Comments on the draft text of an agreement under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction

Deep Ocean Stewardship Initiative (DOSI)
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The Deep Ocean Stewardship Initiative (DOSI) congratulates the President on the draft text of an agreement under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ agreement). DOSI welcomes this opportunity to provide comments on certain scientific and technical aspects of the text. These comments have been prepared through the DOSI BBNJ working group.[1]

Preamble

→ Add text acknowledging the rich biodiversity of ABNJ and the critical ecosystem services it provides

The Preamble currently lacks broad recognition of the extent and importance of biodiversity in ABNJ. For example, the Convention on Biological Diversity (CBD) preamble notes "the importance of biological diversity for evolution and for maintaining life sustaining systems of the biosphere," and "the general lack of information and knowledge regarding biological diversity and of the urgent need to develop scientific, technical, and institutional capacity to provide the basic understanding upon which to plan and implement appropriate measures." A scientifically-informed appreciation of such issues will enable a strong foundation for the BBNJ agreement, particularly given the knowledge gaps relating to vertical and horizontal ecological connectivity, therefore similar language could be included in the Preamble of the BBNJ agreement.

→ Add text recognizing the full "value" of biodiversity including genetic resources

The draft text currently does not elaborate on the value of genetic resources and biodiversity. Making some reference to the value of biodiversity and genetic resources in the Preamble would provide useful context for the reference to "actual or potential value" in the definition of marine genetic resources in Art. 1(9), and lay the foundation for benefit-sharing to contribute to the conservation and sustainable use of biodiversity. For example in the CBD preamble (para. 1), value is broadly recognised as "ecological, social, economic, scientific, educational, cultural, recreational and aesthetic" (see also CBD art. 7a and

[1] DOSI is an international network of deep ocean scientists and experts from other disciplines. DOSI seeks to seeks to integrate science, technology, policy, law and economics to advise on ecosystem-based management of resource use in the deep ocean and strategies to maintain the integrity of deep-ocean ecosystems within and beyond national jurisdiction. For further information see https://www.dosi-project.org/topics/biodiversity-beyond-national-jurisdiction-bbnj/.

Annex I). The "intrinsic value" of biodiversity is also recognized in the CBD, which makes particular reference to the social, scientific, cultural, and economic importance of genomes, genes, ecosystems, habitats, species, and communities. Furthermore, the Nagoya Protocol Preamble (para. 14) notes the importance of genetic resources to "food security, public health, biodiversity conservation, and the mitigation of and adaptation to climate change", and that the value of genetic resources "resides in ecosystems and biodiversity". Consideration should be given to making reference to the environmental, economic, cultural, social and scientific value of biodiversity and genetic and biological resources of ABNJ in the Preamble. The ecosystem services provided by ocean ecosystems beyond national jurisdiction could also be recognised.

Part 1: General Provisions

Article 1, Use of Terms

1.***"Access"*** *means, in relation to marine genetic resources, the collection of marine genetic resources [, including marine genetic resources accessed in situ, ex situ [and in silico] [[and] [as] [digital] [genetic] sequence data [and information]]].]*

The term "in silico" is open to interpretation - there is no common understanding of the meaning of this term in the scientific community. More specific language, such as 'as digital sequence data and/or information', would add clarity, avoid confusion, and support coherent implementation.

8. ***"Marine genetic material"*** *means any material of marine plant, animal, microbial or other origin containing functional units of heredity [collected from areas beyond national jurisdiction]...*

This operational definition of marine genetic material as "functional units of heredity" can be interpreted in several ways, and may be too limiting. Clarifying the nature of the function would be necessary, despite the fact that we do not know the function of large portions of many organisms' genomes. Some scientific experts interpret "functional units" to indicate the subset of the genome comprised of genes (units) that encode proteins (the functional biomolecules that enact chemical reactions). Such an interpretation would exclude the vast majority of many organisms' genomes: for example, only ~2% of the human genome consists of protein-coding genes (ENCODE Project, *Nature*, 2012), and just 3-8% is believed to be under evolutionary selection (which is an alternative proxy for "functional" designation; Asthana et al., *PNAS*, 2007). While it is clearly desirable to be consistent with the CBD, it could be useful to consider what the desired effect is of this language and ensure that there are no alternative interpretations of this complex scientific issue. Scientific uncertainty regarding the precise function of DNA - and thus whether all DNA falls within the definition - can be side-stepped with an alternative definition such as: *"Marine genetic material" means any DNA or RNA [collected from areas beyond national jurisdiction]...*

9. *Alt. 1.* ***"Marine genetic resources"*** *means any material of marine plant, animal, microbial or other origin, [found in or] originating from areas beyond national jurisdiction and containing functional units of heredity with actual or potential value of their genetic and biochemical properties.]*

Alt. 2. "Marine genetic resources" means marine genetic material of actual or potential value.]

Clarity on the meaning of "value" would be helpful in this definition of marine genetic resources. In particular, scientific, educational, ecological, environmental, and cultural significance are all part of the full value of MGR (see comments in the 'Preamble' section above and DOSI 2019b. The meaning of "actual or potential value" is ambiguous, in the absence of any other reference to value in the text. For example, genetic resources are broadly defined as genetic material of "actual or potential economic, environmental, scientific or societal value" in the Forest Genetic Resources Plan (FAO, 2014). This could provide a model for a definition of MGR that recognises their full value.

The reference to "genetic and biochemical properties" is unusual. DNA possesses "genetic properties", but it is unclear what "biochemical properties" refers to. RNA and derivatives (e.g., proteins, natural products, etc.), but not DNA, possess the vast majority of relevant biochemical properties. Clarification on the intended meaning of "biochemical properties" in this context - including whether a genetic resource must possess both genetic and biochemical properties - would be helpful.

15. *Alt. 1. "Utilization of marine genetic resources" means to conduct research and development on the genetic and/or biochemical composition of marine genetic resources [, as well as the exploitation thereof].]*

[Alt. 2. "Utilization of resources" means the taking, harvesting, recovery, extraction, collection, analysis, processing or use for commercial purposes, or that results in commercial advantage, of or from resources of actual or potential value located in areas beyond national jurisdiction.]

It would be useful to clarify the extent to which this definition applies to fundamental scientific research. There are substantial challenges in applying the definitions found in the Nagoya Protocol in terms of differentiating between commercial and non-commercial activities.

We also note the inconsistency between the definition of 4[14], in which "biochemical properties" are mentioned, and this article, in which "biochemical composition" is used.

Article 3, Application

2. This Agreement does not apply to any warship, naval auxiliary, other vessels or aircraft owned or operated by a State and used, for the time being, only on government non-commercial service. However, each State shall ensure, by the adoption of appropriate measures not impairing the operations or operational capabilities of such vessels or aircraft owned or operated by it, that such vessels or aircraft act in a manner consistent, so far as is reasonable and practicable, with this Agreement.

"Other vessels or aircraft owned or operated by a State and used, for the time being, only on government

non-commercial service" signifies a broad category of potentially exempt activities, including state-sponsored scientific research. The full scope of activities - state-operated or otherwise - that are subject to this agreement needs clarification. This is particularly important for marine scientific research vessels, given the subsequent references in the draft text to activities (such as access to data, notification on access to MGR, access to research infrastructure, etc.) to which scientific research could usefully contribute and benefit from.

Article 5, General principles and approaches

(b) Apply an approach that builds ecosystem resilience to the adverse effects of climate change and ocean acidification and restores ***ecosystem integrity****;*

Building ecosystem resilience to the adverse effects of climate change and ocean acidification is indeed crucial. However, there are two modifications that should be considered to strengthen this provision:

1) Rephrase this statement in order to recognise the threat of climate-induced deoxygenation to biodiversity beyond national jurisdiction, e.g.: "*...to the adverse effects of climate change, ocean deoxygenation and ocean acidification…"* or *" to the adverse effects of climate change related impacts and ocean acidification…"*

2) Reconsider the inclusion of, or clarify the meaning of , *"restoring ecosystem integrity"*. Destruction of such long-lived habitats and ecosystems in the deep ocean will not be restorable on any actionable timescale, and should be prevented in order to preserve the capacity of deep ocean ecosystems to continue to provide ecosystem services. Given the long time-scales that define deep ocean ecosystems beyond national jurisdiction, it is not clear what such restoration would entail or how it would be effective. Therefore, a modification to this text could be considered such as: "*...and sustains/protects ecosystem integrity*."

Add reference to the ***precautionary approach***

In addition to the approaches specified, the precautionary approach is an important framework from which to address the objectives of this agreement. Under the precautionary approach, preventive action should be taken in the face of uncertainty, the burden of proof shifts to the proponents of an activity in question, a wide range of alternatives to potentially harmful actions should be examined, and public participation in decision making is enhanced (Kriebel et al., Environmental Health Perspectives, 2001).

The deep sea in particular is deserving of precautionary measures due to the critical ecosystem services it provides and its high temporal inertia. Time operates on a different scale in the deep ocean, where Greenland sharks can live up to 400 years (Nielsen et al., *Science*, 2016), hydrothermal vents such as Lost City are up to 120,000 years old (Ludwig et al., *Geochimica et Cosmochimica Acta*, 2011) and some deep water corals live to 4,000 years old (DOSI, 2018).

DEEP-OCEAN STEWARDSHIP INITIATIVE

Part II: Marine Genetic Resources, Including Questions on the Sharing of Benefits

Article 7, Objectives

[(a) Build the capacity of developing States Parties, in particular least developed countries, landlocked developing countries, geographically disadvantaged States, small island developing States, coastal African States and developing middle- income countries, to access and utilize marine genetic resources of areas beyond national jurisdiction;]

[(b) Promote the generation of knowledge and technological innovations, including by promoting and facilitating the development and conduct of marine scientific research in areas beyond national jurisdiction, in accordance with the Convention;]

We welcome the inclusion of objectives [(a)] and [(b)], noting that existing scientific best practices provide a basis for benefit sharing that can be further strengthened and streamlined through the BBNJ agreement (DOSI, 2019c).

Article 8, Application of the provision of this [Part] [Agreement]

[2. The provisions of this [Part] [Agreement] shall apply to:

[(c) Derivatives.]]

Noting the lack of definition of "derivatives" in Article 1, or elsewhere in the treaty text, the meaning of the term should be clarified.

[3. The provisions of this [Part] [Agreement] shall not apply to:

[(a) [The use of fish and other biological resources as a commodity.] [Fish and other biological resources that are collected beyond a threshold amount shall be considered as a commodity. The threshold amount shall be determined by the [Scientific and Technical [Body] [Network]].] ***[If a species of fish is found to have value for its genetic material, that species shall be treated as a marine genetic resource, regardless of the volume of the catch.]*** *[If a species of fish or other biological resources are found to have value for their genetic material, that species or those resources, where utilized for their genetic material, shall be treated as a marine genetic resource;]]*

With reference to the bold bracketed option above, the activity of utilization should be the focus of this provision, not the species itself. The provisions of this part should not be limited to the species of fish alone, it should apply to "fish and other biological resources".

Article 10, Access to marine genetic resources of areas beyond national jurisdiction

[1. In situ access to marine genetic resources within the scope of this Part shall be subject to [Alt. 1. [prior] notification to the secretariat [, which shall include an indication of the location and date of access, the resources to be accessed, the purposes for which the resources will be utilized and the entity that will access the resources] [of access to marine genetic resources of areas beyond national jurisdiction].]

Prior notification of MGR-relevant activities in ABNJ would provide a useful mechanism to ensure that activities comply with treaty provisions and to establish the provenance of recovered resources. However, given the range of anticipated activities, clarity on the details of the notification process is needed to avoid administrative bottlenecks while providing the most salient information. These parameters could be determined by the scientific body established by the BBNJ agreement, but could include water depth and environmental variables such as temperature, salinity, and redox potential.

[3. States Parties shall take the necessary legislative, administrative or policy measures, as appropriate, to ensure that ex situ access to marine genetic resources within the scope of this Part is free and open [, subject to articles 11 and 13].]

Open access to resources *ex situ* is critical to maximize the sharing of benefits associated with MGR. However, judicious guidelines for usage will be required to ensure that the full value of rare resources can be mobilized - this is something that the scientific body could be tasked to develop. Techniques developed for rare collections - including sub-sampling, production of back-up material, and archiving - could prove useful in this context.

Article 11, Fair and equitable sharing of benefits

3) [(b) Non-monetary benefits [such as access to samples and sample collections, sharing of information, such as pre-cruise or pre-research information, post-cruise or post-research notification, transfer of technology and capacity- building,] [shall] [may] be shared upon access to, research on and utilization of marine genetic resources of areas beyond national jurisdiction. Samples, data and related information shall be made available in open access [through the clearing-house mechanism [upon access] [after [...] years]]. [[Digital] [Genetic] sequence data [and information] related to marine genetic resources of areas beyond national jurisdiction shall be published and used taking into account current international practice in the field.]]

Benefit sharing impacts would be most significant if the "samples, data and related information...made available in open access" were integrated into existing repositories and databases. Such an arrangement would require additional sample tracking, but would also take advantage of institutional knowledge and the community's established operational modalities - i.e. rather than entering data directly into a 'new' database on the clearinghouse mechanism, existing databases should be used wherever possible and linked to by the clearinghouse mechanism (DOSI, 2019c).

In the continued development of specific provisions, it is important to ensure that benefits are shared in a

usable form, in concert with the resources and knowledge needed to derive real value from shared data.

Monitoring the effectiveness of these benefit sharing approaches would be best conducted through iteration on the "rules, guidelines or code of conduct", guided by the scientific and technical body.

4) [(c) To build capacity to access and utilize marine genetic resources of areas beyond national jurisdiction [, including through common funding or pool funding for research cruises and collaboration in sample collection and data access where adjacent coastal States may be invited to participate, taking into account the varying economic circumstances of States that wish to participate];]

"Common funding or pool funding for research cruises" would fulfill a critical need in current research practices, particularly with regard to capacity building. In-person participation in research efforts in ABNJ is among the most logistically challenging and costly components of capacity building; easing this burden would enable researchers from around the world to participate in all aspects of scientific exploration, from scoping to cruise planning, data collection, experimentation, and analysis. Participation in such cruises can be augmented and broadened to a wide audience by using new and emerging communication technologies such as telepresence.

Article 12, Intellectual property rights

4) (a) [Users of] [Applicants for patents on inventions that utilize or have utilized] marine genetic resources of areas beyond national jurisdiction disclose the origin of the marine genetic resources that they utilize;

In addition to the "origin", disclosing additional metadata (e.g., temperature, pressure, co-occurrence data) of the marine genetic resources incorporated into patent applications would strengthen standardization protocols and be consistent with scientific best practices.

Article 13, Monitoring

3) [(a) An identifier is assigned to marine genetic resources collected in situ. In the case of marine genetic resources accessed ex situ [and in silico] [[and] [as] [digital] [genetic] sequence data [and information]], such identifier shall be assigned when databases, repositories and gene banks submit the list mentioned in article 51 (3) (b) to the clearing-house mechanism;]

Assigning identifiers to MGR from ABNJ is a useful process that would make data searchable and thus more widely usable. However, the degree to which "identifiers" would supercede or complement pre-existing approaches to sample tracking is unclear. An *additional* identifier associated with this agreement would be most productive, enabling newly acquired data to be marked as originating from ABNJ, while also capitalizing on the heritage of long-term data sets with pre-existing serial numbers and identification protocols.

3) [(b) Databases, repositories and gene banks within their jurisdiction are required to [notify the

[clearing-house mechanism] [Scientific and Technical [Body] [Network]]] [send a notification through the obligatory prior electronic notification system managed by [the secretariat] [the secretariat and mandated existing international institutions set forth in Part [...]]] when marine genetic resources of areas beyond national jurisdiction, including derivatives, are accessed;]

Clarifying the scope of an obligatory notification system would ensure that monitoring systems are not over-burdened and remain effective. Defining resource "access" will be particularly helpful. In practice, the utilization of MGR will cover a wide range of intensiveness, from cursory bioinformatic searches, to gene or protein modifications based on in silico data, to imagery and destructive or nondestructive analysis of physical samples.

It will be essential to work closely with sample and bioinformatics repositories (e.g., National Museums, NCBI, EMBL-EBI) - through the scientific and technical body - to build necessary identification protocols and metadata provisioning into the user experience.

3) [(c) Proponents of marine scientific research in areas beyond national jurisdiction shall submit periodic status reports [to the clearing-house mechanism] [to the Scientific and Technical [Body] [Network]] [through the obligatory prior electronic notification system managed by [the secretariat] [the secretariat and mandated existing international institutions set forth in Part [...]]], as well as research findings, including data collected and all associated documentation.]]

Maintaining open lines of communication between the research community and the secretariat is an important objective. Reporting requirements for scientific research should be thorough enough to be informative and useful, and sufficiently streamlined to minimize unproductive administrative overhead. The scientific and technical body will be well positioned to clarify the most useful and necessary contents in these "periodic status reports."

Part III: Area-based management tools

Article 14, Objectives

The objectives in Article 14 section 1 should also include that ABMTs must be designed with consideration of future shifts due to climate change to ensure that the framework is flexible enough to adapt to changing conditions. The objectives could be strengthened to better account for the realities of deep ocean ecosystems beyond national jurisdiction, as follows:

(e) "Establishing a system of ecologically representative marine protected areas that are connected [and effectively and equitably managed]"; The need to establish a "linked network" of ecologically representative marine protected areas should be stated, this term presupposes connectivity and ensures that the connections are functional rather than arbitrary.

(f) "Rehabilitating and restoring biodiversity and ecosystems, including with a view to enhancing their

productivity and health and building resilience to stressors, including those related to climate change, ocean acidification and marine pollution";

The terms "rehabilitating" and "restoring" should be more clearly defined and more specific, including approaches to build resistance to stressors such as those related to climate change, ocean acidification, deoxygenation, habitat destruction, and marine pollution. Further, before rehabilitating and restoring, the article should call for measures to protect and preserve in order to maintain the integrity of marine ecosystems, and to maintain adequate area and connectivity necessary for species to replenish themselves and for ecosystems to maintain their functions and services.

Article 16, Identification of areas requiring protection

A list of scientific objectives that would inform the prioritization and selection of areas requiring protection should be developed in order to articulate what the ecological goals of ABMT will be. These objectives might be to sustain biodiversity, maintain the integrity of marine ecosystems, maintain functions and services of ecosystems, and maintain connectivity necessary for populations to replenish themselves (e.g., CCAMLR conservation measure 91-04).

Article 17, Proposals

3. Proposals shall be based on the best available science, apply the precautionary [approach] [principle] and an ecosystem approach and take into account the relevant traditional knowledge of indigenous peoples and local communities.

Regional and sectoral organizations will have a crucial role to play in providing the data necessary to ensure that decisions can be made based on the best available science. Making these data available on a global level would bring substantial benefits to several key objectives of this treaty, including capacity building and scientific research.

Article 21, Monitoring and review

[Alt.1

1. States Parties, individually or collectively, shall report to the Conference of the Parties on the implementation of [area-based management tools, including marine protected areas] [relevant elements of the decisions of the Conference on area-based management tools, including marine protected areas], [established] [designated] under this Part. Such reports shall be made publicly available by the secretariat.

2. Area-based management tools, including marine protected areas, [established] [designated] under this Part, including related conservation and management measures, shall be monitored and periodically reviewed by the Scientific and Technical [Body] [Network].

3. The review referred to in paragraph 2 shall assess the effectiveness of measures and the progress made in achieving their objectives and to provide advice and recommendations to the Conference of the Parties.

4. Following the review, the Conference of the Parties shall, as necessary, take decisions on the amendment or revocation of area-based management tools, including marine protected areas, including any associated conservation and management measures, on the basis of an adaptive management approach and taking into account the best available scientific information and knowledge, including traditional knowledge, the precautionary [approach] [principle] and an ecosystem approach.]

The scientific and technical body will have important roles to play in the monitoring and review of ABMTs, as referred to in Alt. 1. These contributions could include the development of guidelines and minimum requirements for effective monitoring, as well as in identifying priority areas needing protection.

Part IV: Environmental impact assessments

Article 24, Thresholds and criteria for environmental impact assessments

[Alt.1

When States have reasonable grounds for believing that planned activities under their jurisdiction or control [may cause substantial pollution of or significant and harmful changes to] [are likely to have more than a minor or transitory effect on] the marine environment [in areas beyond national jurisdiction], they shall, [individually or collectively,] as far as practicable, [assess the potential effects of such activities on the marine environment] [ensure that the potential effects of such activities on the marine environment are assessed].]

[Alt.2

1. When States Parties have reasonable grounds for believing that planned activities under their jurisdiction or control are likely to have more than a minor or transitory effect on the marine environment, they shall conduct a[n] [initial] [simplified] environmental impact assessment on the potential effects of such activities on the marine environment in the manner provided in this Part.

2. When States Parties have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall [conduct] [ensure that] a [full] [comprehensive] environmental impact assessment [is conducted] on the potential effects of such activities on the marine environment [and ecosystems] and shall [communicate] [submit] the results of such assessments [for technical review] in the manner provided in this Part.]

A determination of "minor or transitory effect" must be guided by scientific knowledge and take into account the long time frames of deep-ocean ecosystems and processes. This characteristic of the deep ocean, coupled with uncertainty surrounding future impacts of climate change, further underscores the importance of the precautionary approach in decision-making and the need to consider cumulative impacts.

[Article 37, Consideration and review of [assessment] reports]

[The environmental impact assessment reports prepared pursuant to this Agreement shall be considered and reviewed on the basis of approved scientific methods [by the Scientific and Technical [Body] [Network]].]

The scientific and technical body should play an important role in considering and reviewing EIAs.

Part V: Capacity building and transfer of marine technology

Article 42, Objectives

(See draft text for full article)

Scientific research is a critical driver of technology transfer and capacity building; its inclusion in several provisions of this article is encouraging.

Article 43, Cooperation in capacity building and transfer of marine technology

(See draft text for full article)

Cooperation is already a core tenet of the scientific community that can be further supported through the BBNJ agreement. Existing regional and global bodies, such as the Intergovernmental Oceanographic Commission of UNESCO, and/or the scientific and technical body, could help facilitate such interaction. However, specifically delineating a more proactive coordination role will be useful (in order to, e.g., establish guidance on technology needs assessments, or develop guidelines and criteria on specific scientific aspects relating to CB and TMT).

Consideration could also be given to referring to the promotion of "collaboration" in CB and TMT. Collaboration requires the combination of resources and expertise, going beyond cooperation which is more generally concerned with aligning components of a system. For example, the role of collaboration in sharing benefits from genetic resources is mentioned in Article 23 of the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity (Nagoya Protocol).

Article 44, Modalities for capacity building and transfer of marine technology

(See draft text for full article)

Consideration could be given to a potential role for the scientific and technical body to help "match" assessed science-related needs with available tools. This service would ensure that technology is deployed in the most effective way possible, and that knowledge gaps between needs and capabilities are bridged - giving effect to the 'exchanging lessons learned' referred to in paragraph 2 of art. 44.

Inclusion of a reporting mechanism - by all parties involved in capacity building and technology transfer efforts - would be useful to support subsequent assessments of the program's effectiveness.

Part VI: Institutional arrangements

Article 49: Scientific and Technical [Body] [Network]

(See draft text for full article)

Both a scientific and technical body and an associated network will be critical for ensuring the treaty achieves its goals. A 'network' for the scientific and technical body suggests an open and inclusive structure that could, for example, include the existing scientific advisory bodies used by existing agreements as well as other scientific experts. However, certain functions cannot be delivered by a network alone; a core body is necessary for its more streamlined decision making role, consistency in decisions, and clearer terms of reference.

Article 51: Clearinghouse mechanism

2. The clearing-house mechanism shall consist primarily of an open-access web- based platform. It shall also include a network of experts and practitioners in relevant fields. The specific modalities for the operation of the clearing-house mechanism shall be determined by the Conference of the Parties.

Ensuring that the clearinghouse mechanism provides all of the functions required by the treaty will require proactive engagement by several stakeholder groups including the scientific community. Full mobilization of the human network associated with the web platform will be critical.

Cross-Cutting Remarks

Ocean deoxygenation

References to climate change and ocean acidification appear throughout the draft text (e.g., articles 1[6], 5b, 14[1]f, 16[2]q, and Annex [b]iv). These are critical issues to consider across all activities, and ocean deoxygenation is a concern of similar magnitude. Oxygen loss in the ocean is a climate-induced threat to biodiversity beyond national jurisdiction that reduces the number of species present, degrades habitat quality and quantity, modulates growth rates, increases disease susceptibility, and interferes with migrations of marine organisms. It is therefore an important factor to consider with respect to ABMTs, building science capacity, technology transfer, and applying precautionary and ecosystem-based management approaches. Consideration should be given to recognising the impacts of and adaptations to

ocean deoxygenation alongside mentions of climate change and ocean acidification in the BBNJ text. For further information, see DOSI (2019a).

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