesia have EEZs that are 457 times, 209 times, and 154 times the size of their respective land area (16).

Another result of the formalization of EEZs under UNCLOS was that what constituted the high seas shrank from approximately 90% of the ocean’s surface area in 1958 to 64% in 1982. Under UNCLOS, states enjoy exclusive rights to decide on the exploration and use of resources, both living and nonliving, within their respective EEZ (14). Furthermore, UNCLOS moved beyond the 1958 Convention on the High Seas by disambiguating between the water column (hereafter referred to as the high seas) on one hand and the seabed and its mineral resources (hereafter the Area) on the other (for a depiction of maritime zones, see **Figure 1**). Collectively, the high seas and the Area are considered areas beyond national jurisdiction (ABNJ) (14).

UNCLOS, which constitutes the centerpiece of ocean governance, further specifies the scope of the freedoms in ABNJ (14, parts VII and XI) and sets out the key principles of freedom of the high seas and common heritage of humankind (see the sidebar titled Principles of Freedom of the High Seas and the Common Heritage of Humankind). While UNCLOS specifies a range of freedoms, including freedom of navigation, freedom of overflight, freedom to lay submarine cables and pipelines, freedom to construct artificial islands, freedom of fishing, and freedom to conduct scientific research, all of these are subject to the relevant parts of the convention and to any other rules of international law (14, art. 87). In these and other cases (e.g., fishing on the high seas), sector-specific agreements have been finalized along with corresponding regulatory frameworks and bodies (17). This framework of governance institutions is described in Section 3 (see also **Figure 2**).

Other key aspects of ABNJ set forth in UNCLOS are that the “high seas shall be reserved for peaceful purposes” (14, art. 88) and that all rights are granted to both coastal states and land-locked states. Crucially, UNCLOS also sets forth flag state responsibilities for vessels operating in the high seas, granting states the right to set forth the conditions under which vessels are allowed

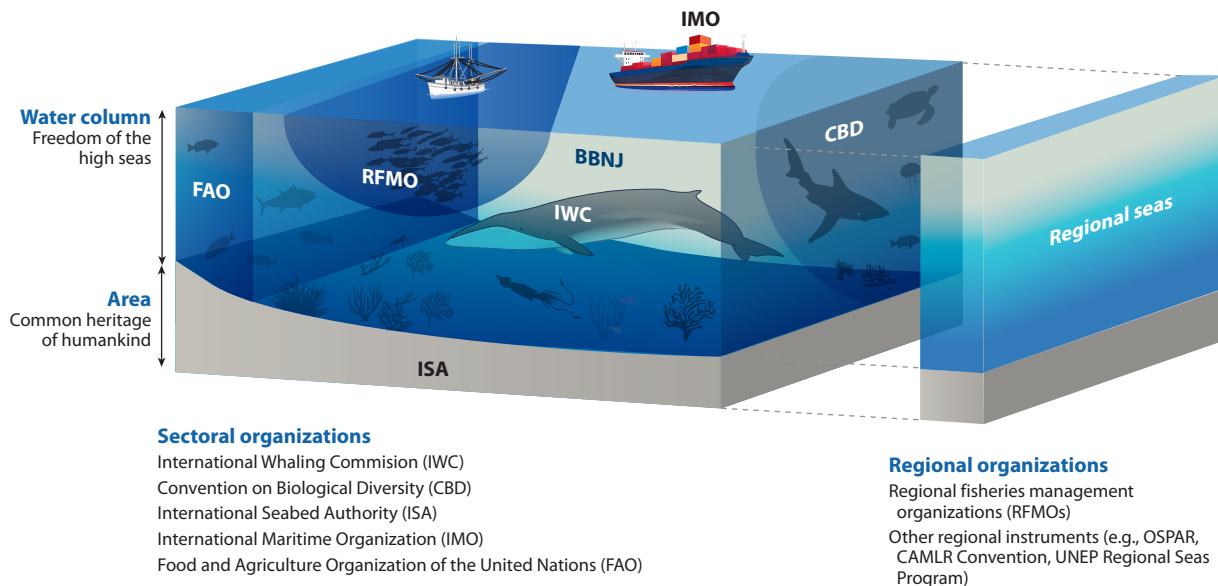


Figure 2

Patchwork of sectoral and regional organizations in ABNJ, including the “international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction” (18), known as the BBNJ Agreement. Abbreviations: ABNJ, areas beyond national jurisdiction; BBNJ, biodiversity in areas beyond national jurisdiction; CAMLR, Conservation of Antarctic Marine Living Resources; OSPAR, Convention for the Protection of the Marine Environment of the North-East Atlantic; UNEP, United Nations Environment Programme. Figure adapted from Reference 18 (CC BY 4.0).

to register and fly their flag and ensuring that a “genuine link” exists between the state and the vessel (art. 91). The flag states have defined duties related to “effectively” exercising their jurisdiction, including for ensuring safety, and maintaining a register of ships flying their flag (art. 94). Further provisions require states to cooperate on addressing issues related to piracy (art. 100) and drug trafficking (art. 108) as well as to render assistance to endangered persons or vessels (art. 98).

3. A PATCHWORK OF GOVERNANCE

While UNCLOS notes that “the problems of ocean space are closely interrelated and need to be considered as a whole” (14), the current governance seascape of the high seas is fragmented. Multiple layers of intergovernmental conventions and sectoral private governance prevent a holistic and integrated management of human use, which would be necessary to drive the high seas toward sustainable futures (19). In the following subsections, we introduce relevant governance mechanisms, focusing first on sectoral mechanisms and then on private governance structures.

3.1. Shipping and Dumping

Established in 1948, the International Maritime Organization (IMO) is a United Nations agency charged with regulating shipping activities. It includes 175 member states and encompasses 50 conventions and protocols related to safety and security of shipping and preventing pollution by ships. Shipping routes cover broad swathes of the high seas, and container shipping collectively accounts for more than 80% of international trade by volume and 70% by value (7, 20).

IMO regulations that are especially relevant for ABNJ include the International Convention for the Prevention of Pollution from Ships (MARPOL), adopted in 1973 (21). MARPOL has been continuously updated since then and now includes a set of six annexes addressing prevention of pollution by oil; discharge of noxious substances; pollution from ship sewage; dumping of garbage; and, most recently, prevention of air pollution to limit emissions of sulfur, nitrogen oxide, and other known ozone-depleting substances (21). Limits on the dumping of waste at sea are further regulated under the London Convention/London Protocol (22).

The IMO's International Convention for the Control and Management of Ships' Ballast Water and Sediments, adopted in 2004, seeks to reduce the movement of invasive species, noting that some 10 billion metric tons of ballast water are transported every day, involving the unintentional transport of an estimated 7,000 species every hour (23, 24). While it is expected that, over time, ships will need to install onboard systems for treating ballast water, it is current practice for ships to exchange ballast water at least 200 nautical miles from land at a depth of at least 200 m (i.e., on the high seas) (25).

Recognizing that shipping can have a negative impact on marine ecosystems and migratory species, the IMO has also identified a series of 18 Particularly Sensitive Sea Areas (PSSAs), within which vessel operations are subject to restrictions and stricter oversight (see <https://www.imo.org/en/ourwork/environment/pages/pssas.aspx>). These include the Galapagos Archipelago, Tubbataha Reefs Natural Park, and Papahānaumokuākea Marine National Monument. Regarding marine mammals such as whales, many of which have long migratory paths that extend across national jurisdictions and the high seas, the IMO has taken initial steps to reduce ship strikes, including by moving some traffic lanes to avoid areas with high densities of whales, implementing mandatory reporting on ship strikes, reducing speed in migratory areas, and issuing nonbinding guidance documents to minimize the risk of cetacean ship strikes and reduce underwater noise (26, 27).

3.2. Fishing

The Food and Agriculture Organization of the United Nations (FAO) was established in 1945 as a specialized agency to address hunger, nutrition, and food security. Its Fisheries and Aquaculture Division has a mandate to work with its members and partners to promote responsible and sustainable management of aquatic food systems, including on the high seas. The FAO distinguishes among shared fish stocks (those that extend across two or more jurisdictions), straddling fish stocks (those that range across one or more jurisdictions and also enter into the high seas), and highly migratory fish stocks (those specified as such in annex I of UNCLOS, primarily tuna, billfish, and swordfish species) (14).

The core legal basis for management of high seas fisheries is the United Nations Fish Stocks Agreement (UNFSA; formally, the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks), adopted in 1995 (28). The UNFSA provides specificity on the general principle contained in UNCLOS that states should cooperate on optimizing use of fishery resources within their jurisdictions and on the high seas (14, art. 116–119). The text defines minimum standards for conservation and sustainable use of straddling and highly migratory fish stocks, and establishes a framework for cooperation among states to achieve these aims. In practice, this has meant the establishment of 19 regional fisheries management organizations (RFMOs) and regional fisheries bodies with widely varying mandates, memberships, conservation measures, and target species (29–31). In some parts of the high seas, fishing operations by multiple states are underway, yet no RFMO currently exists (e.g., eastern Pacific, southwestern Atlantic).

3.3. Mining

UNCLOS (14, part XI, art. 140) defines the Area and its resources as the common heritage of humankind. It further calls upon an “Authority” to ensure the “equitable sharing of financial and other economic benefits derived from activities in the Area” (14, art. 140). As a result, the International Seabed Authority (ISA) was established in 1994 on the basis of an implementing agreement to UNCLOS (32). The ISA has the mandate to administer the resources of the Area. Notably, the spatial extent of the Area and that of the high seas differ considerably due to the opportunity granted to states to register claims on limits of their extended continental shelf beyond 200 nautical miles (14, art. 76; 33). If extended continental shelf claims submitted as of 2019 are granted, only 48% of the seabed would remain the Area (and, thus, in humanity’s shared inheritance), compared with 64% of the ocean’s surface area, which is beyond national jurisdiction (7).

The ISA has developed a Mining Code that defines regulations associated with the prospecting and exploration of mineral resources, and it has granted 31 exploratory licenses to contractors, primarily in the Clarion-Clipperton Zone (CCZ) of the central Pacific, where polymetallic nodules are found in high concentrations (34). Industry projections for large-scale mining operations are projected to result in vast ecological impacts. For instance, projected mining across 500,000 km² of the CCZ would result in plumes and noise pollution across an area triple that size and throughout the 4,500-m water column, generating impacts across some 6,000,000 km³ of the ocean (three times the volume of the Himalayas) (35). The ISA is developing regional environmental management plans (REMPs) to support decision-making that “balances resource development with conservation” (36), including for the CCZ, where nine areas of particular environmental interest (APEIs) have been designated and for which exploratory licenses cannot be granted (36).

In addition, the ISA has published draft rules, regulations, and procedures for exploitation of mineral resources. In July 2021, Nauru triggered a provision under UNCLOS that set a 2-year window to finalize the exploitation aspects of the Mining Code (37). The deadline passed in July 2023 without conclusion of the regulations, suggesting the possibility that exploitation contracts must now be considered by the ISA and provisionally approved despite the lack of finalized rules, regulations, and procedures (37, sect. 1:15). Under UNCLOS, however, the ISA is also required to ensure the “effective protection of the marine environment” (14, art. 150) and to “disapprove areas for exploitation. . . in cases where substantial evidence indicates the risk of serious harm to the marine environment” (14, art. 162). Little is known about the impacts of mining in the deep sea, and a systematic analysis found few areas in which available scientific knowledge would enable decision-making in line with the ISA’s mandate (38). A narrative has emerged that mining the international seabed is crucial for supplying minerals and metals needed for the energy transition, but this notion has been challenged by scientists as well as by rapid technological advancements that reduce reliance on the mining of new minerals and metals (35, 39).

3.4. Scientific Research

A core freedom granted to all states under UNCLOS is the freedom to conduct marine scientific research (14, part XIII). The four principles of such research are that it should be exclusively for peaceful purposes, that it should be conducted with appropriate methods, that it should not interfere unnecessarily with other uses of the sea, and that it should be in compliance with all other relevant regulations (14). As such, marine research is subject to the regulations of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO). The IOC-UNESCO has responsibility for documenting how its 150 member states engage in marine scientific research and implement the 2005 Criteria and Guidelines on the Transfer for Marine Technology (40). It has established or helped

to coordinate multiple scientific and capacity development programs that involve activities on the high seas. These include the Ocean Biodiversity Information System, which contains more than 16,000,000 species records; the Ocean Information Hub; the Ocean Capacity-Development Hub; the Global Ocean Observing System; and the United Nations Decade of Ocean Science for Sustainable Development (2021–2030).

3.5. Species-Specific Agreements and Conventions

Several additional international agreements and conventions are crucial for species groups found in the high seas. These include the Agreement on the Conservation of Albatrosses and Petrels, signed in 2001, which focuses on 31 species of albatrosses, petrels, and shearwaters with a particular emphasis on addressing fishery bycatch. Likewise, the International Whaling Commission was created in 1946 with the aim to “provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry” (41). Members of the commission voted in 1982 to establish a moratorium on commercial whaling and in 1994 to establish the Southern Ocean Whale Sanctuary, which spans some 50,000,000 km² around the continent of Antarctica, much of it in the high seas.

Finally, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which includes 184 parties, was signed in 1973. Its goal is to ensure that trade in species does not undermine their survival in the wild; to this end, more than 38,000 species are subject to varying levels of protection. Trade in multiple pelagic elasmobranch species (sharks and rays), sea turtles, and other species is restricted or banned due to their listing in appendices of the convention, although the extent to which these restrictions are enforced has been questioned (42, 43).

3.6. Private Governance on the High Seas

While the focus of this review is on public governance mechanisms, there is also an ecosystem of private sector actors that at times engage in private governance efforts that will become more relevant as commercial activity increases on the high seas. The ocean economy is highly consolidated; a group of only 100 transnational corporations represents some 60% of the US\$1.9 trillion in revenues generated across their respective sectors (offshore oil and gas, marine equipment and construction, seafood, container shipping, shipbuilding and repair, cruise tourism, port activities, and offshore wind) (44). Among these sectors, the shipping and seafood industries are already widely active on the high seas. Not only are corporations subject to various systems of governance and corresponding regulations, but also, in some cases, they set their own norms for responsible and ethical practice that go beyond regulatory compliance. To this end, one collective mechanism is the establishment of green clubs or voluntary environmental programs, which bring together companies seeking to differentiate themselves through collective, proactive agendas that go beyond existing regulatory frameworks to demonstrate industry leadership (45). Green clubs are found throughout different industries and sectors and vary significantly in terms of membership criteria, sanctioning mechanisms to address free riders, and levels of ambition and transparency (45, 46).

In the shipping sector, the Sustainable Shipping Initiative was established in 2010 and now includes 15 corporate members as well as the nonprofits Forum for the Future and World Wildlife Fund. With an aim of “catalysing change across the maritime ecosystem,” the Sustainable Shipping Initiative has activities guided by a six-part roadmap with milestones in 2020, 2030, and 2040 (47). A 2040 milestone that is particularly relevant to the BBNJ Agreement, for instance, is: “High seas and coastal MPAs [marine protected areas] are established and enforced, and marine spatial plans

are in place” (47). In a broader sense, efforts like the Poseidon Principles bring lenders together to incentivize decarbonization of the shipping industry, with implications for placement of shipping routes within EEZs and the high seas (see <https://www.poseidonprinciples.org>).

In the seafood sector, a wider range of private governance mechanisms are in place. These include the Coalition of Legal Toothfish Operators and the Association of Responsible Krill Fishers, both of which are industry-led groups with operations in ABNJ that have undertaken voluntary steps to establish seasonal fishery closures and additional data transparency mechanisms (48). The science–industry collaboration Seafood Business for Ocean Stewardship has publicly committed to a range of issues that intersect with ABNJ, including implementation of bycatch mitigation measures focused on elasmobranch species and seabirds (49). Certification bodies like the Marine Stewardship Council are likewise involved in setting standards for responsible fisheries, including for high seas fisheries, in a range of areas from labor rights to mitigating “ghost gear” and impacts on endangered species.

4. GAPS IN HIGH SEAS GOVERNANCE

While the past 50 years have seen a considerable expansion of human activities at sea and in the number and scope of multilateral ocean governance mechanisms, as summarized above, significant gaps have become increasingly apparent. Filling these gaps has taken on a sense of increased urgency when considered within the context of (a) unprecedented and, in many cases, exponential growth in the extent and diversity of uses of the ocean (a phenomenon dubbed the “Blue Acceleration”; 7); (b) the rapid decline of iconic species of the high seas, such as sharks, rays, and seabirds (50–52); and (c) growing advocacy for geoengineering and other unprecedented uses of the high seas (53, 54). In the following subsections, we describe key gaps in high seas governance.

4.1. From Fragmentation to Coherence

Institutional and legal fragmentation are a clear hurdle to holistic and effective management of the high seas (8). Each element of the governance landscape is associated with varying numbers of parties, signatories, and members—some involve binding measures, while others do not; some apply globally, others regionally; some are restricted to a single type of commercial activity, others are guided by management processes that specifically seek inclusion and broad participation, and still others are criticized for exclusivity and lack of transparency (8, 55). The end result is complexity that enables forum shopping, free riding, and poorly understood mandates and responsibilities. In this context, two notable gaps have gained particular attention: (a) the lack of standardized rules for conducting Environmental Impact Assessments (EIAs) and Strategic Environmental Assessments (SEAs) and (b) the lack of a coherent mechanism for establishing MPAs on the high seas (32).

4.1.1. Environmental impact assessments. In recent decades, coastlines have become crowded spaces, characterized by an increase in the intensity and diversity of ocean uses (7, 56). The associated potential for conflict and degradation of the marine environment has led to an increased focus on two poorly implemented elements of UNCLOS: to “observe, measure, evaluate and analyze, by recognized scientific methods, the risks or effects of pollution on the marine environment” and to “keep under surveillance the effects of any activities which they permit” (14, art. 204). States are likewise bound to “publish or provide such reports at appropriate intervals to the competent international organizations” (art. 205). Potential impacts of planned activities are subject to the same reporting obligations (art. 206).

Further specifics on the format, content, or details of these assessments are not provided by UNCLOS (32), although the text of the three relevant articles (14, art. 204–206) is in line with

the broad definition of EIAs provided by the United Nations Environment Programme as a tool to examine and assess “planned activities with a view to ensuring environmentally sound and sustainable development” (32, 57). The broader focus of SEAs has been defined by the OECD as a “range of analytical and participatory approaches that aim to integrate environmental linkages with economic and social considerations” (see <https://www.oecd.org>). Whereas EIAs are widely used by regulatory bodies to align approval of projects with environmental policy, SEAs generally extend beyond individual projects to consider a broader set of development objectives for a region or location over time (32, 58). In 1991, the Convention on Environmental Impact Assessment in a Transboundary Context was adopted; it defines obligations for members (currently 45 states) in the context of impacts that cross borders, but it remains limited to national jurisdictions (59).

While EIAs and SEAs are unevenly used within national jurisdictions, their application in ABNJ becomes even patchier and is frequently sectoral in nature. For fisheries, for instance, UNFSA requires states’ fisheries on the high seas to “assess the impacts of fishing, other human activities and environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks” (28; see also 59). Yet some 95% of fish biodiversity in ABNJ, let alone the broader range of species that form the ecosystems upon which commercial stocks in ABNJ subsist, are not assessed (52). Across large swathes of the ocean, RFMOs have likewise not yet been established, while existing RFMOs implement EIAs in an uneven manner that lacks coherence (59). Additional sectoral guidelines of varying specificity and with varying levels of implementation have been proposed or established. Examples include guidelines on prospective commercial mining of the international seabed (36, 59, 60), dumping of waste at sea in line with the London Convention (59, 61), and geoengineering approaches such as ocean fertilization (59, 62, 63).

4.1.2. High seas protected areas. The Global Biodiversity Framework of the Convention on Biological Diversity (CBD) includes a specific areal coverage target for MPAs, reflecting the centrality of these areas as a mechanism for achieving conservation goals. In 2010, the 198 parties to the CBD agreed on the 20 Aichi Biodiversity Targets, including Target 11, which states that, by 2020, “10 per cent of coastal and marine areas. . . are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas.” This target of 10% of MPAs by 2020 was also incorporated into the Sustainable Development Goals (SDGs) as one target of SDG 14, Life Below Water. These were followed in late 2022 with Kunming–Montreal Global Biodiversity Framework Target 3, to “ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas. . . are effectively conserved” (64). With only 36% of the ocean existing within national jurisdiction, achieving this last target is virtually impossible without a mechanism for establishing MPAs in areas beyond national jurisdiction. As of November 2023, only 8.2% of the ocean is covered by MPAs.

Multiple sectoral bodies with mandates that extend into ABNJ have established mechanisms for area-based protection. In the case of fisheries, RFMOs can designate vulnerable marine ecosystems and associated restrictions on fishing activities. This potential remains only partially realized, not least because of the absence of RFMOs from large parts of the ocean (32), limitations on the assessment of marine biodiversity (52), and weak application of this tool (vulnerable marine ecosystems are often temporary and, in some cases, have been applied to areas where fishing was not viable in the first place) (65). The IMO also has the capacity to designate PSSAs, although none have been defined yet in ABNJ, while the International Seabed Authority can describe APEIs and preservation reference zones in line with REMPs to limit harmful impacts of seabed mining.

The lack of a mechanism for establishing holistic MPAs in ABNJ, and the uneven and sectoral focus of existing protection mechanisms, is out of sync with the large-scale CBD targets for protected area designation that are considered necessary for a sustainable future (66). Regional initiatives like the designation of seven MPAs in ABNJ by the Convention for the Protection of the Marine Environment of the North-East Atlantic (in 2010 and 2012) provided initial findings on how MPAs can be established within ABNJ, but they are binding only for signatories (currently 15 nations and the European Union), offer low levels of protection (67), and in most cases are neither effectively implemented nor managed (68). Likewise, the establishment of large-scale MPAs through the Commission for the Conservation of Antarctic Marine Living Resources has nominally resulted in close to 3% of the high seas being covered by MPAs, although this percentage falls below 1% when one considers only MPAs that are implemented as fully or highly protected (69)—levels of protection known to deliver the largest range of social-ecological benefits (70, 71). The issue of underprotection of protected areas is widespread (only 2.9% of the ocean is considered fully or highly protected, while a total of 8.2% is covered by some form of MPA; 69), and the remoteness of ABNJ is likely to pose particular challenges for achieving high levels of protection (71; see <https://mpatlas.org>).

4.2. Fixing High Seas Fisheries

Decentralization has often been promoted as a way to enable tailored and more regionally appropriate and accountable approaches to governance and management (72), as reflected in, for instance, the RFMOs established in line with UNFSA. Yet analyses of the performance of RFMOs over time have underscored a considerable lack of coherence with regard to their performance (30, 73), the extent to which their operations and decision-making processes are transparent (31), and the procedures governing participation (74).

In a broader sense, the key objectives of UNFSA, namely to “ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks” (28, art. 2) and to “apply the precautionary approach” and “protect biodiversity in the marine environment” (art. 5), have not been realized by the current governance regime (75). For instance, the International Seafood Sustainability Foundation publishes annual assessments of tuna stocks and found that only 61% were at healthy levels of abundance. An analysis of tuna RFMOs found variable performance with regard to operationalizing ecosystem-based fisheries management (76). Here, most of the progress was related to monitoring impacts on target species, with little progress on bycatch species or on monitoring impacts on trophic relationships and habitats (76). Although all tuna RFMOs have established conservation management policies that require use of seabird and shark mitigation measures, this is not the case for all other RFMOs. This is a critical issue, as pelagic shark and ray populations have declined by 71% since 1970 and 21 of the world’s 40 albatross and petrel species are classified by the International Union for Conservation of Nature as vulnerable, endangered, or critically endangered (50, 51).

In addition, UNCLOS assigns a broad range of duties and rights to flag states, each of which exercises “jurisdiction and control in administrative, technical and social matters over ships flying its flag” (14, art. 94). These provisions have enabled vessel operators to opportunistically reflag their vessels, in some cases to avoid oversight or to obscure illegal activities (77). While the issue applies to shipping as well, particular scrutiny has been placed on the use of flags of convenience by fishing vessels, resulting in, among other things, a push to adopt the Agreement on Port State Measures (PSMA), a legally binding international agreement that entered into force in 2016 to address illegal, unreported, and unregulated fishing. The PSMA applies to all fishing vessels (as well as support vessels frequently used to enable fishing on the high seas) seeking to enter a port of a state that is different from their flag state, allowing for increased scrutiny of catch, authorizations,

permits, and other relevant information, as well as subsequent improved sharing of information with other states. As of November 2023, the PSMA includes 76 parties, although significant gaps exist across large parts of South America and Asia (77, 78).

Finally, significant research efforts have focused on equity dimensions of high seas fisheries. A pair of 2018 studies, for instance, found that up to 54% of fishing on the high seas would be unprofitable without government subsidies (79) and that high seas fisheries account for only 2.4% of total seafood production (80). Such findings have bolstered broader calls to close the high seas to fishing (81, 82) and to phase out the use of harmful fishery subsidies that encourage overcapacity and illegal, unreported, and unregulated fishing (83).

4.3. Governing for Future Industries

Technological advances have enabled a rapid expansion in the scale and diversity of uses of the ocean and have increasingly extended into the most remote and deepest parts of the ocean (7, 44). These include a growing list of biotechnology applications, including biomimetic innovations inspired by the form or function of marine life (84), as well as increasing commercialization of marine genetic resources (MGRs) (54). Furthermore, the vastness of the ocean, its centrality in the Earth's climate system (4), and a collective global failure to rapidly mitigate carbon emissions are increasingly drawing attention to the potential climate benefits of geoengineering in the high seas.

4.3.1. Marine biotechnology. The Nagoya Protocol to the CBD entered into force in 2014, establishing a framework governing access to genetic resources and sharing of benefits from their use. It is based on a system of user states (i.e., states seeking to use genetic resources located in the jurisdiction of another state) and provider states (i.e., states within whose jurisdiction the genetic resources are based). According to the Nagoya Protocol, user and provider states must set out mutually agreed terms based on free, prior, and informed consent for access and benefit sharing associated with genetic resources. Meant to eliminate biopiracy and generate additional resources and incentives for conservation, the Nagoya Protocol has met with mixed reactions, both because of limited evidence of these conservation resources materializing and because of the additional regulatory burden placed on taxonomists and other scientists engaged in noncommercial activities (85, 86).

Importantly, the Nagoya Protocol applies to national jurisdictions, while a liberal regime of open access to genetic resources has persisted for areas beyond national jurisdiction, where benefit-sharing obligations are absent. Furthermore, rapid advances in biotechnology and the growth of genetic sequence databases have reduced reliance on collection of physical samples (87); access and benefit-sharing obligations are associated with digital sequence information, a focus of ongoing negotiations within the CBD (88).

The scope, scale, and value of marine bioprospecting have been challenging to quantify for several reasons, including limited regulations on disclosure of sample origin in patent filings and a lack of access to commercial data (89, 90). A pair of studies assessed patent filings and concluded that 90% of marine genes referenced in patent filings were from entities in 10 countries (91, 92), and several years later an updated study found that this share had increased to 98% (54), suggesting a growing sector of the ocean economy in which only a handful of countries participate.

4.3.2. Geoengineering and carbon sequestration. Growing urgency regarding the failure to rapidly decarbonize the global economy has led to calls to prioritize research into geoengineering techniques, involving either solar radiation modification (SRM) or carbon dioxide removal (CDR), that would take place in the ocean. While such activities are already the subject of

scientific research and therefore fall under the umbrella of freedoms granted by UNCLOS (14, part XIII), some scholars consider larger-scale applications to fall under the mandate of the IMO and its London Protocol/London Convention on pollution. Parties to this convention have identified four geoengineering techniques for urgent consideration: (a) enhancement of ocean alkalinity (e.g., by distributing finely ground alkaline minerals or sand across the ocean to increase alkalinity and therefore carbon uptake) (93), (b) macroalgae cultivation for sequestration (e.g., growing rafts of macroalgae in the open ocean and sinking them) (94), (c) marine cloud brightening (e.g., through seeding marine stratocumulus clouds to increase albedo and longevity) (95), and (d) artificial use of microbubbles and reflective particles (96, 97). The first two are CDR techniques, and the third and fourth are SRM techniques.

In 2023, an unbroken period of hundreds of days of record sea surface temperatures attracted significant attention (98), not least because it was suggested to be evidence of an unintended ocean geoengineering process (99). Reflective “ship track” clouds have been observed to form along major maritime shipping routes, seeded by sulfur particles from ship fuels (100). With high-sulfur ship fuels reduced by more than 80% in line with a 2020 IMO regulation, ship track clouds have been disappearing, resulting in a less reflective surface and perhaps contributing to the record sea surface temperatures of 2023 (99, 101).

While so-called blue carbon ecosystems like mangroves, seagrass beds, and salt marshes have attracted broad interest for their disproportionate contribution to carbon sequestration and rich biodiversity, the sediments of the seabed (primarily in ABNJ) are thought to be by far the largest marine carbon sink (102). The extent to which disturbances of the seabed (e.g., due to mining or bottom trawling) result in long-term release of carbon stored in bottom sediments is the focus of intense discussion and considerable scientific uncertainty due to data limitations (103–106). Now that blue carbon ecosystems and nature-based solutions are increasingly being included in states’ Nationally Determined Contributions in line with the Paris Agreement (107), the extent to which sequestration in bottom sediments in ABNJ or disturbance of these sediments by individual states should be assigned in carbon accounting schemes is unclear.

4.4. Equity for the High Seas

A common thread that often emerges from consideration of the high seas involves pervasive inequities. Key industries associated with the high seas, like mining, shipping, and marine biotechnology, are limited to a handful of actors, often relying on subsidies. UNESCO’s Global Ocean Science Report (108) underscores the uneven investments in ocean science and ocean science output (**Figure 3**), as well as indicators that inadequate resources are being invested to address these inequities (e.g., 69% of students attending international ocean conferences/symposia are from Europe and North America). Addressing such challenges is a stated priority of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) as well as SDG 14, Target 14a, to “increase scientific knowledge, develop research capacity and transfer marine technology. . . to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries” (109).

Opportunities for moving toward a more equitable relationship for humanity with the high seas may depend not only on pursuing stepwise action along with international development agendas but also on taking transformational approaches that depend on futuristic thinking. In this regard, several useful touchpoints have applied the Nature Futures Framework and other, related methodologies to the ocean to envision different possible futures (19, 110, 111). Others have focused on ocean equity and have sought to move beyond descriptions of existing inequities to articulating

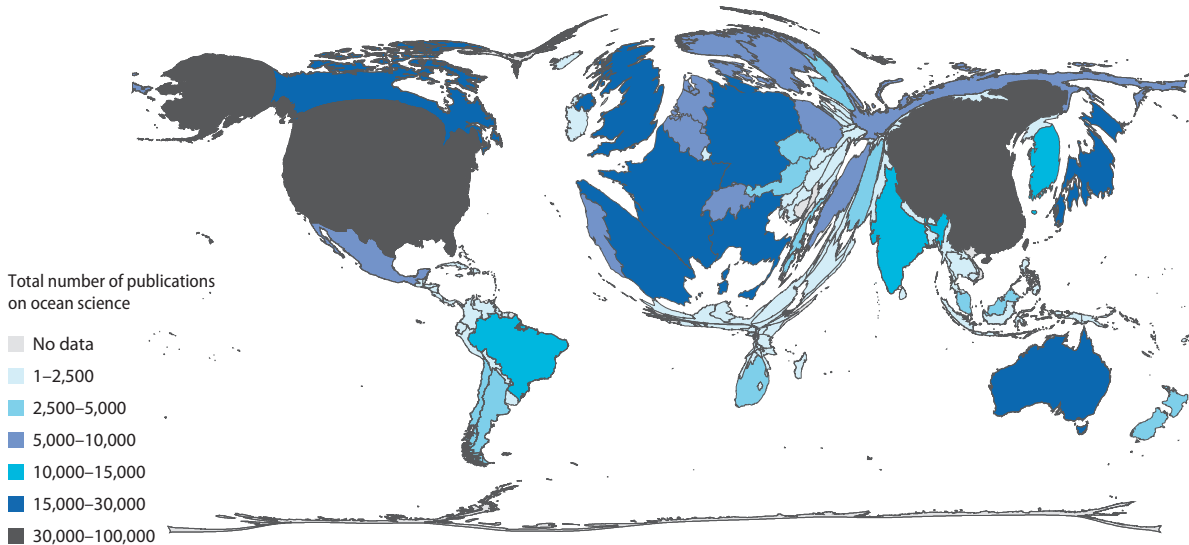


Figure 3

Publication map of the world. The area of each country is scaled and resized according to the number of ocean science publications based on the country of the author's affiliation (or countries when authors from different countries are involved). Between 2010 and 2014, more than 370,000 manuscripts in ocean sciences were published. The numbers of papers are taken from <https://www.science-metrix.com/>. Figure adapted from Reference 116 (CC BY-SA 3.0 IGO).

MOVING BEYOND THE OCEAN ECONOMY

Considerable aspirations have been attached to the prospect that the ocean economy could contribute to achieving global development goals (117). Yet the benefits from the main ocean industries are accrued primarily by a handful of countries, with the 100 largest corporations accounting for 60% of ocean economy revenues (44). In recent decades, the term blue economy has gained traction in diverse settings (118). For some, the ocean economy and the blue economy are synonymous (119), while others consider the blue economy as a distinct concept, defined and distinguished by sustainability (120). Still others consider these qualities an aspirational direction that needs to be explicitly indicated, resulting in calls for transformation to a “sustainable blue economy” (121) and a “sustainable and equitable blue economy” (115, 122).

pathways forward for a more equitable ocean commons (112–115) (see the sidebar titled *Moving Beyond the Ocean Economy*). Solutions presented in these contributions range from a focus on improving inclusivity in ocean science collaborations and critically questioning current mechanisms of collaboration and science–policy engagement all the way to closing the high seas to fishing or enacting a global tax on all ocean industries to fund conservation and science efforts (81, 112, 113).

5. FUTURE GOVERNANCE OF THE HIGH SEAS

5.1. The BBNJ Agreement

Recognition of the gaps in high seas governance triggered an extended round of negotiations on how to conserve and sustainably use biodiversity in areas beyond national jurisdiction (BBNJ).

These negotiations fell under the purview of the United Nations General Assembly (UNGA), the only body with a mandate to deal with BBNJ as a whole, and culminated in the adoption in June 2023 of the BBNJ Agreement (15). The process took nearly 20 years, starting in 2004 with the establishment of the Ad Hoc Open-Ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction, which met from 2006 to 2015. In January 2015, the Ad Hoc Working Group recommended that the UNGA initiate a Preparatory Committee (2016–2017), which, in turn, was charged with making substantive recommendations on elements of an international legally binding treaty on BBNJ. As a result, the Intergovernmental Conference (2018–2022) finalized the text of the Agreement in March 2023, which led to its adoption in June 2023. The Agreement was signed by more than 80 states on the occasion of the UNGA meeting in September 2023. As of May 2024, the BBNJ Agreement has been ratified by eight states (Belize, Chile, Cuba, Mauritius, Micronesia, Monaco, Palau, and Seychelles) and will enter into force 120 days after at least 60 states have ratified it.

5.1.1. Negotiating the BBNJ Agreement. Different stages of the nearly 20 years of negotiations have been the subject of numerous studies that considered the meetings of the Ad Hoc Working Group (32, 123–125), the Preparatory Committee (65, 123, 124), and the Intergovernmental Conference (126–129). Common threads across these studies were the slow pace of progress toward building consensus; the challenges faced by states with limited technical and scientific support; and seemingly intractable divides on key issues, most notably the principles of common heritage of humankind and freedom of the high seas as applied to MGRs (see the sidebar titled Principles of Freedom of the High Seas and the Common Heritage of Humankind).

Two key moments in the negotiation process are particularly notable. The first came in 2011, at the fourth meeting of the Ad Hoc Working Group, when a so-called package deal was created that required negotiations to cover four topics “together and as a whole.” The four topics, which were to dominate negotiations for the next decade, were (a) MGRs, including questions on the sharing of benefits; (b) measures such as area-based management tools (ABMTs), including MPAs; (c) EIAs; and (d) capacity building and the transfer of marine technology (32). The second key moment came in 2018 with UNGA Resolution 72/249 (32), which formally called for the initiation of an Intergovernmental Conference and specified that the negotiations should “not undermine existing relevant legal instruments and frameworks and relevant global, regional and sectoral bodies” (32). This specification became a key point of discussion throughout the remainder of the process and resulted in sectoral issues related to fishing, shipping, and mining being off the table and multiple technical publications focusing on the implications of the “not undermine” clause for the negotiations (130–132).

5.1.2. The BBNJ Agreement. In June 2023, the BBNJ Agreement (15) was adopted, with a structure that largely mirrored the four elements of the package deal defined 12 years earlier. The preamble and general provisions helped to firmly situate the BBNJ Agreement within the context of UNCLOS, specifically reiterating that the Agreement itself would be implemented in a manner that would “not undermine relevant legal instruments and frameworks and relevant global, regional, subregional and sectoral bodies” (art. 5.2). Article 7 describes the general principles and approaches of the Agreement, with specific reference to both the common heritage of humankind and the freedoms of the high seas (the latter specifically includes marine scientific research). Article 47 establishes a Conference of the Parties, which is to meet within 1 year following the entry into force of the Agreement and which is the central decision-making body for all key elements of the Agreement (9).

5.1.2.1. Part II: marine genetic resources, including the fair and equitable sharing of benefits.

The BBNJ Agreement establishes a single regime for access and benefit sharing for MGRs in both the high seas and the Area, covering “any material of marine plant, animal, microbial or other origin containing functional units of heredity of actual or potential value” (15, art. 1.8). Use of MGRs as well as their digital sequence information is considered “in the interests of all States and for the benefit of all humanity” (art. 1.6), with sharing of both monetary and nonmonetary benefits. To enable transparency and benefit sharing, a notification system linked to the Clearing-House Mechanism (an open-access informational platform for the parties; art. 51) will result in the issuance of standardized “batch identifiers” to track key data points related to sample collection (art. 12). Levels of monetary benefit sharing have not been agreed on; they will be the subject of further negotiations after the Agreement enters into force and will subsequently be reassessed on a periodic basis. Potential modalities include milestone payments, payments related to percentages of product sales, tiered fees, or other, to-be-determined mechanisms (art. 14). These financial resources are meant to flow into the Agreement’s funding mechanism (art. 52) to support capacity building, transfer of marine technology, and a range of other potential activities as decided by the parties (art. 52).

5.1.2.2. Part III: measures such as the area-based management tool, including marine protected areas.

The BBNJ Agreement defines an ABMT as any tool (including an MPA) that “achiev[es] particular conservation and sustainable use objectives...for a geographically-defined area” (15, art. 1). Following appropriate collaboration and consultation with relevant stakeholders, parties can formulate and submit proposals for ABMTs to the Conference of the Parties. Proposals are expected to include a minimum set of 10 key elements, including a description of the biological diversity in the identified area; a draft management plan; the duration of the proposed ABMT; and other relevant information, including traditional knowledge of Indigenous peoples and local communities where available (art. 19). While the Conference of the Parties will seek to achieve consensus decisions on proposals, votes can be taken and decided by a three-quarters majority, and parties can object to decisions by providing a written explanation and description of measures they will take to ensure, to the greatest possible extent, that they will not undermine the respective decisions of the Conference of the Parties (art. 23).

5.1.2.3. Part IV: Environmental Impact Assessments.

Part IV of the BBNJ Agreement deals with EIAs, defining obligations for conducting EIAs (15, art. 28) and the relevant thresholds and factors they should address (art. 30). It considers both activities within ABNJ and activities within national jurisdictions that will significantly affect the marine environment in ABNJ. In the latter case, states may opt to follow national EIA processes but are subject to a public notification and consultation process (art. 32) and must submit any resulting reports to the Agreement’s Clearing-House Mechanism (art. 33). The decision as to whether or not an assessed activity may proceed rests with the party under whose jurisdiction the planned activity falls, although other parties may register concerns and call for further reviews (art. 34; see also Reference 9).

5.1.2.4. Part V: capacity building and the transfer of marine technology.

While UNCLOS contains significant text on the transfer of marine technology (14, part XIV) and on international cooperation and capacity building related to marine scientific research (part XIII), and these topics are specifically codified in Target 14a of the SDGs, they have been criticized as some of the least realized elements of UNCLOS (9, 133). In part V of the BBNJ Agreement, one of the objectives of capacity building and transfer of marine technology is to “enable inclusive, equitable and effective cooperation and participation in the activities undertaken under this Agreement” (15, art. 40). The modalities for capacity building and transfer of marine technology are meant to be “a country-driven, transparent, effective and iterative process that is participatory, cross-cutting and

gender-responsive” and are intended to add to, but not duplicate, existing programs (art. 42). A dedicated committee will be established to support these aims, to periodically monitor and review the extent to which they are being achieved, and to make recommendations to the Conference of the Parties on follow-up activities (art. 45).

5.2. Our Future with the High Seas

The BBNJ Agreement has often been considered a missing piece of ocean governance, and its adoption is an encouraging milestone for the possibilities of consensus building and multilateralism in the international community today. Yet it is not a panacea. Ratification of UNCLOS took 12 years, and it is unclear when the BBNJ Agreement will be ratified and enter into force (134), when the first high seas MPAs will be designated, when the first benefits from commercialization of MGRs from the high seas will be shared, or when—in short—change will be evident (134).

The complex fabric of ocean governance mechanisms, institutions, and treaties also means that states will be responsible for ensuring that these result in coherence rather than fragmentation (135–137). For instance, virtually all states are parties to the CBD and have committed to placing 30% of marine areas under protection by 2030, a goal that will necessarily depend on designation of MPAs on the high seas. Yet, the “not undermine” article of the BBNJ Agreement (15, art. 5.2) means that any MPAs designated through the Agreement will be subject to the approval of sectoral bodies for industries like fisheries, mining, and shipping, rather than having any authority to curtail such activities for conservation purposes. Many of the same states are active across these different bodies, and the extent to which this participation results in a coherent approach to conservation and sustainable use of biodiversity will certainly be the subject of close study.

Finally, it remains striking how unevenly humanity shares in the benefits from the high seas. While the principle of the common heritage of humankind is an important foundation, the body of high seas governance institutions can also be judged on its capacity to make the high seas a driver of greater equity and opportunity in the world. Instrumentalizing these institutions to achieve such outcomes can contribute to the SDGs and to a brighter future for humanity.

SUMMARY POINTS

1. The high seas cover some two-thirds of the ocean, and they have long represented a shared resource and responsibility of the global community, albeit with commercial activity dominated by a small number of states.
2. The cumulative impacts of human activities extend across the high seas.
3. A dense fabric of institutions governs areas beyond national jurisdiction, largely on a sectoral basis, including for shipping (International Maritime Organization), fishing (regional fisheries management organizations), and mining (International Seabed Authority). As a result, ocean governance is fragmented.
4. While most commercial activity on the high seas is associated with the shipping and fishing industries, the continually expanding scale and diversity of commercial uses of the high seas are likely to add to the importance of private governance mechanisms.
5. Significant gaps exist with regard to the conservation and sustainable use of biodiversity in areas beyond national jurisdiction, and the negotiation process started in 2004 by the United Nations General Assembly sought to address these gaps. These negotiations culminated in the June 2023 adoption of the BBNJ Agreement, which focuses on four

key issues: marine genetic resources, area-based management tools such as marine protected areas, Environmental Impact Assessments, and capacity building and the transfer of marine technology.

6. The adoption of the BBNJ Agreement is a welcome sign of multilateralism and consensus building in the twenty-first century, but its entry into force is likely still years in the future, and its capacity to promote more coherent governance of the high seas rather than fragmentation remains unknown.

FUTURE ISSUES

1. How can high seas governance contribute to a more equitable and sustainable blue economy?
2. Will the BBNJ Agreement result in greater coherence or fragmentation in relation to the conservation and sustainable use of ocean resources?
3. How will high seas marine protected areas effectively manage all human activities that can negatively affect marine biodiversity?
4. How can holistic valuation of marine genetic resources contribute to improved benefit-sharing and capacity-building efforts?
5. How can the carbon sequestration potential of areas beyond national jurisdiction be better quantified and incorporated into climate negotiations?
6. What role will the high seas play as a testing ground for geoengineering research?
7. Will the legal concept of the rights of nature shape future approaches to governing the global commons that is the high seas?

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AUTHOR CONTRIBUTIONS

R.B. and J.C. conceptualized, reviewed, and edited the article. R.B. led the writing.

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