



OPEN ACCESS

EDITED BY

Sarah Lothian,
University of Wollongong, Australia

REVIEWED BY

Fran Humphries,
Griffith University, Australia
Zakieh Taghizadeh,
Université de Fribourg, Switzerland

*CORRESPONDENCE

Yuqiong Sun

✉ yqsun@shou.edu.cn

Yanxuedan Zhang

✉ yxdzhang@shou.edu.cn

RECEIVED 16 October 2025

REVISED 12 November 2025

ACCEPTED 18 November 2025

PUBLISHED 01 December 2025

CITATION

Yu W, Tang Y, Sun Y and Zhang Y (2025)
Form follows function: in pursuit of solutions
to the unresolved issues of the benefit-
sharing regime for marine genetic
resources under the BBNJ agreement.
Front. Mar. Sci. 12:1726523.
doi: 10.3389/fmars.2025.1726523

COPYRIGHT

© 2025 Yu, Tang, Sun and Zhang. This is an
open-access article distributed under the terms
of the [Creative Commons Attribution License](#)
(CC BY). The use, distribution or reproduction
in other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication
in this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Form follows function: in pursuit of solutions to the unresolved issues of the benefit-sharing regime for marine genetic resources under the BBNJ agreement

Wenlong Yu, Yi Tang, Yuqiong Sun* and Yanxuedan Zhang*

College of Marine Living Resource Sciences and Management, Shanghai Ocean University, Shanghai, China

While the Agreement 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 (BBNJ Agreement) has pioneered the establishment of a benefit-sharing regime for marine genetic resources (MGRs), persistent divergences between developing and developed countries have posed substantial challenges to its implementation. The current legal framework is overly schematic and insufficient to guide practice, leaving many issues unresolved. To explore the solutions for these issues, this article adopts a legal functionalist approach grounded in the principle that “form follows function”. First, this article categorizes the unresolved issues into four types: ambiguous terms in the Agreement, uncertain legal nature of benefit-sharing modalities, weak operability resulting from incomplete guiding rules, and inadequate monitoring rules. Second, it derives potential solutions from a legal functionalist perspective. This approach emphasizes the instrumental value or functionality of law. By focusing on facilitating the achievement of the Agreement’s intended functions and goals, this approach can help steer ongoing international rule-making activities and overcome negotiation deadlocks. Under such an approach, the core guiding principle for problem solving is to make rules operational by addressing conflicts, giving due regard to diverse concerns, and fostering broad consensus among negotiating parties. Finally, this article tentatively applies this approach to specific unresolved issues, including: adopting broader definitions of key terms; designing relatively light monetary benefit-sharing rules that combine mandatory and voluntary mechanisms; facilitating *ex situ* access through multilateral mechanisms; clearly delineating the respective scope of application of different technology transfer modalities; and strengthening supporting information disclosure and

traceability rules. Concurrently, this article suggests that the design and implementation of rules should take into account the needs of marine scientific research, data confidentiality, financial and administrative burdens, and the legitimate rights and interests of stakeholders.

KEYWORDS

marine genetic resources, benefit-sharing, unresolved issues, functionalism, effective implementation, goal-orientation, international negotiations

1 Introduction

After 19 years of negotiations, the *Agreement 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* (BBNJ Agreement) was formally adopted on June 19, 2023, at the further resumed fifth session of the Intergovernmental Conference (IGC). On September 19, 2025, with the formal deposit of ratification instruments by countries such as Morocco and Sierra Leone, the BBNJ Agreement met the conditions for entry into force and began a 120-day countdown to its activation. The Agreement is the third implementing agreement of the *United Nations Convention on the Law of the Sea* (UNCLOS), and stands as one of the most significant legislative achievements in international ocean law, marking an important milestone in the governance of areas beyond national jurisdiction (ABNJ). It serves as a key instrument for conserving marine biological diversity, protecting the marine environment, and promoting the sustainable use of the oceans, with a profound impact on the future international marine political and economic order.

Part II of the BBNJ Agreement has pioneered the establishment of the benefit-sharing regime for marine genetic resources (MGRs), filling the legal gap in international ocean law. This regime is a core component of the BBNJ Agreement, especially valued by developing countries as their primary concern in negotiations. The BBNJ Agreement defines MGRs as “any material of marine plant, animal, microbial, or other origin containing functional units of heredity of actual or potential value.” Scientific research has demonstrated that MGRs hold significant potential commercial, ecological, and other values in areas such as biopharmaceuticals, nutritional supplements, cosmetics, breeding, environmental protection, biomaterials, and chemical engineering (Blasiak et al., 2020). Once relevant products are successfully developed, they generate not only substantial economic benefits but also significant social utility. And the benefit-sharing regime, in turn, precisely governs the distribution of these benefits. It requires users of MGRs to share the benefits derived from activities such as collection, research and development (R&D), and commercialization. Specifically, the current benefit-sharing regime

mainly includes the following parts. First, its primary objective is the fair and equitable sharing of benefits arising from activities with respect to MGRs and digital sequence information (DSI) for the conservation and sustainable use of marine biological diversity of ABNJ. Second, the scope of application extends to the utilization of MGRs and DSI collected or generated before entry into force, unless a Party makes an exception upon ratification. Third, it incorporates the mechanism of monetary benefit-sharing (MBS), with operational rules outlined as follows: the financial mechanism as the multilateral sharing channel; the annual contribution obligation of developed Parties; the Conference of the Parties (COP)’s decision-making authority over newly established MBS modalities and the corresponding voting threshold; the non-exhaustive specific modalities of MBS, including milestone payments, payments or contributions related to the commercialization of products, and a tiered fee, paid on a periodic basis, based on a diversified set of indicators measuring the aggregate level of activities by a Party; and the requirement for regular review and assessment of monetary benefits derived from the utilization of MGRs. Fourth, non-monetary benefit-sharing (NMBS) modalities include *ex situ* access to samples and DSI in accordance with current international practice, open access to scientific data, information notifications, capacity-building and transfer of marine technology (CBTT), and technical and scientific cooperation. Fifth, the monitoring rules provide that monitoring and transparency shall be achieved through notification to the Clearing-House Mechanism (CHM) and the use of standardized batch identifiers, as well as the regular submission and review of Parties’ implementation status reports.

However, due to the serious divergences between developing and developed countries regarding the benefit-sharing regime during negotiations, particularly sharp contradictions on issues such as the MBS and full-chain monitoring (Shi, 2023), the benefit-sharing regime, although established, is in fact only a basic legal framework with many issues remaining unresolved. The BBNJ Agreement is nearing the implementation stage. How to further address these unresolved issues will become the focus of discussions among all parties at the Access and Benefit-sharing Committee (ABSC) and the COP. This is crucial for refining the

Agreement's normative framework and supplementing details of provisions, thereby ensuring its effective implementation. The effectiveness of implementation, in turn, is directly linked to achieving the Agreement's goals of conserving and sustainable using marine biological diversity in ABNJ. Accordingly, research is needed to address the unresolved issues of the benefit-sharing regime. Since the BBNJ Agreement was adopted in 2023, existing research has yet to provide a relatively comprehensive mapping of the unresolved issues or explore systematic pathways for their resolution.

Given the diversity and complexity of unresolved issues, this article identifies certain issues through vertical comparison between Agreement text, negotiation documents, and negotiation reports; horizontal comparison with other international instruments on benefit-sharing; and a comprehensive review of the Agreement. Subsequently, using the method of contradiction analysis and returning to the essence of the issues, it analyzes the main causes of the unresolved issues and the key points for their resolution. Building on this the article explores a basic approach for resolving the issues based on how to prioritize addressing the main contradictions to support the early implementation of the BBNJ Agreement and advance its goals. Finally, by applying deductive reasoning, comparative research, and legal interpretation, this article puts forward suggestions on the underlying logic to address the specific unresolved issues.

2 Types of unresolved issues in the benefit-sharing regime

The unresolved issues are manifested in generally four types, including the uncertainty caused by ambiguous terms, unconfirmed legal nature of benefit-sharing modalities, weak operability resulting from incomplete benefit-sharing rules, and insufficient monitoring rules (see Table 1). While in theory it is normal to leave space and flexibility for implementation as the Agreements enters into practice, especially in international fora, the reality is normally otherwise. Some loopholes will persistently prevent rules from functioning.

2.1 Ambiguous terms of the Agreement

The use and definition of a certain term in an international agreement are directly related to the scope of legal application and the scope of rights and obligations. Yet divergences among negotiating parties on many issues make it difficult to reach a precise and commonly recognized conclusion on all terms in the BBNJ Agreement. In order to ensure that the Agreement could be adopted at IGC-5 in 2023, many provisions have been ambiguously worded. However, as the Agreement enters the implementation

TABLE 1 Unresolved issues of the benefit-sharing regime.

Type	Issue	Method	Material
Scope of terms	DSI	provision comparison	the Agreement
	derivatives	horizontal comparison	other instruments
	benefit	provision comparison legal interpretation	the Agreement
	current practices	legal interpretation	the Agreement
	scientific data	legal interpretation	the Agreement
Legal nature	MBS	vertical comparison	negotiation documents negotiation reports
	<i>ex situ</i> access	vertical comparison	as above, with national proposals
Key details of framework rules	preset milestone events	vertical comparison legal interpretation	negotiation documents negotiation reports
	payment rates	vertical comparison horizontal comparison	as above, with other instruments
	diversified indicators and periodic timing	vertical comparison legal interpretation	negotiation documents negotiation reports
	implementation mechanism for <i>ex situ</i> access	legal interpretation horizontal comparison	the Agreement other instruments
	application scopes of different transfer modalities of technology	legal interpretation	the Agreement
supporting monitoring rules	notification of information	vertical comparison horizontal comparison legal interpretation	negotiation documents other instruments the Agreement
	disclosure of origin	vertical comparison horizontal comparison	negotiation documents other instruments

phase, concrete legal, ecological, and economic decisions must rest on a shared understanding of the terms' meaning or at least on agreed management of them (Sebuliba and Sammler, 2025). At present, the connotation and denotation of several terms in the Agreement remain unclear, failing to provide robust legal directions or legal certainty. For example:

First, the scope of DSI. The BBNJ Agreement is the first legally binding instrument to establish regulations governing DSI (Marciniak et al., 2025). It explicitly brings DSI within its scope of application, which is an important contribution at the international agreement level. However, the scope of DSI remains contested, and there is no agreed definition at the international agreement level to date. The BBNJ Agreement does not resolve this gap. An *ad hoc* technical expert group on DSI under the *Convention on Biological Diversity* (CBD) put forward three sets of expert suggestions on the scope of DSI: DNA and RNA only; DNA, RNA, proteins, and epigenetic modifications; or DNA, RNA, proteins, epigenetic modifications, metabolic molecules, and other macromolecules (UNEP, 2020). These suggestions provide useful reference points for future deliberations.

Second, derivatives. Following the approach of the *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization* (the Nagoya Protocol) under CBD, the BBNJ Agreement incorporates derivatives indirectly through the definitions of “biotechnology” and “utilization of MGRs”. Under Article 2(e) of the Nagoya Protocol, “derivative” means a naturally occurring biochemical compound resulting from the genetic expression or metabolism of biological or genetic resources, even if it does not contain functional units of heredity. However, the BBNJ Agreement does not directly define derivatives. Under the current text, the reference to “biochemical composition” in the definition of “utilization of MGRs” may be a substitute for “derivatives” as used in the definition of “biotechnology”. In addition, the term “derivatives” does not reappear in the subsequent specific rules of the Agreement. The definition, scope and applicable rules for derivatives therefore require further clarification and study.

Third, the scope of benefits. Article 14 of the BBNJ Agreement provides that benefits arising from activities related to MGRs and their DSI shall be shared in a fair and equitable manner. Literally, the benefits refer to outputs generated by activities involving the collection and utilization of MGRs, such as samples, data, knowledge, R&D results, products and funds. This is a narrow sense of benefits, meaning that the benefits are closely related to the MGR activities themselves, which is also the typical and commonly understood meaning of benefits. However, the BBNJ Agreement does not adhere strictly this logic when specifying benefit-sharing types. For example, the annual contribution in MBS is not generated from MGR activities but is a fixed contribution obligation. Such types of benefits are loosely connected to MGR activities and fall within a broad sense of benefits. This inconsistency in how the Agreement frames the scope of benefits may affect future rule-making. For instance, the current types of monetary benefits are not limited, and it remains to be discussed whether the new types of monetary benefits that may be added in the future are coupled (i.e.,

the generation of benefits is linked to MGRs activities) or decoupled (i.e., the generation of benefits is decoupled from MGRs activities, such as fixed access fees, annual licensing fees, and membership fees) (Oldham et al., 2025).

Fourth, current international practices. Article 14, paragraph 2 (a) and (b) of the BBNJ Agreement provide that samples and DSI shall be obtained in accordance with current international practices. One of the aims in drawing on existing international practices was to build upon existing best practices adopted by researchers, avoid redundant efforts, and refrain from disrupting bottom-up approaches driven by the scientific community (Broggiato et al., 2025). However, there is no unified and standardized best scientific practices at the international level. Consequently, this provision fails to provide a clear, determinate legal direction and cannot be directly implemented in accordance with its term.

Fifth, the boundary of scientific data. Article 14, paragraph 2 (c) of the BBNJ Agreement provides for open access to findable, accessible, interoperable and reusable (FAIR) scientific data. However, unlike subparagraph (d), which sets a relatively clear scope for the information to be provided by reference to Article 12, no such clear scope is set for scientific data. In general, scientific data may include metadata, species data, taxonomic data, baseline biodiversity data, environmental data or biogeographic information collected *in situ* (Rabone et al., 2019). However, these categories may partially overlap with the information provided for in Article 12. What is the boundary between the two? What does “scientific data” encompass, and does it include data generated during the experimental stage?

Although these terms are ambiguous, their use is unavoidable in the subsequent discussion. To enhance readability for readers, they may therefore be simply understood in their typical or representative form. For example, the typical form of DSI refers to DNA and RNA; the typical form of derivatives refers to secretions from marine organisms; and the typical form of current international practice refers to the practice established under other benefit-sharing instruments; the typical form of scientific data related to the collection and utilization of MGRs includes data on taxonomic identification, morphological characteristics, and metadata.

2.2 Uncertain legal nature of benefit-sharing modalities

The choice of the legal nature of a certain benefit-sharing modality is crucial for establishing its basic implementation model and serves as the foundation for the subsequent development and refinement of its specific rules. However, under the current Agreement, the legal nature of several benefit-sharing modalities remains unclear. For example:

First, MBS. The *President's Aid to Negotiations* prepared for IGC-2 in 2019 mentioned the legal nature of benefit-sharing and listed two possible options: benefits may be shared on a voluntary basis, or benefits shall be shared (UNGA, 2018). These options reflected the fundamental divergences among negotiating parties on

this issue. Developing countries, including the African Group, the Caribbean Community, the Pacific Small Island Developing States and the Landlocked developing countries, hold that benefits arising from the utilization of MGRs, both monetary and non-monetary benefits, should be shared on a mandatory basis. By contrast, developed countries such as the United States, Japan, and South Korea only tend to share non-monetary benefits on a voluntary basis and do not support the sharing of monetary benefits (IISD, 2018, IISD, 2019). Such divergences have basically persisted throughout subsequent negotiation. At IGC-5, to ensure adoption of the Agreement, developing and developed countries made mutual compromises and reached a consensus. As a result, the Agreement text retains the MBS regime but provides only principled provisions, with the mandatory annual contributions by developed countries in exchange for deferring the formulation of specific rules (Zhang, 2024). Eventually, the BBNJ Agreement as a whole, including the rules on MBS, was adopted. The Agreement explicitly provides that non-monetary benefits shall be shared. For monetary benefits, the text addresses only whether to include MBS as a basic modality. At present, apart from the obligation of annual contributions, the legal nature of MBS remains unresolved, returning the issue to the choice between mandatory sharing and voluntary sharing.

Second, *ex situ* access to MGRs and DSI. *Ex situ* access, unlike *in situ* collection, obtains previously collected samples and generated DSI from repositories and databases held by scientific facilities in other countries. Regarding the conditions or threshold for *ex situ* access, there emerged two models during negotiations, namely “free and open *ex situ* access” and “public access with reasonable conditions”.¹ The negotiating parties failed to reach a unanimous agreement on the model of free and open access. Brazil, the Caribbean Community, the European Union (EU), and Philippines supported open access (IISD, 2017, IISD, 2018; UNGA, 2020); South Korea favored voluntary open access; (UNGA, 2020); China supported easy access rather than free and open access (China, 2017; IISD, 2019); Turkey supported Option II in the 2022 *Further Revised Draft Text*, namely public access subject to reasonable conditions (UNGA, 2022c); and the United States removed the phrase “open access” in its proposals, while supporting mandating the samples, data and related information publicly available (UNGA, 2020). The final text adopted the second option and deleted the mention of free and open *ex situ* access. Notably, the

Chair’s overview of the third session of the Preparatory Committee in 2017 recorded the fact that there seemed to be some convergence on the need to not hinder but rather promote marine scientific research (MSR) and to facilitate access (UNGA, 2017). Although it is certain that *ex situ* access constitutes public access with reasonable conditions, the Agreement also does not explicitly use the term “facilitated access” when it describes NMBS modalities in paragraph 2 of Article 14, merely describing *ex situ* access vaguely as “in accordance with current international practice”. By contrast, the Agreement explicitly uses the formulation “facilitated” when describing information, scientific data, knowledge and so on. Accordingly, how should the legal nature of public access with reasonable conditions be understood? Should it be treated as a form of facilitated access?

2.3 Lack of key details in the rules results in weak operability

Although the BBNJ Agreement establishes a benefit-sharing regime for MGRs, it remains merely a legal framework. Many sharing rules lack key details, rendering the modalities of benefit-sharing nothing more than terms on legal paper, which makes them difficult to practically operate. For example:

First, the preset milestone events or payment time nodes of milestone payments. The milestone payment model was established with the reference to the Nagoya Protocol. In essence, it is a conditional, phased scheme along the product development value chain, meaning that a fee should be paid once a preset or pre-identified milestone event is reached. During negotiations, the phased approach to benefit-sharing gained support from many states (IISD, 2022). However, the preset milestone events or payment time nodes of milestone payments have not yet been determined.

Second, the rate or range of payments related to the commercialization of products. In 2018, a 1% payment rate scheme appeared in the *President’s Aid to Negotiations* (UNGA, 2018). In 2022, Article 11, paragraph 6 of the *Further Refreshed Draft Text* provided that the initial payment rate should be 2% of the sales value of products commercialized through the utilization of MGRs, increasing by one percentage point annually until the 12th year, after which it should remain at 8% (UNGA, 2022a). However, this provision was deleted from subsequent drafts and remains unresolved in the current Agreement.

Third, the diversified indicators and periodic timing for tiered payments. The scheme of tiered payments emerged relatively late in the process of negotiation, with its first discussion taking place at the resumed session of IGC-5 in February 2023 (IISD, 2023). It was proposed by the Group of 77 and China, which expanded a new modality of MBS beyond milestone payments and royalties (Concepcion, 2024). It first appeared in the *Draft Agreement* at the further resumed session of IGC-5 in June 2023 (UNGA, 2023). Periodic tiered payments are regarded as an attempt to adopt a broader range of standards for benefit-sharing in determining the proportion of contributions that a Party should make when

¹ These documents, such as 2018 *President’s aid to negotiations*, 2019 *Draft Text*, and 2020 *Revised Draft Text*, referred to the option that the Parties shall take necessary measures to ensure that *ex situ* access to MGRs within the scope of the BBNJ agreement is free and open. Additionally, 2022 *Further Revised Draft Text* provided two options: Option 1 is that Parties shall ensure that samples and data, when available, are deposited in publicly available and open-access databases, biorepositories or gene banks as soon as they become available, without associated payment requirements; Option 2 is that MGRs subject to the utilization under their jurisdiction, where available, are deposited in publicly accessible biorepositories, gene banks or other collections, and specifies that *ex situ* access may be subject to reasonable conditions, including certain payment requirements (no material fees).

assuming obligations under the Agreement. However, the final text does not reflect the details of the tiered payment proposal put forward by developing countries (Concepcion, 2024). Currently, the Agreement's rules on periodic tiered payments remains relatively vague, and several issues such as the diversified indicators and periodic timing have not yet been clarified.

Fourth, the implementation mechanism for *ex situ* access. The current BBNJ Agreement adopts Option II, namely public access with reasonable restrictive conditions, which resolved the issues of conditions and thresholds for *ex situ* access. However, it does not yet address the issues of subsequent access procedures, mechanisms for operationalizing the rules of *ex situ* access, and safeguards for ensuring that subsequent benefits from access are shared in accordance with the Agreement.

Fifth, the scope of application of different modalities for the transfer of marine technology. The BBNJ Agreement sets out two parallel modalities for the transfer of marine technology, namely Article 42 (mandatory transfer modalities) and Article 43 (voluntary commercial transfer modalities).² Among these modalities, Article 43 operates as the additional modalities. Many types of capacity-building and technology transfer listed in Article 44 and in the non-exhaustive indicative list in Annex II are drawn from the *IOC Criteria and Guidelines on the Transfer of Marine Technology*, which guide implementation of UNCLOS Part XIV. However, UNCLOS Part XIV provides only for one transfer modality, namely voluntary transfer. By contrast, the BBNJ Agreement applies both modalities concurrently, with significant differences in their applicable conditions, procedures, rights and obligations. Accordingly, merely listing technology types without distinguishing the scope of technologies applicable to different transfer modalities constitutes a deficiency. The respective scopes of the two modalities need to be clarified; otherwise, it will lead to confusion and uncertainty in application.

2.4 Insufficient supporting monitoring rules

Monitoring rules serve the benefit-sharing regime. As a supporting and safeguarding mechanism, they are premised on the benefit-sharing schemes, with corresponding monitoring arrangements designed to match them. The non-technical

monitoring issues closely related to the realization of benefit-sharing are mainly as follows:

First, the requirements for notification of information on the utilization of MGRs. The *President's Aid to Negotiations* set forth certain relevant possible requirements in the monitoring provisions, including that proponents of MSR in ABNJ shall submit periodic status reports and research results (including collected data and relevant documents), and that Parties shall submit reports explaining the utilization of MGRs (UNGA, 2018). The *Further Revised Draft Text* then provided two Options of the monitoring provisions. Option I newly added two choices for the submission cycle of Parties' reports, namely annual or biennial, and does not mention other information that should be submitted. Option II highlighted the requirement to submit, assess and review information on the achieved commercialization of products (UNGA, 2022b). In the current BBNJ Agreement, paragraph 2 of Article 16 provides that Parties shall periodically notify the status of implementation, including utilization and benefits-sharing, but it does not specify a reporting cycle. In addition, information notification requirements are also scattered in other provisions. For example, paragraph 8 of Article 12 requires notification of where results of utilization can be found, the sale of products, and their further development. Overall, the existing notification requirements for utilization information remain relatively simplistic. They largely set out only a general obligation for Parties to report implementation status, with few details on the specific content or types of notifications. By contrast, although *Nagoya Protocol* establishes only a general notification obligation without more details, paragraph 1 of Article 17 requires that domestic checkpoints should monitor the utilization of genetic resources, or to the collection of relevant information at, inter alia, any stage of research, development, innovation, pre-commercialization or commercialization. It also provides that users and providers of genetic resources should share such information. This provision offers a direct legal basis for setting any information requirements in mutual agreed terms. Additionally, the *EU Access and Benefit-Sharing Regulation*, adopted as the EU's compliance measure for *Nagoya Protocol*, provides that users shall submit the information related subsequent users at the stage of final development of a product developed through the utilization of genetic resources or traditional knowledge³, and Article 16 of the Regulation specifies the reporting cycle for Member States to submit their implementation reports. Thus, the notification rules of the BBNJ Agreement do not provide complete institutional support.

Second, requirements for disclosure of origin. During the negotiations, disclosure of origin was repeatedly mentioned as an important measure to enable monitoring. The *Draft Text* once included intellectual property provisions, which provided the presumption of origin in patent applications, requirements for disclosure of origin, and the legal consequences of non-disclosure (UNGA, 2019). However, in the 2022 *Further Revised Draft Text* for

² Paragraph 1 of Article 42 provides that "Parties shall ensure capacity-building and shall cooperate to achieve the transfer of marine technology", rather than adopting euphemistic and non-mandatory formulations such as "shall... promote, promote actively, or endeavor to foster" used in Part XIV of UNCLOS. This provision therefore confers a mandatory effect on the obligation of technology transfer under the modalities of Article 42, while paragraph 3 explicitly provides that such modalities are country-driven. According to paragraph 2 of Article 43, the additional modalities fall within the category of voluntary commercial transfer modalities. Under this framework, the transfer of marine technology takes place in the form of market transactions, in which the provider and recipient need to reach mutually agreed terms or contracts.

³ See Article 4, paragraph 3 (b) and Article 7, paragraph 2 (b) of the *EU Access and Benefit-Sharing Regulation*.

IGC-5, these provisions were deleted (UNGA, 2022b). With the exclusion of intellectual property issues, the Agreement also does not provide for requirements on origin disclosure. If the research results on MGRs are to be used for patent applications in the future, the issue of origin disclosure will need to be addressed, whether through supplementary provisions under the BBNJ Agreement or through rulemaking by the World Intellectual Property Organization (WIPO). For the reason that: first, patent data indicate that nearly 90% of patent applications related to marine species fail to disclose the origin of the species involved (Blasiak et al., 2018). Second, as marine species may appear in exclusive economic zones and terrestrial aquatic environments due to their varying activity and life cycles, it is highly difficult to accurately identify whether a given sample originates from ABNJ (Oldham et al., 2014). Accordingly, if there is an absence of active origin-disclosure requirements for MGRs from ABNJ, it will lead to a gap in full-chain monitoring. Although the Nagoya Protocol also does not expressly set origin disclosure requirements for genetic resources, this gap can be filled through the domestic laws of its Parties. Approximately 32 countries, along with the EU and the Andean Community, have established various origin disclosure systems for genetic resources (WIPO, 2020). For example, Article 4, paragraph 3 (b) and Article 7, paragraph 2 (b) of the EU *Access and Benefit-Sharing Regulation* provides that users shall submit the source of genetic resources or traditional knowledge. However, the BBNJ Agreement specifically governs MGRs in ABNJ rather than the areas within national jurisdiction, making it impossible to replicate the practice of the Nagoya Protocol. Instead, uniform requirements must be established at the international law level.

3 Analysis of the causes for the unresolved issues of benefit-sharing

3.1 Ideological divergence: the deadlock over the legal basis for benefit-sharing

The basic construction logic of the benefit-sharing regime is largely influenced by the fundamental principles of the BBNJ Agreement. However, developing and developed countries have long held significant divergences on this issue throughout the negotiations. The former advocate applying the principle of the common heritage of humankind, arguing that MGRs are part of the common heritage, shared by all humanity, and not subject to monopoly by any specific entity (Liu and Qi, 2022). They contend that the benefits derived from the development and utilization of MGRs constitute the common interests of all humanity and should be shared fairly and equitably among all countries, encompassing both monetary and non-monetary ones (G77 and China, 2016). The latter assert that MGRs should be governed by the principle of freedom of the high seas and constitute *res nullius* that may be freely utilized. They contend that there is no legal gap in the field of MGRs, and MGRs fall within high seas regime of UNCLOS. They oppose extending the principle of

common heritage of humankind beyond the international seabed area (the Area) (US, 2016), stressing that designating any part of the high seas water column as such is inconsistent with UNCLOS (UNGA, 2014). They further maintain that MGRs follow the “first come, first served” rule (Zheng et al., 2017). Consequently, the benefits arising from their development and utilization would be controlled autonomously by the utilizing party. Thus, it can be seen that developing and developed countries hold sharply opposing positions on the legal basis. The two camps have not reached a consensus to date. The divergence remains significant, with great difficulty in reconciling their differences, and the dispute over the legal basis persists.

Finally, the Agreement incorporates two mutually exclusive principles, thereby rendering the legal basis for benefit-sharing ambiguous. There is interpretive uncertainty regarding which principle should serve as the foundation for benefit-sharing. Under the principle of the common heritage of humankind, with all humanity as the subject of rights, benefits should undoubtedly be shared, and arbitrariness is excluded. The proportion, timing, and conditions of sharing, among other aspects, cannot be unilaterally determined by the utilizing party. By contrast, under the principle of freedom of the high seas, benefit-sharing may be interpreted as development assistance provided by developed countries to developing countries. The utilizing party would have broad autonomy in deciding how to share benefits, and benefit-sharing could become logically disconnected from the utilization of MGRs. This interpretive uncertainty poses hidden risks for further negotiations at the COP.

3.2 Practical difficulties: uncertainty in the development of MGRs

Developed countries, as the primary utilizing parties, argue that the commercialization of MGRs is costly, difficult and lengthy (IISD, 2018). They are concerned that MBS will further exacerbate these difficulties and increase costs, thereby hindering MSR (IISD, 2016). Specifically including:

First, upfront R&D costs are high. For one thing, specialized marine research vessels are required for the collection of deep-sea biological resources, with daily operational costs of at least US \$25,000 (UN, 2016). For another, input costs in technology, equipment, personnel and clinical trials are considerable, with approximately US\$800 million to US\$1 billion needed to bring a marine drug from R&D to market (Blasiak et al., 2023; Leary et al., 2009).

Second, R&D on MGRs entails high failure risk and long payback periods. There is significant uncertainty regarding whether a research project will succeed or generate commercial returns. Research efforts spanning years or even decades may ultimately yield no practical outcomes (Morris, 2018). Taking marine drug development as an example, it typically takes 15 to 20 years from sampling to the final commercialization of products, with only about 0.001% of products advancing to human clinical trials (Leary et al., 2009; Zheng et al., 2018). Most microbial

compounds remain in preclinical research phase (Blasiak et al., 2020), and upfront sunk costs do not yield predictable returns.

Third, there are concerns about potential financial and administrative burdens. Specifically: (1) MBS may increase the costs of product development; (2) it may heighten investment uncertainty and risks, thereby discouraging investment and impeding research; (3) complex monitoring, tracing, and compliance requirements may impose additional burdens on researchers (Broggiato et al., 2018; Collins et al., 2020).

3.3 Essence reason: the crux of the unresolved issue lies in conflicts of interest

Divergences in past negotiations on the benefit-sharing regime of the BBNJ Agreement essentially stem from conflicts of interest between different negotiating parties.

Foremost, national interest is key to understanding a state's negotiating behavior. States formulate foreign policy and make certain national actions or decisions based on their interests, with considerations rooted in their interest orientation. A state is regarded as a rational actor; it calculates its interests and chooses the optimal foreign policy to achieve its goals (Więclawski, 2020). The rationality of state behavior in international affairs is reflected in safeguarding interests, maximizing benefits, and minimizing losses.

Secondly, as the guardian of the interests of all its citizens, a state's national interest is shaped not by a single force but by interaction and bargaining among multiple stakeholders. In practice, national interest is jointly influenced by the preferences of various domestic interest groups, such as industrial sectors, environmental organizations, and the scientific community (Marchiori et al., 2017). Domestic forces are a critical factor that cannot be ignored in the formation of a state's foreign policy. The interest demands of various domestic forces collectively participate in shaping the national positions presented in negotiations. The government, after weighing the pros and cons of different proposals and balancing stakeholders demands, formulates policies aligned with the state's overall and long-term interests.

Thirdly, there exists competition and cooperation between different stakeholders, and their demands or preferences may conflict (Bunea, 2014). For example, industry tends to favor lenient policies to reduce costs and unnecessary burdens (Rogers et al., 2021; Vandenbrink et al., 2020), and worries that benefit-sharing (such as data sharing and technology transfer) may lead to the leakage of core trade secrets and harm market competitiveness (Jyotia and Efraxia, 2023). Environmental organizations advocate strict policies and the active assumption of national responsibilities to protect the environment (Vandenbrink et al., 2020). The scientific community argues for unencumbered access to and use of DSI from public databanks, thereby facilitating global scientific research and innovation, and supporting biological conservation (Abatayo et al., 2025; Joint Stakeholder, 2019). This outcome is reflected, for example, in advancing biological research, deepening understanding of biodiversity through taxonomic studies, and conducting international research cooperation (Joint Stakeholder,

2019). In addition, studies indicate that a clear and equitable benefit-sharing framework could provide new funding sources and cooperation opportunities for MSR (Harden-Davies and Snelgrove, 2020; Rogers et al., 2021).

Finally, in view of differences among countries in overall development level, industrial capacity, technological level, and development needs, a basic picture of national interests on benefit-sharing emerges. Benefit-sharing parties (mainly developed countries) tend to narrow the scope of benefit-sharing obligations, reduce payment liabilities, ease burdens, and mitigate impacts on MSR and industrial activity. Beneficiaries (mainly developing countries) seek to maximize legitimate interests, ensuring a share in benefits from advances in marine science, including economic interests, scientific data, knowledge, and products, thereby securing funding, data, and technological support for national development (Hassanali, 2023).

Inevitably, these tendencies lead to conflicts of interest between the two sides. However, the conflict is not zero-sum; it is a benign rebalancing process within the framework of global ecological cooperation. The urgency of marine biodiversity conservation, combined with the complexity of global ocean governance driven by ecological connectivity and the vastness of the governance area, means that the arduous task of achieving the Agreement's goals cannot be accomplished by a few states alone; instead, it is essential to strengthen broad-based international cooperation. Diligent fulfillment of benefit-sharing obligations by developed countries can secure and exchange the support of developing countries in relation to marine protected areas and environmental impact assessments. Furthermore, pursuant to the Agreement, shared benefits shall be used to fund CBT projects and related activities on the conservation and sustainable use of marine biological diversity, assist developing country Parties in implementing the Agreement, and support any other activities as decided by the COP. In turn, conserving genetic resource diversity will ultimately benefit developed countries more significantly, given their stronger utilization capacity; also, this will help promote improvements in the marine ecological conditions, and such an outcome will be beneficial to all countries around the world.

Effective implementation of the BBNJ Agreement and the achievement of common goals will require cooperation among all parties. Accordingly, a priority for future work on unresolved benefit-sharing issues is to minimize conflicts of interest among states, on the premise of ensuring effective implementation. Correspondingly, the crux of resolution lies in giving due regard to the reasonable concerns of all parties.

4 Exploring a feasible approach to address unresolved issues

4.1 Approaches proposed during negotiations

In the past, disputes between developing and developed countries over applicable fundamental principles and the

attendant institutional design reflected a logicism approach. Logicism, grounded in conceptual jurisprudence, emphasizes the analysis and distinction of legal concepts, thereby formulating legislative models and determining the foundation for constructing the legal system (Zhang, 2023). However, deep divergences over the legal status of MGRs or the legal basis for benefit-sharing revealed the limits of logicism. Past negotiation situation shows that neither side is likely to make significant concessions. These divergences are unlikely to be bridged in the short term, and prospects for promptly resolving the legal basis are poor, risking renewed deadlock. Accordingly, if negotiations continue to settle the issue of legal basis, progress will be slow. The outcome, in turn, will hinder the timely implementation of the Agreement and undermine the achievement of the goals of conserving and sustainably using marine biodiversity. Accordingly, it is imperative to explore a more realistic and feasible approach to advance the implementation of the Agreement.

At present, the Agreement practically incorporates both the principle of the common heritage of humankind and the principle of freedom of the high seas, with both principles having attained the status of fundamental legal principles. This implies that the two principles will operate concurrently. Furthermore, given deep ideological divergences, the legal status of MGRs cannot be fully categorized as anyone single nature, meaning MGRs can hardly be defined as either the common heritage of humankind or *res nullius*. Accordingly, the legal status of MGRs will remain undetermined for a long time. However, it is impossible for subsequent issues related to access and benefit-sharing to be entirely stalled due to uncertainties over legal status, as the BBNJ Agreement needs to operate practically to fulfill its intended role.

It is note that efforts were made during negotiations to bridge the ideological gap between the two camps. For instance, the EU and other parties advocated a “Third Way”: a pragmatic approach that bypassed disputes over fundamental principles and formulated feasible measures for access and benefit-sharing (EU and its Member States, 2016). However, the EU’s proposal covered only non-monetary benefits such as facilitated access, information and knowledge sharing, scientific cooperation, technology transfer, and capacity-building (EU and its Member States, 2017; IISD, 2019). Its aim was to limit benefit-sharing to scientific research itself rather than to the subsequent economic utilization of research outcomes (Liu, 2020), but it fail to contribute a consensus on MBS. Nevertheless, the basic logic of this approach, namely avoiding disputes over principles, focusing on the design of institutional rules, and attempting to coordinate the reasonable concerns and demands of both developing and developed countries, merits adoption. This logic reflects a paradigm of legal functionalism and has gained support from some states and scholars.

4.2 Legal functionalism as a guiding ideology

One of the core concepts of legal functionalism can be summarized as the principle that “form follows function”. This

concept was introduced by President Rena Lee during IGC-2, implying that the new institutions established under the negotiating instrument should be responsive to actual needs. Moreover, this concept has also been accepted and applied by scholars in studies of the BBNJ Agreement (Tang, 2024), and the sectoral division design approach adopted international agreements likewise reflects a functional inclination.

Guided by the concept, legal functionalism is primarily characterized by the following aspects⁴: First, it is function- or goal-oriented. Legal functionalism focuses on the operative role of law in society, emphasizes the social effects of legal operations (Mermin, 1973) and treats legal outcomes as fundamental (Kraus, 2002). It specifies the goal that law should attempt to achieve and the means that law deploys to achieve those goals (Schwartz et al., 2020). Second, it is problem-oriented. Legal functionalism emphasizes law’s role for resolving specific social issues (Zhang and Yuan, 2024). It underscores the extent to which the law responds to the requirements, customs, and necessities emerging from social practice (Zumbansen, 2008). Third, it stresses the instrumentality of law. Legal functionalism views law as a means to achieve particular social, political or economic ends (Michaels, 2012). It focuses on the law’s tool attribute in social regulation. Fourth, rules should be designed and interpreted in accordance with its functions. This approach takes the views that legal schemes are determined based on the social impacts of law enforcement and society’s differentiated functional demands on law (Lao, 2020), and legal interpretation should be influenced by law’s social functions (Xu, 2024). Fifth, it shows a strong pragmatist orientation. Legal functionalism stresses institutional integration, arguing that in order to achieve specific functions and goals, legal design may transcend the boundaries of existing models (Zheng, 2016). Grounded in practical needs of real life, it identifies substantively reasonable orientations for interest perception and criteria of value selection, and further legalizes the interest tendencies and value choices that are intelligible and acceptable to practical reason (Tian, 2024).

In the BBNJ context, the primary functions of the Agreement should focus on conserving and sustainably using marine biodiversity. If debates over the legal basis delay realization of its intended function, the Agreement will deviate from its goals. Legal functionalism is well-suited to the BBNJ Agreement’s need to resolve current negotiation challenges, break through the dilemma, and promote the reaching of consensus and the achievement of goals. Accordingly, the concept of “form follows function” should be adhered to, and the legal functionalist approach should be adopted as the guiding direction for subsequent negotiations. This requires temporarily bypassing disputes over the legal basis and prioritizing the design of specific institutional rules, with a view to shifting the focus to how to better realize the Agreement’s functions and goals. However, legal functionalism is

⁴ There are various interpretations of functionalism in academic scholarship. Here, only those aspects that correspond to the concept of “form follows function” are selected.

not flawless. It may overlook certain values, such as fairness, due to its overemphasis on the functions of law. Accordingly, while pursuing goals and designing specific rules, it is necessary for COP to accord due regard to the concerns and legitimate interests of different stakeholders.

In addition, transforming rule schemes into legal rules under the BBNJ framework ultimately depends on the COP and its relevant subsidiary bodies performing their respective functions. After completing negotiations on the COP's rules of procedure, subsidiary bodies, the establishment of the Clearing-House Mechanism, and financial rules in the preparatory meeting phase, negotiations on the substantive rules for benefit-sharing and monitoring will be conducted during the COP phase. Subsequently, whether specific rules are refined through supplementary documents or guidelines, they will require multilateral negotiations at the COP and adoption by vote. Meanwhile, subsidiary bodies under the COP, including the ABSC, the Capacity-Building and Transfer of Marine Technology Committee (CBTTC) and the informal working group on the CHM, have authorities to recommend and review matters concerning benefit-sharing modalities and implementation status. These bodies will also play a crucial role in refining the Agreement's rules. Accordingly, when the COP and its subsidiary bodies exercise their relevant functions, they may consider taking the aforementioned legal functionalist approach as guidance.

4.3 Feasibility of adopting solutions under a legal functionalist approach

4.3.1 Political and legal feasibility for a legal functionalist approach

The current benefit-sharing framework has been basically established, and the formulation of specific rules will largely depend on the political will of developing and developed countries, as well as the outcomes of their respective interest-based assessments.

On the one hand, developments at IGC-5 indicate that consensus on specific benefit-sharing provisions remains possible between the two camps. For instance, in parallel sessions, some participants such as the EU shifted from their previous stance of opposing MBS and began to explore the feasibility and specific schemes of MBS; the Chinese delegation also adjusted its position on whether *ex situ* access includes DSI (Shi, 2023). The final adoption of the Agreement signals that both sides made reciprocal compromises: neither side fully abandoned its claims, nor did either insist on them absolutely, reflecting a negotiated balance rather than a unilateral victory.

On the other hand, as stakeholders in developed countries have noted, the potential benefits and burdens of benefit-sharing hinge on the details of the rules and how they are implemented (Collins et al., 2020). Accordingly, as long as the corresponding rule schemes can align with the fundamental concerns of the two camps—namely, ensuring the fair and equitable sharing of benefits (including monetary benefits) for developing countries, and

avoiding obstacles to MSR and industrial activity for developed countries—the two sides may still reach mutual compromise.

Thus, the issue of the legal basis does not necessarily need to be resolved first and may be temporarily bypassed. Even without settling this issue, it remains possible to resolve the unresolved issues of benefit-sharing. Accordingly, in order to implement the BBNJ Agreement and advance effective conservation and sustainable use of marine biodiversity, future efforts should account for different positions and proposals simultaneously, and develop rule designs that help better facilitate broad consensus.

4.3.2 Favorable conditions for a legal functionalist approach

In negotiations over international agreements, the negotiation strategies of states are not only adjusted as talks progress but also often undergo significant shifts before and after the formal adoption of the agreement text. These shifts are driven by two factors: (i) a narrowing of negotiating space (from open-ended to constrained) and (ii) a change in negotiating objectives (from maximizing interests to safeguarding interests while ensuring implementation). The realist school holds that the essence of international politics lies in conflicts and competition for power among states, that core driver of state behavior is the preservation and maximization of national interests, and that national interests guide the formulation of foreign policies (Horowitz, 2018).

Prior to the Agreement's adoption, the formal text remained undetermined, leaving wide negotiating space for all parties. Guided by the objective of maximizing national interests, each party sought to secure the greatest possible benefits before the text was finalized, advocating inclusion of clauses aligned with their interests or exclusion of adverse provisions. Consequently, negotiating parties at this stage tended to scrutinize the Agreement's provisions, adopting relatively aggressive negotiating strategies and holding clear-cut positions. They fully articulated, and at times amplified, their claims to gain leverage in negotiations or to preserve bargaining space for potential compromises or concessions if positioned unfavorably.

However, once the Agreement's text is finalized, the negotiating space narrows, as the textual framework serving as the basis for negotiations becomes constrained. At this point, the negotiating objectives shift from "securing the most favorable clauses" to "protecting core interests, ensuring effective implementation of the Agreement, and advancing common goals". Correspondingly, negotiating strategies often shift from aggressive to more moderate, making compromise more likely in subsequent negotiations. This shift can be attributed to four reasons: Firstly, the BBNJ Agreement is itself the product of compromise, with many provisions already reflecting the interest preferences of negotiating parties to varying degrees. Secondly, the Agreement now incorporates elements previously opposed, such as MBS and application to MGRs obtained through *ex situ* access. It is a settled fact that subsequent negotiations will proceed on this agreed text. Thirdly, the transformation of the Agreement's norms from legal text to practical operation, that is, from normative requirements to social effectiveness, ultimately depends on effective participation by

various parties or stakeholders. This, in turn, requires strengthened cooperation going forward. Fourthly, to achieve the common goals of conserving and sustainably using marine biodiversity, support and joint participation from multiple parties are needed not only in benefit-sharing but also in other areas such as marine protected areas and environmental impact assessments. Each area is prioritized by different interest groups. In exchange for support from other Parties in their priority areas, Parties are likely to engage in further interest-based trade-offs and reciprocal compromises.

In conclusion, as objective conditions change, Parties' negotiating strategies tend to shift from aggressive to more moderate. Because Parties need effective cooperation with each other, future negotiations are likely to be more conducive to reaching compromises than in the pre-adoption phase. Accordingly, this is likely to create favorable conditions for adopting a legal functionalist approach.

4.4 The ought-to-be criteria for the legal functionalist approach

Synthesizing the foregoing analysis, the legal functionalist approach may be specified as follows: First, guided by the Agreement's functions and goals, efforts should focus on the design of specific benefit-sharing rules to advance the negotiation process and promote the subsequent implementation, while temporarily setting aside disputes over the legal basis. Second, the key to resolving unresolved issues lies in managing conflicts and coordinating concerns. When addressing specific rulemaking matters, COP should accord due regard to the diverse interest demands of Parties, and coordinate reasonable concerns to build consensus. Only when the Agreement's rules are genuinely accepted by Parties will effective implementation be achieved and the Agreement's functions realized.

The aforementioned approach can be further decomposed into the following ought-to-be aspects:

1. Effectiveness: it should help forge broad consensus, drive progress in negotiations, and promote the Agreement's implementation.
2. Goal-orientation: rule designs must prioritize and align with the Agreement's goals. They should contribute to achieving the Agreement's ultimate goals, as well as the phased or subsidiary objectives that serve the ultimate goals (e.g., promoting MSR, facilitating the generation of benefits). If a law fails to achieve its intended goals in practice, it will be of little value even if its provisions are textually flawless.
3. Substantive requirements: it should give due regard to the reasonable concerns, and enable flexible resolution of divergences. However, such coordination must be premised on ensuring the achievement of the Agreement's core goals.
4. Threshold criterion: it is unrealistic for a rule scheme to satisfy all stakeholders. Appropriate reference may be made

to the principle of "the greatest happiness for the greatest number" proposed by utilitarian school. In other words, the concern to be coordinated should be the primary and fundamental concerns of the two camps, with a focus on resolving the main contradictions.

5. Operationality: in rule design, operational criteria may be adopted to enhance the practical operability of the rules and to facilitate their transformation from legal texts into effective practices. These criteria may include acceptability, enforceability, measurability, transparency, and traceability. Specifically, measures may be taken such as ensuring cost affordability, defining clear triggers, setting indicative ratios, developing measurable indicators, refining accessible reporting rules, and introducing incentives or sanctions.
6. Interplay: other design principles are derived from the concept of "form follows function." In turn, to realize the intended functions, it is essential to ensure that the corresponding rules can be effectively implemented. However, implementation depends largely on the decisions on implementation taken by Parties (Freestone and Mossop, 2025) and the compliance of relevant entities. Rules that entities are willing to comply with should thus be acceptable or affordable to them. Accordingly, rule design must address conflicts and give due regard to diverse concerns to enhance acceptability. Moreover, these rules are adopted through voting in the COP. For a proposal to reach the necessary threshold for adoption, it must gain broad support and consensus among multiple Parties.

5 The application of the legal functionalist approach to the unresolved issues

5.1 Refining the Agreement terms guided by function

The scope of defined terms directly affects the subsequent scope of rights and obligations related to benefit-sharing, and plays a foundational role in the entire BBNJ Agreement. Accordingly, regarding term issues, the primary consideration should be to facilitate the achievement of the Agreement's goals.

First, the role of terms such as DSI, derivatives, and scientific data in promoting scientific research and cooperation should be leveraged. On the one hand, when the ABSC addresses the definitional scope of key terms, it is appropriate to adopt a broad scope of terms, along with a basic and indicative list of categories. Such a broad scope would provide a good foundation for the establishment of a potential CHM-based global database to facilitate sharing of sequence information, scientific data, and other resources. Aggregating such information, data and knowledge can create a common pool (Broggiato et al., 2014),

and, together with developments in artificial intelligence (e.g., AlphaFold 3), enhance research efficiency and drive a surge in scientific advancements. By leveraging the advantages of artificial intelligence and supercomputing capabilities, gene mining, simulation, and calculation can be made more rapid. This accelerates R&D progress of products such as marine pharmaceuticals, shortens development cycles, and reduces input costs and failure risk. At the same time, it should be noted that DSI is difficult to monitor due to its intangible nature. Accordingly, when the informal working group on CHM designs the database, emerging technologies such as blockchain (Yuan and Liao, 2019) can be integrated to ensure that database access is recorded and tracked, thereby guaranteeing the full-chain traceability of DSI. On the other hand, the ABSC and the Scientific and Technical Body should strengthen cooperation with the scientific and industrial communities and solicit stakeholders' opinions. For one thing, the legitimate interests of stakeholders should be taken into account. Stakeholders may choose not to disclose sensitive research- or experimental-phase data, including data generated from the analysis and processing of sequence data (e.g., predicted protein functions or gene associations). Some commentators argue that these data have R&D value and that access should be subject to fees (UNEP, 2021). For another thing, the legal boundaries between different terms should be clarified. This is because classifying a specific data type under different terms yields different legal binding force of associated obligations. The ABSC should survey and synthesize existing international practice, including practice and reform progress under relevant instruments and practice in the scientific and industrial communities, and then identify best scientific practices by drawing on practitioners' experience and perspectives.

Second, a broad sense of benefits generally provides greater flexibility and adaptability for rule design. On the one hand, when the ABSC and the CBTTTC take this concept as guidance to recommend potential benefit-sharing modalities, it makes it possible to develop new modalities that are goal-aligned, reasonable, feasible, and affordable in light of changes and needs in practical circumstances. A broad conception is therefore more practical for governance. On the other hand, it cannot be generalized whether expanding the scope of a specific type of benefit is conducive to achieving the Agreement's goals. Specific analysis is required for each case. Whenever a new benefit-sharing modality is proposed, its rule scheme should be assessed for effects on utilization practices, stakeholder acceptance, operational feasibility, and contribution to the Agreement's goals. For instance, with regard to potential types of MBS, COP should adopt decoupled payment types sparingly. This is because many such types are likely to be applicable as early as the initial stages of research. Although this enables the BBNJ Special Fund to receive financial inflows at an earlier stage, it will impose additional burdens on MSR. Furthermore, decoupled types may not fully capture the value from high-profit activities and require careful calibration to ensure fairness and effectiveness (Oldham et al., 2025). Accordingly, the expanded scope of benefits primarily

refers to non-monetary benefits. Meanwhile, the overall design should keep benefit-sharing requirements relatively light.

5.2 Clarification of the legal nature of specific sharing modalities

5.2.1 Selection and rectification of the scheme for the legal nature of MBS

Under the *International Treaty on Plant Genetic Resources for Food and Agriculture* (ITPGRFA), the *Standard Material Transfer Agreement* (SMTA) provides that where a recipient or user of genetic resources chooses to restrict a commercialized product from being freely available to others for further research and breeding, the recipient shall be subject to a mandatory payment obligation (Article 6.7); conversely, the recipient may undertake a voluntary payment obligation (Article 6.8). This arrangement constitutes an optional scheme; but once a user elects, only a single legal nature of payment obligation applies to the user, which is essentially a variant of a single-nature scheme. Its practical implementation can be used to examine the effectiveness of both mandatory and voluntary schemes simultaneously. In practice, users tend to prefer the voluntary payment model, as mandatory payments would increase their financial burdens and thus lack attractiveness. However, voluntary payments have not been effectively implemented, given that they can place paying users at a competitive disadvantage in the market compared to non-paying competitors (FAO, 2014). The voluntary payment option has undermined the operational effectiveness of the ITPGRFA Multilateral System for access and benefit-sharing, including the mandatory payment pathway. The Multilateral System cannot rely on the "goodwill" of voluntary payments (FAO, 2016b). As of 2023,⁵ total revenue from users of the Multilateral System amounted to US\$ 391,721, accounting for only 1.11% of the Benefit-Sharing Fund (FAO, 2023a). The magnitude and sustainability of payments from users of the Multilateral System have fallen short of expectations (FAO, 2023b).

Both mandatory and voluntary schemes exhibit distinct strengths and limitations. At the same time, the legal nature of MBS affects the direct interests of different parties, and none is likely to make a fundamental concession on this issue. Therefore, a single-nature approach is not practically feasible, as past negotiations have also demonstrated. A legal functionalist approach is to explore a preset hybrid model that combines mandatory and voluntary elements. It can flexibly coordinate diverse interest demands. Moreover, such a model has precedents in other benefit-sharing instruments, such as the World Health Organization (WHO) *Pandemic Influenza Preparedness (PIP) Framework for the sharing of influenza viruses and access to vaccines and other benefits* (see Table 2).

⁵ Meetings of the governing body of the ITPGRFA are held once every two years. Accordingly, the 2022-2023 Benefit-Sharing Fund Report is the latest published report.

TABLE 2 SMTA 2 outside the global influenza surveillance and response system (GISRS).

Legal nature	Wording of provision	Benefit-sharing modality
Mandatory obligation	The recipient “shall commit”	Such as: <ul style="list-style-type: none"> • Donate pandemic vaccine or needed antiviral medicine; • Reserve pandemic vaccine or needed antiviral medicine at affordable prices; • Grant manufacturers in developing countries licenses on technology, know-how, products and processes, or royalty-free licenses on intellectual property rights (IPRs); • Grant WHO royalty-free, non-exclusive licenses on IPRs.
Voluntary obligation	The recipient “shall consider contributing to the measures listed below, as appropriate”	<ul style="list-style-type: none"> • Donations of vaccines, or pre-pandemic vaccines, or antivirals, or medical devices, or diagnostic kits; • Affordable pricing; • Transfer of technology and processes; • Granting of sublicenses to WHO; • Laboratory and surveillance capacity building.

Further discussion is needed on which legal nature should take precedence. Developments in the ITPGRFA reform indicate an intention to convert the voluntary payment provision in Article 6.8 to a mandatory one. In the draft revised SMTA, the alternative provisions for Article 6.8 have shifted from two parallel options, namely mandatory payments and voluntary contributions, to a single mandatory-payment option. The remaining distinction is that the payment rate under this revised Article 6.8 would be set lower than that the rate under Article 6.7 (FAO, 2016a, FAO, 2019, FAO, 2023b). This change is worthy of reference. Under the BBNJ Agreement, MBS should be predominantly mandatory, with voluntary elements serving as a supplement. Because a payment scheme centered on voluntariness would leave the Special Fund without a stable and predictable source of funding. Such scheme fails to effectively respond to the needs and concerns of developing countries. Furthermore, during negotiations, negotiating parties engaged in interest exchanges and reciprocal compromises to reach an overall agreement on the package of issues. Developing countries accepted and supported the marine protected area regime in exchange for developed countries’ acceptance and support for the benefit-sharing regime (IISD, 2011). If MBS were centered on voluntariness, the final practical outcome of this package deal would be interest imbalance. The benefits that developing countries anticipated during negotiations would be difficult to realize in practice, thereby undermining the principle of fairness, substantive justice, and the “spirit of pacta sunt servanda” in cooperation and transactions. Although a predominantly mandatory MBS scheme also has shortcomings, it leaves room for adjustment. Specifically, developed countries primarily worry that a predominantly mandatory payment model may increase MSR burdens, discourage investment, and thus hinder the actual generation of benefits. To address this, developed countries’ concerns can be given due regard by formulating light specific

rules for MBS and reducing the number of newly introduced MBS modalities. As for the lower limit of reduction, it should be set at a level that does not undermine the Agreement’s intended funding objectives. While adopting the light MBS scheme, incentive measures should be implemented to encourage good-faith compliance, and the possibility of punitive measures (such as restrictions on voting rights) should not be excluded. This is because, where a domestic user intentionally fails to comply without just cause and does not cure the payment default within the grace period, the relevant Party shall bear supervisory responsibility.

5.2.2 Facilitated *ex situ* access

Given the R&D difficulty of MGRs, substantial benefits are realized only in the medium to long term. *Ex situ* access, as an NMBS modality positioned at the front end of utilization and capable of being operationalized relatively early, is of clear significance. Under a legal functionalist reading, *ex situ* access can be interpreted as a form of facilitated access. This interpretation is more aligned with the Agreement’s goals, for the following reasons: First, facilitated access helps ensure full utilization of collected MGRs and DSI, promotes MSR and strengthens scientific collaboration, thereby advancing technological progress and scientific development. On the one hand, it facilitates the deepening of scientific understanding and the continual updating of scientific knowledge, which in turn supports the conservation and sustainable use of marine biodiversity (Collins et al., 2020), and contributes to a healthy ocean. On the other hand, it drives the creation of new research outputs and products that will benefit all of humanity. Second, it helps reduce unnecessary or duplicative *in situ* collection activities, minimizing disturbances to natural environment and ecosystems, particularly fragile deep-sea ecosystems. Meanwhile, the Agreement has taken into account the high costs of *in situ* collection and included an embargo period provision that requires access to *ex situ* MGRs shall be provided no later than three years from the start of utilization.⁶ This provision already given due regard to the interests of *in-situ* collectors and their R&D needs. Accordingly, there is no issue of interest imbalance.

In addition, the current Agreement provides textual bases for interpreting *ex situ* access as “facilitated access”. First, paragraph 5 of Article 12 provides that notifications following *in situ* collection shall include the repository or database in which samples and DSI are deposited. This may be read as providing a convenient channel for other Parties to access such resources subsequently. Second, paragraph 4 of Article 14 confines “reasonable conditions” to cost recovery for the storage and provision of samples and DSI. This means that *ex situ* access is subject to a low threshold. Furthermore, qualifying these conditions as “reasonable” implies that they must remain moderate and justified. In other words, providers should not refuse access requests from other Parties absent just cause.

⁶ See Article 14(3) of the BBNJ Agreement.

5.3 Provision of key details for specific benefit-sharing rules

5.3.1 Preset milestone events

The presetting of milestone events should fully take into account the characteristics of different phases in the utilization chain of MGRs and be discussed on a phased basis.

First, at the access phase. For *in situ* collection, the BBNJ Agreement does not distinguish between collection for scientific research and collection for commercial research. The sole difference lies in research intent and objectives; outwardly the observable activities, equipment, methods, and other features are the same (Salpin and Germani, 2007). Moreover, contemporary research entities are complex combinations balancing public and private interests in varying proportions (Thambisetty, 2018), and subsequent research objectives often shift (from non-commercial to commercial). Accordingly, maintaining such a distinction has little practical value. Essentially, both types of collection are part of MSR activities conducted on the high seas and in the Area under UNCLOS. For this reason, payment requirements should not be contemplated at this phase so as to avoid imposing unreasonable obstacles to MSR activities, consistent with the consensus to “promoting rather than hindering MSR” (UNGA, 2017). For *ex situ* access, the BBNJ Agreement requires the accessing party to bear the reasonable expenses incurred by the custodian for storing and providing MGR samples, data, or information. Such expenses only serve to offset the custodian’s inputs and do not constitute monetary benefits available for benefit-sharing.

Second, at the R&D phase, the R&D activities involving MGRs require substantial upfront input and carry a high risk of failure. Therefore, requiring milestone payments at this stage would increase upfront financial burdens and unduly interfere with R&D activities. Such a requirement lacks sufficient reasonableness and feasibility, and in practice, inappropriate payment requirements would also be difficult to comply with. However, MSR activities remains subject to certain NMBS obligations, such as the sharing of data, knowledge, and information, because these obligations do not impose significant burdens on scientific research activities.

Third, at the patent application phase, the grant of a patent only signifies only potential commercial interests and does not, by itself, guarantee commercial returns. No actual monetary benefits are generated at this stage. For patent transfers and licensing, while the likelihood of realizing commercial value increases somewhat at this point, commercial risks still persist. Mandatory payment requirements would be inappropriate here. However, voluntary contributions may be permitted, without the imposition of fixed contribution standards. As an incentive, the extent of benefit-sharing obligations in subsequent phases could be reduced commensurate with the level of such contributions.

Fourth, triggering payment requirements upon the commercial utilization of MGRs is more reasonable, as this can minimize the inhibitory effect on R&D and innovation (Pisupati et al., 2008). What needs further discussion are the timelines for mandatory and voluntary milestone payments in subsequent phases, such as when

researchers recoup their upfront R&D costs and achieve large-scale commercialization, or when product sales revenue exceeds a specific amount.

5.3.2 Payment rates related to the commercialization of products

The determination of payment rates may draw on the provisions of relevant international legal instruments and their implementation. For example:

Under the ITPGRFA system, the original SMTA included a set of optional schemes: Article 6.7 within the mandatory payment scheme set a rate of 1.1%; Article 6.11 operated as an alternative to Article 6.7 by lowering the rate to 0.5% while correspondingly broadening the scope of products subject to benefit-sharing; no payment rate was specified for the voluntary payments under Article 6.8. However, these schemes were not effectively implemented, and all payment rates are subject to reduction (see Table 3). The draft revised SMTA indicates that the payment rates for Article 6.7 and Article 6.8 (which has been revised to mandatory payment) will be reduced by 30% (FAO, 2019) (FAO, 2023b). The revision proposal for Article 6.11 provides that if a recipient chooses to become a subscriber to the Subscription System, it shall make annual contributions at a rate of 0.01% to 0.1% of its revenue, including product sales (FAO, 2023b).

In this regard, two points merit attention. First, the changing trend of payment rates under SMTA offers useful guidance. The BBNJ Agreement should avoid setting excessively high payment rates, as these would be difficult to implement effectively. However, it is also necessary to note that the ITPGRFA governs the food and agriculture sector, where value added per product is generally lower than that in the MGRs field; furthermore, the primary objective of benefit-sharing under the ITPGRFA is to support sustainable agriculture and ensure food security. Accordingly, even if payment rates under the BBNJ Agreement are set at comparatively low levels, they may still be higher than that under the SMTA. Second, the BBNJ Agreement may also adopt a set of optional schemes to flexibly accommodate diverse utilization scenarios in practice. But each selected scheme should be predominantly mandatory in terms of its core obligations.

Under the CBD System, Resolution 16/2 of CBD COP 16, adopted on November 1, 2024, sets indicative rates for DSI: specifically, 1% of profits or 0.1% of revenues from all DSI-related products and services shall be contributed to the Global Fund (UNEP, 2024). Apart from differences in the scope of covered entities and the stringency of access restrictions, the utilization activities related to DSI and associated arrangements in the context of the BBNJ Agreement resemble those under the CBD. Accordingly, the ABSC may take these payment rates as a reference and should closely monitor relevant developments under the CBD.

A useful reference is the floating payment rate tied to metal price fluctuations that was proposed during negotiations on the *Draft Regulations on Exploitation of Mineral Resources in the Area* (China, 2019). In designing the payment rate scheme under the BBNJ Agreement, the COP and the ABSC may consider allowing ex

TABLE 3 Changes in payment rates under the ITPGRFA framework.

Article	Previous rate	Revised rate	Reduction
6.7	1.1%	0.77%	30%
6.8	None	1. A further 30% reduction based on the potential payment rate. 2. 5–10 times higher than the payment rate in Article 6.11 (FAO, 2016b)	30%
6.11	0.5%	0.01% to 0.1%	98% to 80%

post adjustments to the payment rates, thereby making them variable over time rather than fixed. Specifically, a graded floating payment rate system within a preset range could be established, calibrated to factors including annual and cumulative revenues of different products and their commercial potential. Subsequently, different rates could be flexibly applied in line with actual progressive performance and preset standards.

5.3.3 Periodic tiered payments

The diversified indicators are used to measure “the aggregate level of activities by a Party”, which means that the determination of tiers is based on a comprehensive assessment of the overall level of all utilization activities conducted within a Party’s jurisdiction and under its regulatory control. In this arrangement, the payment obligation should rest with the Party rather than with individual utilization entities. The funds paid by a Party may come from, but are not limited to, national taxation and other sources. This arrangement implies that the financial burden would be allocated by all domestic entities, thereby reducing the impact on individual utilization entities.

Periodic tiered payments are on a par with payments related to product commercialization. This entails two implications. First, commercialization status may serve only as one of the reference indicators for tiering, and tiered payments may commence prior to commercialization. Second, commercialization status only indirectly affects the specific payment amount by influencing the tier level. The payment amount shall be uniquely linked to the Party’s tier, and Parties within the same tier shall pay a comparable amount. The diversified indicators that can comprehensively reflect Party’s overall level of activities may include: substantive or tangible outcomes in the form of publications, patents, or products, which are key factors for determining a Party’s tier (Thambisetty et al., 2023); the type, added value, and market of products as well as the quantity of such products; commercialization status along with annual and cumulative revenue; a country’s level of development; and contributions to the conservation of marine biological diversity in ABNJ. In general, tiered payments are calibrated to multiple criteria that diversify the basis for revenue generation, enabling the immediate sharing of monetary benefits (Thambisetty et al., 2023) (see Table 4).

Additionally, the term “periodic” implies that tiers are relatively stable in the short term yet not fixed, with the possibility of subsequent upward or downward regrading. To balance evolving

R&D progress, changes in commercial revenue, realized benefits for by developing countries, and the administrative costs of periodic review and regrading, the COP may set the regrading cycle at approximately 4 or 6 years, namely every 2 or 3 COP sessions.

5.3.4 Implementation mechanisms for *ex situ* access

At present, international multilateral practice for *ex situ* access to genetic resources is exemplified by the ITPGRFA. The ITPGRFA’s multilateral model is characterized by establishing a multilateral system for access and benefit-sharing, and by adopting the SMTA as a key legal tool. The multilateral system is essentially a global network composed of repositories managed by States, international institutions, global sub-centers or agencies, and various international research centers (FAO, 2011). It applies to a limited set of plant genetic resources listed in Annex. Genetic resources within the multilateral system are subject to uniform access and benefit-sharing rules. Users are required to sign an SMTA before accessing these resources, as well as for any subsequent transfers.

The ITPGRFA’s multilateral model offers several advantages and can be introduced for *ex situ* access to MGRs. First, it dispenses with the prior informed consent procedure and bilateral negotiation, requiring only the signing of an SMTA, which can be completed via the Easy-SMTA online platform. By streamlining procedures, it significantly enhances the efficiency of access, reduces the costs and time associated with case-by-case negotiations, ensures the continued transfer of resources without impediment, and thereby facilitates access and utilization of resources. Second, the SMTA is essentially a standard-form contract. It is concluded on the basis of multilateral negotiations and reflects the multilateral consensus of participants. No party may unilaterally modify its clauses or conditions in any form. This enhances legal certainty and ensures consistency in the rights and obligations of global users. Third, the model imposes lower demands on negotiating capacity and remedies bargaining power asymmetries between parties, thereby enabling more countries, especially economically disadvantaged countries with scarce resources, to secure access to resources. In sum, this model demonstrates many advantages in terms of efficiency, practicability, feasibility, and effectiveness. Accordingly, future implementation mechanism for *ex situ* access under the BBNJ Agreement should be based on the multilateral model, leveraging the CHM to establish a multilateral system and developing an SMTA. However, there are approximately 2.2 million species of marine flora, fauna, and microorganisms worldwide, of which only about 10% have been actually discovered, described or classified (UNEP, 2011). This implies that the BBNJ Agreement will confront more complex circumstances, and it is inappropriate to adopt the approach of a limited list as used in the ITPGRFA.

5.3.5 Application of technology transfer modalities

By level of technological development, marine technology under the BBNJ Agreement can be broadly grouped into two types: basic and advanced technology. These categories should

TABLE 4 A brief timeline of MBS.

Phase	Milestone payments	Payments related to the commercialization	Periodic tiered payments (paid by Parties)
MGRs access	None	None	None
R&D	None	None	Yes, if publications occur
Patent grant	voluntary payment	None	Yes
Commercialization	mandatory payment	mandatory payment	Yes

not be governed by the same rules and require further targeted handling based on specific circumstances.

On the one hand, for basic technologies that support developing countries in implementing the Agreement and achieving the conservation and sustainable use of marine biological diversity in ABNJ, particularly those related to the needs and priorities of developing countries, the mandatory transfer modality in Article 42 should be fully applied, and voluntary transfer should not be allowed; otherwise, it will be detrimental to the achievement of the Agreement's goals. Furthermore, the types of capacity-building and technology transfer listed in Annex II indicate that the rules were designed to prioritize providing assistance for basic technologies and building basic-level capacity. Accordingly, ensuring the mandatory transfer of such basic technologies would enable developing countries to acquire the technical capacity to participate in MSR and to assess, conserve, and manage marine biological resources, either independently or in cooperation. However, the transferring party still retains a certain degree of autonomy regarding which specific technologies will be transferred and how to transfer them. In addition, the Agreement may coordinate the concerns of both sides by limiting the scope and scenarios of use of the transferred technology, thereby giving due regard to the rights and interests of technology holders. First, the transferred technology should be restricted to use within the recipient Party's jurisdiction and should only be used by specific, limited authorized entities. Second, permissible purposes should be restricted to meeting the special needs and priorities of recipient developing countries and to achieving the protection of the marine environment and marine biological resources, not to pursuing commercial interests.

On the other hand, the mandatory transfer modality is not suitable for advanced technologies. Paragraph 1 of Article 42 provides that "Parties shall provide, within their capabilities, resources to support such capacity-building and the development and transfer of marine technology." The formulation "within their capabilities" indicates that transfers should be reasonable and affordable for the technology providers. However, the successful development of advanced technologies typically requires substantial investment in time, personnel, funds, and equipment during the early-stage of R&D and subsequent processes for verification and improvement. Rights holders related to the technology expect to

obtain substantial returns from deployment, gain technological leadership, and preserve a competitive advantage. From this perspective, it is unrealistic to include advanced technologies within the scope of mandatory transfer modalities. Rights holders are unlikely to easily transfer them to others; in other words, this would exceed their "capabilities" in the sense contemplated by Article 42. In addition, many developing countries lack highly complex or scientifically advanced knowledge reserves required to master and apply advanced technologies, as well as advanced instruments and equipment. Pragmatically focusing on basic technologies, knowledge, and equipment is of greater practical and developmental significance to developing countries.

5.4 Improvement of disclosure requirements

With respect to notification requirements for utilization information, first, the design of CHM notification rules is crucial to the implementation of full-chain monitoring and the realization of the benefit-sharing regime; however, the scope and extent of notification are also related to the legitimate rights and interests of Parties and their domestic users. In this regard, information exempted from disclosure under a Party's domestic law or other applicable laws, such as commercially sensitive or confidential information, may be excluded from disclosure. Additionally, where a Party makes an exception in accordance with Articles 10 and 70, the information related to MGRs and DSI collected or generated before the Agreement's entry into force is not required to be disclosed. Beyond this, Parties may generally be required to ensure that users within their jurisdiction provide specific information, including: notification of actual R&D expenditures by stage; phased notification of R&D progress, with opportunities, where appropriate, for participation by other countries; notification of the conclusion of contracts (e.g., SMTAs, patent licensing and transfer contracts, and product sales contracts); and notification of commercialization (e.g., production costs, sales prices, sales volumes, net profits, and annual profit reports). Such information is critical for timely learning of the timeline for recovering upfront costs and the number of benefits available for sharing. Second, a traceability system should be established to link end products to the original MGRs used in their development (Humphries et al., 2021). The BBNJ Agreement does

not specify whether Parties must adopt legislative or other measures requiring users of MGRs accessed *ex situ*, and downstream users within their jurisdiction, to provide updated information on activities involving MGRs. To enable timely tracking and full-chain traceability, obligations to update should be set along the utilization chain, requiring notifications at key points such as *ex situ* access, transfer of samples to third parties, and changes in the intended use of MGRs (Broggiato et al., 2018). Third, to balance the need for timely monitoring and review with Parties' capabilities and compliance costs, the COP may require Parties to submit an implementation report every two years, that is, at each COP session.

With respect to source disclosure requirements in patent applications, first, mandatory formal requirements should be embedded in the patent application procedure. Patent applicants should submit adequate documentation verifying the source of the involved MGRs to checkpoints such as domestic regulatory authorities or the patent offices of the applicant's home jurisdiction or of the jurisdiction where patent protection is sought. If the applicant fails to provide such documentation and does not remedy the deficiency, the applicant should bear the adverse legal consequence of rejection of the application. Another option for the legal consequence is to presume that the genetic resources used originate from ABNJ, thereby triggering application of the BBNJ Agreement. Although this would not affect the arising of benefit-sharing obligations, it would introduce an inherent weakness in the patent. Because the source of the MGRs involved remains unclear, it would impede the reproducibility of results disclosed in the patent, which is detrimental to scientific progress. Second, if a prior applicant fails to disclose the source as required, whereas a concurrent or later applicant makes lawful disclosure for similar results, the prior applicant should not be entitled to priority and should not preclude the subsequent application. Additionally, it is noted that the *WIPO Treaty on Intellectual Property Rights, Genetic Resources and Associated Traditional Knowledge* was adopted in 2024. It provides that even where genetic resources do not originate from a specific country of origin, patent applicants must still disclose the source. The formulation, in principle, encompasses resources from ABNJ.⁷ This offers a pathway or option to address the issue of source disclosure.

6 Conclusion

This article has shown that, while the BBNJ Agreement represents a landmark in the law of the sea and the governance of ABNJ, its benefit-sharing framework for MGRs remains conceptually ambitious but operationally fragile. As the Agreement approaches entry into force, unresolved issues on definitional scope of key terms, legal nature of benefit-sharing modalities, detailed design of framework provisions, and supporting monitoring rules may constrain its effectiveness and erode the trust of States and stakeholders. These deficiencies are not

accidental, they reflect deeper structural tensions between competing normative foundations of the regime, diverging national interests, and the inherently high costs and risks associated with MGR research and development.

To address the unresolved issues, this study has argued that a legal functionalist perspective—linking institutional design to its practical purpose—offers a constructive pathway for early rule-making, and provides a coherent analytical framework that integrates a general approach with specific applications. The legal functionalist approach emphasizes the principle that “form follows function”, with its goal-orientation and problem-solving focus, prioritizes the design of operational rules for the benefit-sharing regime, and accords due regard to the core concerns and demands of developing and developed countries. It can help advance the negotiation process, foster broad consensus in COP, and enhance the operability of benefit-sharing rules, thereby ensuring the effective implementation of the Agreement and the achievement of its intended functions and goals. The specific application scheme would begin by clarifying terminology and data governance. Establishing broad and operational definitions for DSI, derivatives, and scientific data, supported by indicative lists of categories, would facilitate the sharing and accumulation of scientific information, data, knowledge, and other resources, thereby forming a common pool and advancing scientific research. Second, equally essential is the calibration of legal obligations. MBS should operate as a predictable and primarily mandatory mechanism for financing capacity-building and conservation, implemented through light user obligations and affordable financial contributions, complemented by incentives that encourage voluntary participation. *Ex situ* access should be treated as facilitated access subject to reasonable cost-recovery, which would promote scientific research and reduce duplicative sampling. Third, the operability of the regime also depends on refining its detailed rules. Sequencing payment triggers—from voluntary contributions at patenting to mandatory payments at commercialization—can align incentives along the research-innovation chain. Indicative rate bands adjustable over time and Party-level tiered obligations based on measurable indicators would strike a balance between fairness and administrative feasibility. The CHM, supported by an SMTA, could serve as a uniform platform for *ex situ* access and benefit distribution. The technology transfer modalities emphasize the transfer of basic technologies so as to reconcile the need to achieve the Agreement's goals with the protection of stakeholders' interests. Fourth, strengthening compliance and monitoring through adequate notification and origin-disclosure rules, with due regard to data confidentiality, would enhance traceability and harmonize the BBNJ regime with evolving international intellectual-property standards.

Taken together, these measures could transform the Agreement's benefit-sharing regime from a declaratory framework into an operational mechanism that simultaneously reduces burdens on early-stage marine scientific research, maintains incentives for innovation, and ensures predictable benefit flows toward conservation and capacity-building. The proposed reforms are designed to preserve the delicate balance that underpinned the Agreement's adoption while enabling measurable progress through the work of its subsidiary bodies.

⁷ See Article 3.1 and 3.2 of the *WIPO Treaty on Intellectual Property Rights, Genetic Resources and Associated Traditional Knowledge*.

The analysis remains exploratory and primarily text-based. The administrative costs, distributive impacts, and behavioral responses to these proposals require empirical assessment once implementation begins. Future research should therefore model differentiated payment-rate scenarios, test data-governance mechanisms in pilot projects, and examine the interaction of the BBNJ framework with processes under the related international instruments. Ultimately, the success of the BBNJ Agreement will depend not on doctrinal consensus, but on the gradual accumulation of workable, proportionate, and reviewable rules that render benefit-sharing both credible and operational in practice.

Author contributions

WY: Writing – original draft, Formal analysis, Writing – review & editing, Data curation, Methodology, Conceptualization. YT: Validation, Resources, Writing – review & editing, Methodology, Supervision, Conceptualization. YS: Resources, Writing – review & editing, Validation, Supervision. YZ: Conceptualization, Methodology, Supervision, Project administration, Writing – review & editing, Funding acquisition, Resources.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by the Major Project of the National Social

Science Foundation of China: Research on Establishing and Improving the Property Rights Regime of Natural Resources Assets (NO.22ZDA109).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Abatayo, A. L., Ding, X., Neira-Monsalve, E., and Richter, A. (2025). Citizen consensus and diverging views on benefit-sharing for genetic resources. *NPJ Biodivers* 4, 1–5. doi: 10.1038/s44185-025-00093-7
- Blasiak, R., Jouffray, J. B., Amon, D. J., Claudet, J., Dunshirn, P., Jørgensen, P. S., et al. (2023). Making marine biotechnology work for people and nature. *Nat. Ecol. Evol.* 7, 482–485. doi: 10.1038/s41559-022-01976-9
- Blasiak, R., Jouffray, J.-B., Wabnitz, C. C. C., Sundström, E., and Österblom, H. (2018). Corporate control and global governance of marine genetic resources. *Sci. Adv.* 4, 1–7. doi: 10.1126/sciadv.aar5237
- Blasiak, R., Wynberg, R., Grorud-Colvert, K., et al. (2020). *The Ocean Genome: Conservation and the Fair, Equitable and Sustainable Use of Marine Genetic Resources*. Available online at: <https://www.researchgate.net/publication/340685975> (Accessed May 3, 2025).
- Broggiato, A., Arnaud-Haond, S., Chiarolla, C., and Greiber, T. (2014). Fair and equitable sharing of benefits from the utilization of marine genetic resources in areas beyond national jurisdiction: Bridging the gaps between science and policy. *Mar. Policy* 49, 176–185. doi: 10.1016/j.marpol.2014.02.012
- Broggiato, A., Dunshirn, P., Jaspars, M., and Pena-Neira, S. (2025). “Monetary and non-monetary benefit sharing under the BBNJ agreement,” in *Decoding Marine Genetic Resource Governance Under the BBNJ Agreement*. Ed. F. Humphries (Springer Nature, Gewerbestrasse, Switzerland), 168.
- Broggiato, A., Vanagt, T., Lallier, L. E., Jaspars, M., Burton, G., and Muyldermans, D. (2018). Mare geneticum: balancing governance of marine genetic resources in international waters. *Int. J. Mar. Coast. Law* 33, 3–33. doi: 10.1163/15718085-13310030
- Bunea, A. (2014). Explaining interest groups’ Articulation of policy preferences in the European commission’s open consultations: an analysis of the environmental policy area. *J. Common Mark. Stud.* 52, 1224–1241. doi: 10.1111/jcms.12151
- China. (2017). *Written Submission of the Government of the People's Republic of China*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/streamlined/China.pdf (Accessed December 25, 2024).
- China. (2019). *Commentary of the Government of the People's Republic of China on the Draft Regulations on Exploitation of Mineral Resources in the Area*. Available online at: https://www.isa.org.jm/wp-content/uploads/2023/08/Comments_of_China_Chinese.pdf (Accessed May 7, 2024).
- Collins, J. E., Vanagt, T., and Huys, I. (2020). Stakeholder perspectives on access and benefit-sharing for areas beyond national jurisdiction. *Front. Mar. Sci.* 7. doi: 10.3389/fmars.2020.00265
- Concepcion, R. T. D. L. (2024). Negotiating fair and equitable sharing of benefits in the BBNJ agreement: Role of the Group of 77 and China. *Mar. Policy* 163, 1–5. doi: 10.1016/j.marpol.2024.106085
- EU and its Member States. (2016). *Written Submission of the EU and Its Member States*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/EU&MS_Written_Submission_BBNJ.pdf (Accessed March 3, 2025).
- EU and its Member States. (2017). *Written Submission of the EU and Its Member States: Marine Genetic Resources, Including Questions on the Sharing of Benefits*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/rolling_comp/EU_Written_Submission_on_Marine_Genetic_Resources.pdf (Accessed March 3, 2025).
- FAO. (2011). *Introduction to the international treaty on plant genetic resources for food and agriculture*. Available online at: <https://www.fao.org/4/i2631e/i2631e.pdf> (Accessed July 2, 2024).
- FAO. (2014). *Background on the work undertaken by the Ad Hoc Advisory Committee on the Funding Strategy, and its further development (IT/OWG-EFMLS-1/14/3)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/19bf1860-cbc0-47a6-85ca-2ffc7cdfba27/content> (Accessed November 25, 2024).

- FAO. (2016a). *Note by the Co-chairs on the Outcome of the Friends of the Co-chairs Groups (IT/OWG-EFMLS-5/16/4)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/e5edd8b3-70ea-4737-bbd9-955ed9e08b50/content> (Accessed March 10, 2025).
- FAO. (2016b). *Report from the Friends of the Co-chairs Group on Access Mechanisms and Payment Rates (IT/OWG-EFMLS-5/16/Inf.5)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/98051505-0a3f-4cc6-a04d-d95895b2ab3/content> (Accessed September 1, 2024).
- FAO. (2019). *Interim Report of the Ad Hoc Open-ended Working Group to Enhance the Functioning of the Multilateral System (IT/OWG-EFMLS-9/19/Interim Report)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/f0ae3b54-a4f9-4115-943a-4c3f6a3877a/content> (Accessed February 27, 2025).
- FAO. (2023a). *The Benefit-sharing Fund: 2022–2023 Report (IT/GB-10/23/10/Inf.1)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/f05d4407-f00f-4c9-8022-90d3f6256c6/content> (Accessed March 10, 2025).
- FAO. (2023b). *Checkpoint Report of the Co-Chairs of the Ad Hoc Open-ended Working Group to Enhance the Functioning of the Multilateral System (IT/GB-10/23/9.2)*. Available online at: <https://openknowledge.fao.org/server/api/core/bitstreams/c5fd5468-2a75-4cf6-b42f-cd9ed0f9fef7/content> (Accessed February 28, 2025).
- Freestone, D., and Mossop, J. (2025). "Conclusion," in *The Agreement on Marine Biodiversity of Areas Beyond National Jurisdiction: Commentary and Analysis*. Eds. J. Mossop and D. Freestone (Oxford University Press, Oxford, England, UK), 475–490.
- G77 and China. (2016). *Group of 77 and China's Written submission*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/rolling_comp/Group_of_77_and_China.pdf (Accessed December 24, 2024).
- Harden-Davies, H., and Snelgrove, P. (2020). Science collaboration for capacity building: advancing technology transfer through a treaty for biodiversity beyond national jurisdiction. *Front. Mar. Sci.* 7. doi: 10.3389/fmars.2020.00040
- Hassanali, K. (2023). The Agreement on Biodiversity in Areas Beyond National Jurisdiction – Caribbean Community perspectives on interests, asks and outcomes. *Mar. Policy* 156, 105800–105810. doi: 10.1016/j.marpol.2023.105800
- Horowitz, I. L. (2018). "Political realism: the primacy of interests over values," in *Foundations of Political Sociology* (Routledge, London, United Kingdom), 496–509.
- Humphries, F., Rabone, M., and Jaspars, M. (2021). Traceability approaches for marine genetic resources under the proposed ocean (BBNJ) treaty. *Front. Mar. Sci.* 8. doi: 10.3389/fmars.2021.661313
- IISD. (2011). *Summary of the Fourth Meeting of the Working Group on Marine Biodiversity Beyond Areas of National Jurisdiction*. Available online at: <https://enb.iisd.org/events/4th-meeting-bbnj-working-group/summary-report-31-may-3-june-2011> (Accessed September 28, 2024).
- IISD. (2016). *Summary of the First Session of the Preparatory Committee on Marine Biodiversity Beyond Areas of National Jurisdiction*. Available online at: <https://enb.iisd.org/events/1st-session-bbnj-preparatory-committee/summary-report-28-march-8-april-2016> (Accessed November 23, 2024).
- IISD. (2017). *Summary of the Third Session of the Preparatory Committee on Marine Biodiversity Beyond Areas of National Jurisdiction*. Available online at: <https://enb.iisd.org/events/3rd-session-bbnj-preparatory-committee> (Accessed December 22, 2024).
- IISD. (2018). *Summary of the First Session of the Intergovernmental Conference on an International Legally Binding Instrument under the UN Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biodiversity of Areas Beyond National Jurisdiction*. Available online at: <http://enb.iisd.org/oceans/bbnj/igc1/> (Accessed July 13, 2024).
- IISD. (2019). *Summary of the Second Session of the Intergovernmental Conference on an International Legally Binding Instrument under the UN Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biodiversity of Areas Beyond National Jurisdiction*. Available online at: <http://enb.iisd.org/oceans/bbnj/igc2/> (Accessed December 22, 2024).
- IISD. (2022). *Summary of the Fourth Session of the Intergovernmental Conference on an International Legally Binding Instrument under the UN Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biodiversity of Areas Beyond National Jurisdiction*. Available online at: <https://enb.iisd.org/marine-biodiversity-beyond-national-jurisdiction-bbnj-igc4> (Accessed March 16, 2024).
- IISD. (2023). *Summary of the Resumed Fifth Session of the Intergovernmental Conference on an International Legally Binding Instrument under the UN Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biodiversity of Areas Beyond National Jurisdiction*. Available online at: <https://enb.iisd.org/sites/default/files/2023-03/enb25250e.pdf> (Accessed December 24, 2024).
- Joint Stakeholder. (2019). *Promoting sustainable use and conservation of biodiversity through open exchange of Digital Sequence Information*. Available online at: <https://www.cbd.int/abs/DSI-views/2019/Joint-stakeholder-statement-DSI.pdf> (Accessed January 8, 2025).
- Jyoti, C., and Efraxia, Z. (2023). Understanding and exploring the value co-creation of cloud computing innovation using resource based value theory: an interpretive case study. *J. Bus. Res.* 164, 113970–113987. doi: 10.1016/j.jbusres.2023.113970
- Kraus, J. (2002). "Philosophy of contract law," in *The Oxford Handbook of Jurisprudence and Philosophy of Law*. Eds. J. L. Coleman and S. Shapiro (Oxford University Press, Oxford, England, UK), 692.
- Lao, D. Y. (2020). Criminal policy and functionalist criminal law system. *China Leg. Sci.* 1, 126–148. doi: 10.14111/j.cnki.zgxf.2020.01.007
- Leary, D., Vierros, M., Hamon, G., Arico, S., and Monagle, C. (2009). Marine genetic resources: A review of scientific and commercial interest. *Mar. Policy* 33, 183–194. doi: 10.1016/j.marpol.2008.05.010
- Liu, S. Z. (2020). The benefit-sharing mechanism of marine genetic resources beyond national jurisdiction. *Zheng Fa Lun Cong* 5, 70–82.
- Liu, H. R., and Qi, X. W. (2022). An analysis on the common heritage of mankind principle's appearance or not in the BBNJ international agreement. *Leg. Forum* 37, 150–160.
- Marchiori, C., Dietz, S., and Tavoni, A. (2017). Domestic politics and the formation of international environmental agreements. *J. Environ. Econ. Manage* 81, 115–131. doi: 10.1016/j.jeem.2016.09.009
- Marciniak, K. J., Broggiato, A., and Gobin, J. (2025). "Marine genetic resources," in *The Agreement on Marine Biodiversity of Areas Beyond National Jurisdiction: Commentary and Analysis*. Eds. J. Mossop and D. Freestone (Oxford University Press, Oxford, England, UK), 83–151.
- Mermin, S. (1973). Legal functionalism. *Anu. Filos. Derecho* 17, 81–92. https://www.boe.es/biblioteca_juridica/anuarios_derecho/abrir_pdf.php?id=ANU-F-1973-10008100092
- Michaels, R. (2012). "The functional method of comparative law," in *The Oxford Handbook of Comparative Law*, vol. 351. Eds. M. Reimann and R. Zimmermann (Oxford University Press, Oxford, England, UK), 360–361.
- Morris, A. (2018). Marine Genetic Resources in Areas beyond National Jurisdiction: How Should the Exploitation of the Resources be Regulated? *N.Z. J. Environ. Law* 22, 57–86. doi: 10.3316/informit.416229016782258
- Oldham, P., Hall, S., Barnes, C., et al. (2014). *Valuing the Deep: Marine Genetic Resources in Areas Beyond National Jurisdiction*. Available online at: <https://www.researchgate.net/publication/273139809> (Accessed December 24, 2024).
- Oldham, P., Kindness, J., Davidson, E., et al. (2025). *Study on 'Marine Genetic Resources' Market Value and State of the Art of Commercialization of Related Products in the Context of the BBNJ Negotiations*. Available online at: https://cinea.ec.europa.eu/publications/emfaf-study-about-market-value-marine-genetic-resources-context-agreement-biodiversity-beyond_en (Accessed June 9, 2025).
- Pisupati, B., Leary, D., and Arico, S. (2008). Access and benefit sharing: issues related to marine genetic resources. *Asian Biotechnol. Dev. Rev.* 10, 49–68. <https://www.cbd.int/doc/articles/2009/A-00675.pdf>
- Rabone, M., Harden-Davies, H., Collins, J. E., Zajderman, S., Appeltans, W., Droege, G., et al. (2019). Access to marine genetic resources (MGR): raising awareness of best-practice through a new agreement for biodiversity beyond national jurisdiction (BBNJ). *Front. Mar. Sci.* 6. doi: 10.3389/fmars.2019.00520
- Rogers, A. D., Baco, A., Escobar-Briones, E., Currie, D., Gjerde, K., Gobin, J., et al. (2021). Marine genetic resources in areas beyond national jurisdiction: promoting marine scientific research and enabling equitable benefit sharing. *Front. Mar. Sci.* 8. doi: 10.3389/fmars.2021.667274
- Salpin, C., and Germani, V. (2007). Patenting of research results related to genetic resources from areas beyond national jurisdiction: the crossroads of the law of the sea and intellectual property law. *Rev. Eur. Community Int. Environ. Law* 16, 12–23. doi: 10.1111/j.1467-9388.2007.00538.x
- Schwartz, A., and Markovits, D. (2020). "Function and form in contract law," in *The Oxford Handbook of the New Private Law*. Eds. A. S. Gold, J. C. P. Goldberg, D. B. Kelly, et al. (Oxford University Press, Oxford, England, UK), 243–260.
- Sebuliba, S., and Sammler, K. G. (2025). Governing biodiversity: ambiguity and fragmentation in the BBNJ Agreement. *Ocean Coast. Manag* 270, 107913–107924. doi: 10.1016/j.ocecoaman.2025.107913
- Shi, Y. B. (2023). A step to victory: main divergences of and prospects for intergovernmental negotiations on marine biological diversity of areas beyond national jurisdiction. *Asia Pac. Secur. Mar. Aff* 1, 36–50+33. doi: 10.19780/j.cnki.ytaq.2023.1.3
- Tang, J. (2024). Form follows function: An initial evaluation of the BBNJ Agreement's achievements regarding the "not undermining" proviso. *Mar. Policy* 159, 105952–105959. doi: 10.1016/j.marpol.2023.105952
- Thambisetty, S. (2018). *Marine Genetic Resources Beyond National Jurisdictions: Components of an Informed, Fair and Progressive Internationally Binding Legal Instrument*. Available online at: <https://www.researchgate.net/publication/326909840> (Accessed February 15, 2024).
- Thambisetty, S., Oldham, P., and Chiarolla, C. (2023). The expert briefing document: A developing country perspective on the making of the BBNJ treaty. *SSRN Electron. J.* doi: 10.2139/ssrn.4580046
- Tian, Y. F. (2024). The authority allocation logic of development zone management committees: A functionalist analysis. *Local Gov. Res.* 3, 2–13.
- UN. (2016). *The First Global Integrated Marine Assessment*. Available online at: <https://efml.kaist.ac.kr/docs/WOA1stCompilation.pdf> (Accessed April 23, 2025).
- UNEP. (2011). *UNEP's Latest Research Report: How Many Species Are There on Earth? 8.7 Million*. Available online at: <https://news.un.org/zh/story/2011/08/157582> (Accessed October 11, 2024).

- UNEP. (2020). *Report of the Ad Hoc Technical Expert Group on Digital Sequence Information on Genetic Resources (CBD/DSI/AHTEG/2020/1/7)*. Available online at: <https://www.cbd.int/doc/c/ba60/7272/3260b5e396821d42bc21035a/dsi-ahteg-2020-01-07-en.pdf> (Accessed August 14, 2025).
- UNEP. (2021). *Digital Sequence Information on Genetic Resources (CBD/WG2020/3/4)*. Available online at: <https://www.cbd.int/doc/c/afd4/4df3/d2d62f5f6a1bfe367c7448f4/wg2020-03-04-en.pdf> (Accessed December 8, 2023).
- UNEP. (2024). *Decision adopted by the Conference of the Parties to the Convention on Biological Diversity on 1 November 2024*. Available online at: <https://www.cbd.int/doc/decisions/cop-16/cop-16-dec-02-en.pdf> (Accessed January 9, 2025).
- UNGA. (2014). *Letter dated 25 July 2014 from the Co-Chairs of the Ad Hoc Open-ended Informal Working Group to the President of the General Assembly (A/69/177)*. Available online at: https://www.un.org/depts/los/biodiversityworkinggroup/documents/BBNJreport_69_177.pdf (Accessed October 20, 2024).
- UNGA. (2017). *Chair's overview of the third session of the Preparatory Committee*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/Chair_Overview.pdf (Accessed December 19, 2024).
- UNGA. (2018). *President's aid to negotiations (A/CONF.232/2019/1)*. Available online at: <https://docs.un.org/en/A/CONF.232/2019/1> (Accessed December 25, 2024).
- UNGA. (2019). *Draft text of an agreement 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 (A/CONF.232/2019/6)*. Available online at: <https://docs.un.org/en/a/conf.232/2019/6> (Accessed July 17, 2024).
- UNGA. (2020). *A compilation of textual proposals for consideration at the fourth session dated 15 April 2020 (A/CONF.232/2022/INF.1)*. Available online at: https://www.un.org/bbnj/sites/www.un.org/bbnj/files/textual_proposals_compilation_-_28_feb_2020.pdf (Accessed March 16, 2024).
- UNGA. (2022a). *Further refreshed draft text of an agreement 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 (A/CONF.232/2023/2)*. Available online at: <https://docs.un.org/en/a/conf.232/2023/2> (Accessed October 26, 2024).
- UNGA. (2022b). *Further revised draft text of an agreement 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 (A/CONF.232/2022/5)*. Available online at: <https://docs.un.org/en/A/CONF.232/2022/5> (Accessed January 8, 2025).
- UNGA. (2022c). *Textual proposals submitted by delegations by 25 July 2022*. Available online at: <https://www.un.org/bbnj/sites/www.un.org/bbnj/files/20220803bbnjgc5compilationproposals.pdf> (Accessed January 8, 2025).
- UNGA. (2023). *Draft agreement 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 (A/CONF.232/2023/L.3)*. Available online at: <https://docs.un.org/en/A/CONF.232/2023/L.3> (Accessed October 5, 2024).
- US. (2016). *Views Expressed by the United States Delegation Related to Certain Key Issues*. Available online at: https://www.un.org/depts/los/biodiversity/prepcom_files/USA_Submission_of_Views_Expressed.pdf (Accessed December 24, 2024).
- Vandenbrink, D., Pauzé, E., and Kent, M. P. (2020). Strategies used by the Canadian food and beverage industry to influence food and nutrition policies. *Int. J. Behav. Nutr. Phys. Act* 17, 1–13. doi: 10.1186/s12966-019-0900-8
- Więclawski, J. (2020). Considering rationality of realist international relations theories. *Chin. Political Sci. Rev.* 5, 111–130. doi: 10.1007/s41111-020-00144-3
- WIPO (2020). *Key Questions on Patent Disclosure Requirements for Genetic Resources and Traditional Knowledge*. Available online at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1047_19.pdf (Accessed May 22, 2024).
- Xu, Z. Y. (2024). The paradigm of functional interpretation from the perspective of civil law doctrine. *Jurist* 1, 15–26. doi: 10.16094/j.cnki.1005-0221.2024.01.002
- Yuan, X., and Liao, Y. C. (2019). Analysis on the institutional construction for acquisition and benefit-sharing of marine genetic resources in areas beyond national jurisdiction. *J. Nanchang Univ* 50, 73–84. doi: 10.13764/j.cnki.ncds.2019.05.009
- Zhang, P. H. (2023). The integration of contract systems based on functionalism. *Leg. Sci.* 6, 149–161. doi: 10.16290/j.cnki.1674-5205.2023.06.004
- Zhang, S. B. (2024). Monetary benefit-sharing of marine genetic resources in BBNJ agreement: construction logic, deficiency and perfection. *J. Bound. Ocean Stud.* 9, 20–40.
- Zhang, Z. M., and Yuan, M. (2024). Functionalism trend of legal interpretation in environmental administration: taking policy support as the core. *Stud. Pract.* 8, 1–13. doi: 10.19624/j.cnki.cn42-1005/c.2024.08.005
- Zheng, Z. H. (2016). The historical evolution of the functionalism in comparative law: from an academic history perspective. *Comp. Law Stud.* 3, 1–14.
- Zheng, M. Z., Liu, Y., and Qiu, W. F. (2017). Focal issues of marine biological diversity beyond areas of national jurisdiction. *J. Ocean Univ. China* 1, 62–69. doi: 10.16497/j.cnki.1672-335x.20161009.003
- Zheng, M. Z., Liu, Y., and Zhang, X. Y. (2018). "Study on the regime of access to and benefit-sharing of marine genetic resources in areas beyond national jurisdiction," in *Conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction*. Eds. Y. Liu and M. Z. Zheng (Economic Science Press, Beijing, China), 31–40.
- Zumbansen, P. (2008). Law after the welfare state: formalism, functionalism, and the ironic turn of reflexive law. *Am. J. Comp. Law* 56, 769–808. doi: 10.5131/ajcl.2007.0027