Centre for International
Governance Innovation

CIGI Papers No. 232 — November 2019

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A Climate-essential Development?

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Table of Contents

About the Author

Cameron S. G. Jefferies is an associate professor in the Faculty of Law at the University of Alberta. His work focuses on matters of international and domestic environmental law, oceans law and policy, energy and natural resources law, and tort law. He is the author of *Marine Mammal Conservation and the Law of the Sea* (Oxford University Press, 2016), co-author of the sixth edition of the leading text *Tort Law* (Thomson Reuters, 2017), and a co-editor of *Global Environmental Change and Innovation in International Environmental Law* (Cambridge University Press, 2018). His work has also appeared in leading journals and edited collections, including the *Energy Law Journal, Journal of Environmental Law and Practice,* and *Journal of International Wildlife Law and Policy.* He is actively involved in the local environmental rights movement and advocates for improved environmental law and policy. He previously worked as a research associate at the Health Law Institute and qualified as a lawyer with the Edmonton firm Field LLP. He earned his doctorate in law at the University of Virginia, where he studied as a Fulbright scholar.

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Acronyms and Abbreviations

ABMTs	area-based management tools
ABNJ	areas beyond national jurisdiction
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
BBNJ	biodiversity beyond national jurisdiction
CAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CDR	carbon dioxide removal
CIFOR	Center for International Forestry Research
CO2	carbon dioxide
COP	Conference of the Parties
EBSAs	Ecologically or Biologically Significant Marine Areas
EEZ	exclusive economic zone
FAO	UN Food and Agriculture Organization
G77	Group of Seventy-Seven
IPCC	Intergovernmental Panel on Climate Change
ITLOS	International Tribunal for the Law of the Sea
IUCN	International Union for the Conservation of Nature
MPAs	marine protected areas
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic
PNAS	Proceedings of the National Academy of Sciences
SPAMI	Specially Protected Areas of Mediterranean Importance
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
VMEs	vulnerable marine ecosystems

Executive Summary

The high seas are a critical biodiversity reservoir and carbon sink. Unfortunately, the oceans, generally, and the high seas, in particular, do not feature prominently in international climate mitigation or climate adaptation efforts. There are, however, signals that ocean conservation is poised to occupy a more significant role in international climate law and policy going forward. This paper argues that improved conservation and sustainable use of high seas living marine resources are essential developments at the convergence of climate action and ocean governance that should manifest, at least in part, as climate-informed high seas marine protected areas (MPAs). MPAs are an attractive nature- and area-based management tool that, when properly designed and implemented, contribute to ecosystem health and resilience while simultaneously preserving, or even enhancing, the ocean's blue carbon potential. The living marine resources that are the focus of this study include photosynthetic diatoms, microscopic ocean calcifers, krill and the open ocean macro-algae. These biological components of open ocean ecosystems are not the typical subjects of area-based conservation measures; moreover, their potential contributions to climate mitigation have not been accounted for in existing scientific criteria utilized across international legal regimes to identify high seas MPA sites. These organisms are, however, disproportionately important to maintaining the high seas' functionality as a global carbon sink and the ocean's climate-regulating ecosystem service. The logical venue for advancing climate-informed high seas MPAs is the ongoing negotiation of an international legally binding instrument for biodiversity beyond national jurisdiction (BBNJ instrument), where area-based management tools (ABMTs), including MPAs, are a key item being addressed. Achieving this development requires the incorporation of the blue carbon potential of living marine resources of the high seas into the criteria that are used to identify and propose MPAs.

Introduction

The high seas, defined as areas beyond national jurisdiction (ABNJ),[1] cover those portions of the ocean's water column outside the 200 nautical mile exclusive economic zone (EEZ), where states hold sovereign rights and jurisdiction over resource use and management. Once thought to be barren of life, the high seas are now regarded as one of earth's largest biodiversity reservoirs[2] and the source of essential life-sustaining ecosystem services.[3] However, the high seas are increasingly threatened by the direct and indirect consequences of human activity.

One threat that looms large is climate change and the biological, physical and chemical consequences of a warmer, more acidic and less oxygenated marine environment. The Intergovernmental Panel on Climate Change (IPCC), in a special report titled *Global Warming of 1.5°C: Summary for Policymakers*, is clear: anthropogenic climate change is already responsible for 0.8–1.2°C of warming above pre-industrial levels; warming will likely exceed the 1.5°C threshold between 2030 and 2052; and mitigation pathways "limiting global warming to 1.5°C" will require "rapid and far-reaching" system transitions and "deep emissions reductions."[4] The IPCC projects that all mitigation pathways limiting warming to 1.5°C will require between 100 and 1,000 Gt of additional carbon dioxide (CO_2) removal (CDR) during the 21st century.[5] It is increasingly apparent that enhanced investigation of the consequences of climate change on the

1 See *United Nations Convention on the Law of the Sea,* 10 December 1982, 1833 UNTS 397 (entered into force 16 November 1994) [*LOSC*]. Article 86 describes the high seas as "all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State." The seabed and ocean floor beyond national jurisdiction are defined in article 1(1) of the LOSC as the "Area."

2 Elizabeth Wilson, "Underwater Treasures of the High Seas" (24 March 2016), online: Pew Environmental Trust <www.pewtrusts.org/en/research-and-analysis/issue-briefs/2016/03/underwater-treasures-of-the-high-seas>.

3 A Rogers et al, *The High Seas and Us: Understanding the Value of High-Seas Ecosystems* (Oxford, UK: Global Ocean Commission, 2016) at 8.

4 IPCC, "Summary for Policymakers" in V Masson-Delmotte et al, eds, *Global Warming of 1.5°C* (2018) at 17, online: <www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf>.

5 *Ibid* at 19.

ocean is required and that ocean-based solutions to climate change are urgently needed.[6]

The term "blue carbon" describes the carbon that is captured and stored by coastal and marine ecosystems.[7] The oceans are the earth's most fertile carbon sink, and the living marine resources of the high seas comprise a significant proportion of the ocean's climate mitigative potential. A substantial quantity of oceanic carbon is sequestered and stored in ocean floor sediment, where it is effectively eliminated from the carbon cycle for thousands of years.[8] This analysis does not disregard the future importance — or regulatory challenges — of novel and additional CDR activities,[9] but focuses instead on the equally important task of maintaining or restoring the ocean's natural capacity to assimilate CO_2.

Climate change mitigation and adaptation do not feature prominently in existing ocean conservation measures; moreover, the oceans are afforded limited treatment under the United Nations Framework Convention on Climate Change[10] (UNFCCC), the Kyoto Protocol[11] and the Paris Agreement.[12] Attention to climate change mitigation and adaption is similarly scant in Aichi Target 11[13] under the Convention on Biological Diversity[14] (CBD) and in the United Nations Sustainable Development Goal 14.[15] There are, however, encouraging signals that the considerable gap between climate action and oceans governance is starting to close.[16] One conservation tool that holds unrealized potential in this regard is the designation of MPAs. MPAs are an attractive nature- and area-based management tool at the intersection of ocean governance and climate action that, when properly designed and implemented, contribute to ecosystem health and resilience while simultaneously preserving, or even enhancing, the ocean's blue carbon potential.

This paper argues that improved conservation and sustainable use of high seas living marine resources is an essential development at the convergence of climate action and ocean governance that should manifest, at least in part, as climate-informed high seas MPAs. The living marine resources that are the focus of this study include photosynthetic diatoms, microscopic ocean calcifers, krill and the open ocean macro-algae called *Sargassum*.[17] These biological components of open ocean ecosystems are not the typical subjects of area-based conservation measures; moreover, their potential contributions to climate mitigation have not been accounted for in existing scientific criteria utilized across international legal regimes to identify high seas MPA sites. These organisms are, however, disproportionately important to maintaining the high seas' functionality as a global carbon sink and the ocean's climate-regulating ecosystem service. Future efforts to preserve these ecosystems, and their services, would be well served by the establishment of climate-informed MPAs.

Since both the impacts of climate change and mitigation initiatives pertinent to this ocean zone are arguably outside the jurisdiction of the

6 See Jean-Pierre Gattuso et al, "Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems" (2018) 5 Frontiers in Marine Science 1.

7 James W Fourqurean et al, "Seagrass ecosystems as a globally significant carbon stock" (2012) 5 Nature Geoscience 505.

8 Silvania Avelar, Tessa S van der Voort & Timothy I Eglinton, "Relevance of carbon stocks of maritime sediments for national greenhouse gas inventories of maritime nations" (2017) 12:10 Carbon Balance & Management 1 at 3.

9 See e.g. Rosemary Rayfuse, Mark G Lawrence & Kristina Gjerde, "Ocean Fertilisation and Climate Change: The Need to Regulate Emerging High Seas Uses" (2008) 23:2 Intl J Marine & Coastal L 297; Kemi Fuentes-George, "Consensus, Certainty, and Catastrophe: Discourse, Governance, and Ocean Iron Fertilization" (2017) 17:2 Global Environmental Politics 125.

10 *United Nations Framework Convention on Climate Change,* 9 May 1992, 1771 UNTS 107, 31 ILM 849 (entered into force 21 March 1994) [*UNFCCC*].

11 *Kyoto Protocol to the United Nations Framework Convention on Climate Change,* 11 December 1997, 2303 UNTS 148, 37 ILM 22 (1998) (entered into force 16 February 2005).

12 UNFCCC, *Report of the Conference of the Parties on Its Twenty-First Session, Held in Paris from 30 November to 13 December 2015,* FCCC/CP/2015/10/Add.1 (entered into force 4 November 2016) [*Paris Agreement*].

13 Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), *The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets,* UN Doc UNEP/CBD/COP/DEC/X/2 (2010) [*Aichi Targets*].

14 *Convention on Biological Diversity,* 5 June 1992, 1760 UNTS 79, 31 ILM 818 (entered into force 29 December 1993).

15 *Transforming our world: the 2030 Agenda for Sustainable Development*, UNGAOR, 70th Sess, UN Doc A/RES/70/1 (2015) at 14 [*Transforming our world*].

16 See e.g. UNFCCC, *Because the Ocean Declaration* (2015), online: <www.vardagroup.org/wp-content/uploads/2016/10/Because-the-Ocean-Peru.pdf>. This declaration was confirmed in 2016 at the UNFCCC COP23 and in 2017 at COP24 and calls upon the international community to include the oceans in international climate talks.

17 See D Laffoley et al, eds, *The Significance and Management of Natural Carbon Stores in the Open Ocean* (Gland, Switzerland: International Union for the Conservation of Nature [IUCN], 2014).

UNFCCC regime,[18] cooperative international efforts to maintain or enhance the climate-regulating ecosystem services of the high seas must occur in a different forum. The logical venue is the ongoing negotiation of an international legally binding BBNJ instrument,[19] where ABMTs,[20] including MPAs, are a key item being addressed. Achieving this development requires the incorporation of the blue carbon potential of living marine resources of the high seas into the criteria that are used to identify and propose MPAs.[21]

The central argument is advanced in three parts. First, the case for integrating blue carbon potential into the design and implementation of high seas MPAs is stated by surveying the blue carbon contribution made by key high seas organisms. Improvements in our understanding of the high seas ecosystems and literature, arguing in favour of integrating climate considerations into near-coastal MPAs,[22] serve as useful signposts. Second, the unrealized potential for enhanced utilization of high seas MPAs as nature-based climate mitigative tools is established. The scientific criteria that are currently used to identify possible high seas MPAs are reviewed to demonstrate that the mitigative climate potential of high seas ecosystems is not adequately accounted for in *any* established criteria. Third, the manner in which blue carbon might be included in the process of high seas MPA selection is considered and important knowledge gaps are identified.[23] The assessment concludes by offering key learnings that should inform the normative objectives and legal framework of the BBNJ instrument and reflects on why the negotiation of the BBNJ instrument is an incredibly important opportunity to link ocean governance and climate action at an unprecedented scale.

18 See Nilufer Oral, "Ocean Acidification: Falling Between the Legal Cracks of UNCLOS and the UNFCCC" (2018) 45:1 Ecology LQ 9 (the author concludes that "[o]cean acidification is not addressed under the existing climate change regime of the UNFCCC, Kyoto Protocol as amended, or the Paris Agreement. However, this does not mean that it cannot be in the future" at 29). See also Rachel Baird, Meredith Simons & Tim Stephens, "Ocean Acidification: A Litmus Test for International Law" (2009) 3:4 Carbon & Climate L Rev 459; Ellycia R Harrould-Kolieb, "Ocean Acidification and the UNFCCC: Finding Legal Clarity in the Twilight Zone" (2016) 6:2 Washington J Environmental L & Policy 612.

19 Intergovernmental Conference on Marine Biodiversity of ABNJ, *Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction*, GA Res A/RES/72/249 (2017) [*BBNJ Resolution*].

20 Elizabeth M De Santo, "Implementation challenges or area-based management tools (ABMTs) for biodiversity beyond national jurisdiction" (2018) 97 Marine Policy 34 at 34 where ABMTs are defined as spatial closures that are protected to a greater degree than surrounding areas, for a specified purpose, and obviously include MPAs, but also "Emission Control Areas/Special Areas and Particularly Sensitive Sea Areas (PSSAs), seasonal or year-round area fisheries closures, and Areas of Particular Environmental Interest (APEIs)." At 35, De Santo makes the point that ABMTs, then, can include measures that are "more adaptive/tailored to particular sectors" and also "potentially shorter-term" than MPAs. See also David Johnson, Maria Adelaide Ferreira & Ellen Kenchington, "Climate change is likely to severely limit the effectiveness of deep-sea ABMTs in the North Atlantic" (2018) 87 Marine Policy 111.

21 Goals supported by *Our ocean, our future: call for action,* GA Res A/RES/71/312, UNGAOR, 71st Sess (2017) at paras 13(b) & (j).

22 Jennifer Howard et al, "The potential to integrate blue carbon into MPA design and management" (2017) 27:S1 Aquatic Conservation: Marine & Freshwater Ecosystems 100 [Howard et al, "MPA design and management"].

23 *Ibid*.

The Case for Climate-informed High Seas MPAs

Blue Carbon Potential of High Seas Ecosystems

The majority of the ocean's 40,000 billion tonnes of carbon is dissolved in the water as inorganic bicarbonate ions.[24] Carbon also occurs in seawater in living particulate form and as non-living fecal waste.[25] There are three main mechanisms through which carbon is taken up from the atmosphere and transferred from surface waters to deep waters: the physiochemical "solubility pump" whereby atmospheric CO_2 is absorbed by the ocean at the air-water interface and eventually sinks to considerable depths at the poles;[26] the "biological pump" whereby living organisms in the sunlit euphotic zone utilize atmospheric CO_2 and dissolved carbon for primary production through photosynthesis;[27] and the "carbonate pump"

24 Laurent Bopp et al, "The Ocean: a Carbon Pump" in *Ocean and Climate, 2015 – Scientific Notes* (2015) at 13, online: <www.ocean-climate.org/wp-content/uploads/2015/06/150601_ScientificNotes.pdf>.

25 *Ibid* at 13.

26 Laffoley et al, *supra* note 17 at 17; Laurent Bopp, Louis Legendre & Patrick Monfray, "La pompe à carbone va-t-elle se gripper?" (2002) 355 La Recherche 48.

27 Laffoley et al, *supra* note 17 at 18.

whereby the calcium carbonate produced by calcifying microorganisms sinks to the ocean floor.[28]

Together, these biological and chemical processes account for approximately two-thirds of the vertical fluctuation in ocean carbon;[29] moreover, a significant proportion[30] of this biologically assimilated carbon is transferred from near-surface water to the ocean's interior and the sea floor, where it becomes part of stable sedimentary layers. In this way, the pumps take "carbon out of contact with the atmosphere for several thousand years or longer and maintain atmospheric CO_2 at significantly lower levels than would be the case if it did not exist."[31] In sum, the ocean takes up 1.5 billion tonnes of carbon per year,[32] which accounts for 25 percent of annual anthropogenic emissions.[33]

Scientific understanding of the ocean is most advanced for near-shore and coastal locations.[34] The high seas are, however, gaining recognition as "one of the planet's largest reservoirs of biodiversity" that serve as habitat for whales, sharks, sea turtles and a wide variety of commercially harvested fish species,[35] and feature a number of rare and important biological hotspots. Healthy populations of teleost (ray-finned) fish[36] and cetaceans (whales, dolphins and porpoises)[37] have both been identified as potentially significant for their blue carbon contributions. While each ecosystem and its marine living resources are worthy of study from a climate-informed perspective, four living marine resource groupings are particularly important — and, arguably, often overlooked — in this regard: diatoms, ocean calcifers, krill and *Sargassum* macro-algae.

Diatoms are globally distributed microscopic single-celled algae.[38] Diatom species represent a "major component of the phytoplankton community"[39] that utilize and fix dissolved carbon dioxide through photosynthesis[40] and are critical primary producers. Collectively, diatoms contribute approximately 40 percent of the ocean's total productivity,[41] which corresponds to roughly 20 percent of the earth's annual photosynthetically fixed CO_2.[42]

Diatom communities "bloom," which is to say they periodically experience an exponential increase in population size and biological productivity.[43] Diatom blooms are an important component of the ocean's biological carbon pump that "contribute disproportionately to the export of carbon to the ocean interior" through the sinking of phytoplanktonic cells and fecal matter.[44] Diatomic blooms usually last for weeks and occur most frequently in spring and summer months; they are commonly concentrated "around Antarctica and the polar frontal zones" and "in the most northerly sector of the NW Pacific and North Atlantic oceans"[45] and in the high seas

28 David A Hutchins & Feixue Fu, "Microorganisms and ocean global change" (2017) 2:6 Nature Microbiology 1 at 1.

29 Uta Passow & Craig A Carlson, "The biological pump in a high CO_2 world" (2012) 470 Marine Ecology Progress Series 249 at 249.

30 Laffoley et al, *supra* note 17 at 17.

31 Samarpita Basu & Katherine RM Mackey, "Phytoplankton as Key Mediators of the Biological Carbon Pump: Their Responses to a Changing Climate" (2018) 10:3 Sustainability 869 at 870.

32 Glen Wright et al, "The long and winding road: negotiating a treaty for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction" in IDDRI, Studies No 08/18 (2018) at 15.

33 Laffoley et al, *supra* note 17 at 22.

34 Editorial, "Science at Sea: Debate on a United Nations treaty to protect the ocean offers an opportunity for scientists" (2018) 553 Nature 127 at 128.

35 Wilson, *supra* note 2.

36 Teleosts store carbon in their biomass, but release it through respiration (as CO_2) and defecation (in the form of calcium carbonate). The net effect of teleost calcium carbonate excretion as an acidity buffer or contributor to carbon sequestration is still an area of some uncertainty. See Jennifer Howard et al, "Clarifying the role of coastal and marine systems in climate mitigation" (2017) 15:1 Frontiers in Ecology & Environment 42 at 47.

37 Cetaceans serve as important pumps by transporting nutrients to the ocean's surface through feeding and defecation and also transport considerable quantities of carbon to the ocean floor when they die and sink to the bottom. See Joe Roman et al, "Whales as marine ecosystem engineers" (2014) 12:7 Frontiers in Ecology & Environment 377 at 377–78.

38 Laffoley et al, *supra* note 17 at 44.

39 *Ibid*.

40 *Ibid*.

41 Paul G Falkowski, Richard T Barber & Victor Smetacek, "Biogeochemical Controls and Feedbacks on Ocean Primary Production" (1998) 281:5374 Science 200.

42 Karine Leblanc et al, "Nanoplanktonic diatoms are globally overlooked but play a role in spring blooms and carbon export" (2018) 9:953 Nature Communications 1 at 1.

43 Laffoley et al, *supra* note 17 at 44.

44 Leblanc et al, *supra* note 42 at 2; Louis Legendre & Jacques Le Fèvre, "Microbial food webs and the export of biogenic carbon in oceans" (1995) 9 Aquatic Microbial Ecology 69.

45 Laffoley et al, *supra* note 17 at 45.

portion of the North Pacific subtropical gyre.[46] The conditions responsible for diatom blooms remain an area of scientific investigation.[47]

The ocean calcifers are comprised primarily of the coccolithophores (calcite-shelled, bloom-forming phytoplankton), foraminifera (eukaryotic protists) and pteropods (free-swimming, shelled snails).[48] The bio-calcification process that defines this group uses dissolved bicarbonate ions to create calcium carbonate shells and other exo-structures.[49] Calcifers are a crucial component of the ocean's carbon system. For example, coccolithophore calcite shells "transport 50–80% of the carbon in the surface ocean to...the deep sea carbon reservoir."[50] Further, planktonic foraminifera account for between 32 and 80 percent of deep ocean carbon fluctuations,[51] and pteropod shell construction activity may represent up to 50 percent of deep ocean carbon fluctuation.[52] Similar to diatoms, calcifer distribution and concentration depend upon an array of biological and chemical factors, but they are globally distributed and commonly bloom in the high seas.[53]

"Krill" is a general term used to describe 85 species of globally distributed crustacean-like euphausiids.[54] The seven krill species found in the Southern Ocean, and *Euphausia superba* specifically, are particularly noteworthy, owing to their status as "the key species of the Southern Ocean ecosystem" that is both "major prey for most of the marine predators" and "major grazer of primary production within its range."[55] Krill may be the most abundant metazoan animal on earth;[56] the biomass of *E. superba* alone is an estimated 379 million tonnes.[57] Antarctic krill tend to aggregate in "swarms" that can range from 10- to 100-metre-long concentrated patches to 41-kilometre-long "super-swarms."[58] The commercial harvest of krill in the Southern Ocean is managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

Krill mediate carbon pathways and sequester at least 0.26 percent of the total CO_2 released from fossil fuel combustion annually.[59] As grazers, krill are responsible for up to 80 percent of vertical deep-water carbon fluctuation in the Antarctic region through their defecation.[60] As prey, krill account for between 3.1 and 4.9×10^13 grams of carbon that may be assimilated into the "long-lived carbon pool" (i.e., cetacean and pinniped biomass) per year.[61] Research investigating krill feeding behaviour points to an increased capacity for krill to export carbon to the deep ocean for long-term sedimentary sequestration. Geraint A. Tarling and Sally E. Thorpe demonstrate that within krill swarms, satiated individuals reduce their movement and sink lower in the water column; as they sink, satiated krill are replaced by individuals engaged in active feeding. This "satiated sinking" phenomenon is significant because krill tend to defecate while resting post-feeding and, when defecation occurs deeper in the water column, the result is enhanced transfer of

46 Tracy A Villareal, "Summer Diatom Blooms in the North Pacific Subtropical Gyre: 2008–2009" (2012) 7:4 e33109 PLoS ONE 1 at 1.

47 Philip W Boyd et al, "Microbial control of diatom bloom dynamics in the open ocean" (2012) 39:18 Geophysical Research Letters L18601.

48 Laffoley et al, *supra* note 17 at 34–35. Note that the larval stages of most benthic invertebrate species also qualify.

49 *Ibid* at 34.

50 *Ibid*. See also Yuichiro Tanaka, "Coccolith Carbonate Fluxes in the Northwest Pacific Ocean" in M Shiyomi et al, eds, *Global Environmental Change in the Ocean and on Land* (Tokyo, Japan: TERRAPUB, 2004) at 133–46.

51 Laffoley et al, *supra* note 17 at 37; Christopher L Sabine et al, "The Oceanic Sink for Anthropogenic CO_2" (2004) 305:5682 Science 367.

52 BPV Hunt et al, "Pteropods in Southern Ocean ecosystems" (2008) 78:3 Progress in Oceanography 193.

53 Timothy S Moore, Mark D Dowell & Bryan A Franz, "Detection of coccolithophore blooms in ocean color satellite imagery: A generalized approach for use with multiple sensors" (2012) 117 Remote Sensing Environment 249.

54 Stephen Nicol, *The Curious Life of Krill: A Conservation Story from the Bottom of the World* (Washington, DC: Island Press, 2018) at 7.

55 Laffoley et al, *supra* note 17 at 70.

56 *Ibid*.

57 A Atkinson et al, "A re-appraisal of the total biomass and annual production of Antarctic krill" (2009) 56:5 Deep Sea Research Part I: Oceanographic Research Papers 727; Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), "Krill fisheries and sustainability", online: <www.ccamlr.org/en/fisheries/krill-fisheries-and-sustainability>.

58 Geraint A Tarling & Sally E Thorpe, "Oceanic swarms of Antarctic krill perform satiation sinking" (2017) 284:1869 Proceedings of the Royal Society B 284: 20172015.

59 Laffoley et al, *supra* note 17 at 71 (interpreting the work of Corinne Le Quéré et al, "Trends in the sources and sinks of carbon dioxide" [2009] 2 Nature Geoscience 831).

60 EA Pakhomov, PW Froneman & R Perissinotto, "Salp/krill interactions in the Southern Ocean: spatial segregation and implications for the carbon flux" (2002) 49 Deep Sea Research Part II: Topical Studies in Oceanography 1881.

61 Volker Siegel & Stephen Nicol, "Population Parameters" in Inigo Everson, ed, *Krill: Biology, Ecology and Fisheries* (Oxford, UK: Blackwell Science, 2000) at 103–49 (as interpreted in Laffoley et al, *supra* note 17 at 71–72).

carbon from the swarm to the deep ocean.[62] This finding warrants further investigation into the true carbon sequestering capability of Antarctic krill.

Open ocean floating macro-algae, primarily *Sargassum natans* and *Sargassum fluitans* (*Sargassum*) are unlike most macro-algae species that inhabit shallow coastal waters anchored to the sea floor because *Sargassum*'s entire lifecycle is spent in the open ocean buoyed by gas-filled bladders.[63] *Sargassum* has a tendency to form dense "rafts" that are hotspots for primary production and biodiversity.[64] The distribution of *Sargassum* is centred around the Sargasso Sea, which is an "enormous eddy located in the North Atlantic subtropical Gyre" that is wholly high seas, save for the portion that overlaps with Bermuda and its maritime zones.[65] In any given year, there are 2 million tonnes of *Sargassum* in the Gulf of Mexico and North Atlantic,[66] which corresponds to 8×10^10 grams of carbon.[67] The Sargasso Sea Commission, formed in 2014,[68] exercises a "stewardship role for the Sargasso Sea."[69]

Sargassum contributes to carbon sequestration in three ways. First, some S*argassum* sinks to the deep ocean as it ages and dies.[70] Particulate *Sargassum* has been identified on the abyssal sea floor,[71] and with as much as 10 percent possibly sinking to the ocean's floor,[72] this carbon export mechanism warrants future investigation.[73] Second, the organisms that inhabit *Sargassum* rafts produce fecal pellets that "release dissolved organic matter to the ocean through dissolution and microbial decomposition."[74] Based on estimates of fecal-pellet sinking from coastal *Sargassum* species,[75] approximately 10 percent are transported to the sea floor annually.[76] Third, macro-algae growth releases dissolved organic carbon.[77] Most, but not all, of this carbon is in a form that can be consumed by bacteria.[78] The remaining carbon is "recalcitrant" or "labile," meaning it resists bacterial consumption and can effectively be sequestered in the ocean for thousands of years.[79] In total, *Sargassum* contributes an estimated 1.6×10^10 grams of carbon per year[80] in this "massive yet all but invisible carbon flux."[81]

Collectively, the living marine resources canvassed above share key features: global distribution, found commonly in the high seas; aggregation in identifiable patches as "blooms," "swarms," or "rafts"; and mediation of biological pathways in the ocean's carbon system. The extent to which MPAs can be utilized to maximize the blue carbon potential or resilience of high seas ecosystems depends on the type of living marine resource — and threats — in question. For example, *Sargassum* is directly threatened by destructive fishing practices and commercial seaweed harvest, and

62 Tarling & Thorpe, *supra* note 58 at 5–6.

63 See J Ramus, "Productivity of Seaweeds" in Paul G Falkowski & Avril D Woodhead, eds, *Primary Productivity and Biogeochemical Cycles in the Sea* (1992) 43 Environmental Science Research 239.

64 Richard Blaustein, "United Nations Seeks to Protect High-Seas Biodiversity" (2016) 66:9 BioScience 713 at 718; David Freestone, "The Sargasso Sea Alliance: Working to Protect the 'Golden Floating Rainforest of the Ocean'" (2014) 44:1 Environmental Policy & L 151 at 151–52; D Laffoley et al, *The Protection and Management of the Sargasso Sea: The golden floating rainforest of the Atlantic Ocean* (Washington, DC: Sargasso Sea Alliance, 2011).

65 Laffoley et al, *supra* note 17 at 56.

66 Jim Gower & Stephanie King, "Distribution of floating *Sargassum* in the Gulf of Mexico and the Atlantic Ocean mapped using MERIS" (2011) 32:7 Intl J Remote Sensing 1917 at 1925.

67 Laffoley et al, *supra* note 17 at 59.

68 Sargasso Sea Commission, *Hamilton Declaration on Collaboration for the Conservation of the Sargasso Sea,* 11 March 2014, online: <www.sargassoseacommission.org/storage/Hamilton_Declaration_with_signatures_April_2018.pdf>.

69 *Ibid*. The Sargasso Sea Commission does not exercise prescriptive jurisdiction.

70 Laffoley et al, *supra* note 17 at 59.

71 Dorte Krause-Jensen & Carlos M Duarte, "Substantial role of macroalgae in marine carbon sequestration" (2016) 9 Nature Geoscience 737 at 737.

72 Gilbert T Rowe & Nick Staresinic, "Sources of Organic Matter to the Deep-Sea Benthos" (1979) 1:6 Ambio Special Report 19 at 22.

73 See HM Dierssen et al, "Potential export of unattached benthic macroalgae to the deep sea through wind-driven Langmuir circulation" (2009) 36:4 Geophysical Research Letters L04602; Laffoley et al, *supra* note 17 at 60 (proposing methods through which data gaps could be filled).

74 Laffoley et al, *supra* note 17 at 61.

75 Hiroshi Itoh et al, "Fate of organic matter in faecal pellets egested by epifaunal mesograzers in a *Sargassum* forest and implications for biogeochemical cycling" (2007) 352 Marine Ecology Progress Series 101.

76 Laffoley et al, *supra* note 17 at 61.

77 *Ibid* at 60.

78 Nianzhi Jiao et al, "Microbial production of recalcitrant dissolved organic matter: long-term carbon storage in the global ocean" (2010) 8 Nature Rev Microbiology 593.

79 James E Bauer, Peter M Williams & Ellen RM Druffel, "14C activity of dissolved organic carbon fractions in the north-central Pacific and Sargasso Sea" (1992) 357 Nature 667.

80 Laffoley et al, *supra* note 17 at 60.

81 Mary Ann Moran et al, "Deciphering ocean carbon in a changing world" (2016) 113:12 Proceedings of the National Academy of Sciences of the United States of America (PNAS) 3143 at 3144.

indirectly threatened by environmental pollutants, including chemical and invasive species introduced by transiting vessels.[82] Krill are threatened by ocean warming, and the magnitude of this threat is amplified by over-harvesting.[83] The direct conservation benefits that could be derived from area-based protection for microscopic organisms such as diatoms and calcifers are less obvious, owing to the fact that their abundance and distribution are influenced primarily by changes in ocean temperature and acidity. Nevertheless, as critical primary producers and the base constituent of many ocean ecosystems, it is important to monitor and quantify changes to distribution and abundance, which may, in turn, influence broader ecosystem considerations.[84] Protected areas can also serve as scientific control sites, offering researchers the opportunity to conduct threat assessment and "evaluate the impact of fishing and environmental change on marine ecosystems," and managers to control or limit "controversial geoengineering experiments" that impact ocean health.[85] With perhaps the exception of krill, these resources have not been the subject of targeted conservation measures such as MPAs, which, arguably, should emerge as a priority for future action targeting maintenance or maximization of the ocean's blue carbon potential.

MPAs as a Climate-informed Conservation Tool

The International Union for the Conservation of Nature (IUCN) describes an MPA as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."[86] MPAs have been the "flagships of marine conservation"[87] for over 25 years and are a fixture in ocean conservation work.[88]

MPAs are a diverse management tool capable of "protecting habitat, maintaining ecosystem functioning, buffering against environmental variability, protecting genetic diversity, providing reference points for conducting stock assessments and setting harvest limits, and serving as a precautionary approach to management."[89] MPAs can be designated by coastal states landward of the 200 nautical mile EEZ limit or, on the high seas, through cooperative action. Importantly, because all states are "equally entitled to exercise high seas freedoms," any MPA that purports to restrict a state's ability to exercise these freedoms will only bind those states that consented to its creation.[90] Existing institutions that are capable of designating high seas MPAs include: the Conference of the Parties to the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean[91] (Barcelona Convention); the CCAMLR pursuant to the Convention on the Conservation of Antarctic Marine Living Resources[92] (CAMLR); and the Convention for the Protection of the Marine Environment of the North-East Atlantic[93] (OSPAR Convention). Additionally, potential high seas MPA sites could be identified — but not legally designated — based on their description as ecologically or biologically significant marine

82 Tammy M Trott et al, "Efforts to Enhance Protection of the Sargasso Sea" (2010) *Proceedings of the 63rd Gulf and Caribbean Fisheries Institute* 282 at 284.

83 Emily S Klein et al, "Impacts of rising sea temperature on krill increase risks for predators in the Scotia Sea" (2018) 13:1 PLoS ONE, DOI: <10.1371/journal.pone.0191011>.

84 See Paul Tréguer et al, "Influence of diatom diversity on the ocean biological carbon pump" (2017) 11 Nature Geoscience 27.

85 Editorial, *supra* note 34 at 128.

86 Jon Day et al, *Guidelines for applying the IUCN Protected Area Management Categories to Marine Protected Areas: Developing capacity for a protected planet,* Best Practice Protected Area Guidelines Series No 19 (Gland, Switzerland: IUCN, 2012).

87 Susan Gubbay, "Marine protected areas – past, present and future" in Susan Gubbay, ed, *Marine Protected Areas: Principles and techniques for management* (London, UK: Chapman & Hall, 1995) 1 at 1.

88 Duncan EJ Currie, "Ecosystem-Based Management in Multilateral Environmental Agreements: Progress towards Adopting the Ecosystem Approach in the International Management of Living Marine Resources" (2007), online: World Wildlife Fund <awsassets.panda.org/downloads/wwf_ecosystem_paper_final_wlogo.pdf>.

89 Benjamin S Halpern, Sarah E Lester & Karen L McLeod, "Placing marine protected areas onto the ecosystem-based management seascape" (2010) 107:43 PNAS 18312 at 18318.

90 Petra Drankier, "Marine Protected Areas in Areas beyond National Jurisdiction" (2012) 27:2 Intl J Marine & Coastal L 291 at 295.

91 *Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean,* 16 February 1976, 1102 UNTS 27 (entered into force 2 December 1978).

92 *Convention on the Conservation of Antarctic Marine Living Resources,* 20 May 1980, 1329 UNTS 48 (entered into force 7 April 1982).

93 *Convention for the Protection of the Marine Environment of the North-East Atlantic*, 22 September 1992, 2354 UNTS 67 (entered into force 25 March 1998) [*OSPAR Convention*].

areas[94] (EBSAs), pursuant to an expert process administered by the CBD. Regional fisheries management organizations can protect vulnerable marine ecosystems (VMEs) from deep-sea-bottom fishing based on criteria developed by the UN Food and Agriculture Organization (FAO).[95]

Pursuant to Aichi Target 11 adopted by the parties to the CBD, the international community has committed to protecting "at least...10 per cent of coastal and marine areas...through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures."[96] This quantitative target (although not the detail) is replicated in the United Nations Sustainable Development Goal 14.[97] Scientists consistently assert that this coverage target is insufficient and that it should be set, minimally, at 30 percent.[98] Currently, only 6.97 percent of the ocean is officially protected,[99] and the vast majority of protected sites exist landward of the 200 nautical mile EEZ limit where states have clear jurisdiction to utilize area-based conservation mechanisms.[100] Of this 6.97 percent, only two percent qualify as either strongly or fully protected.[101] Moreover, realizing effective conservation through MPA designation is dependent on much more than simple paper designations; according to Graham J. Edgar and colleagues, MPA success turns on the presence of prescriptive "no-take" or "no commercial activity" measures and strong enforcement actions for large reserved spaces (greater than 100 km^2), that remain protected for lengthy periods of time (at least 10 years) and that are not isolated.[102] David A. Gill et al demonstrate that limitations in staffing and financial capacity are a consistent constraint across most MPA sites.[103] According to Enric Sala et al, the "good news" is that there has been "remarkable progress" in MPA designation over the last decade, which is "tilting the trajectory of area protected steeply upward."[104]

An emerging line of MPA research focuses on these areas' role in view of the ongoing and predicted effects of global climate change.[105] On one level, MPAs are an attractive precautionary measure that can be utilized as part of a broader ocean-based climate adaptation and resiliency response. They can serve as an ecological "insurance policy" where anthropological activities are restricted, offering ecosystems and species the best possible opportunity to adapt to changing ocean conditions.[106] At another level, MPAs are an attractive nature-based mechanism that can "support the protection of blue carbon ecosystems" and contribute to climate mitigative action.[107] Coastally, climate-mitigation benefits have been explored in the context of important blue carbon ecosystems such as mangroves, seagrasses and tidal marshes.[108] The blue carbon capacity of MPAs should not, however, be construed as a "substitute for rapid reductions in greenhouse gas emissions."[109] Moreover, their deployment must be complemented by other sustainability-based initiatives that are tailored to the target ecosystem or species.

94 COP 9 to the CBD, *Marine and coastal biodiversity*, Dec IX/20, UNEPOR, UN Doc UNEP/CBD/COP/DEC/IX/20, Annex 1 ("Scientific Criteria for Identifying Ecologically or Biologically Significant Marine Areas in Need of Protection in Open-Ocean Waters and Deep-Sea Habitats") [*EBSA*].

95 Food and Agriculture Organization of the United Nations (FAO), Fisheries and Aquaculture Department, *The FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (Rome: FAO, 2009).

96 *Aichi Targets, supra* note 13.

97 *Transforming our world, supra* note 15.

98 See Bethan C O'Leary et al, "Effective Coverage Targets for Ocean Protection" (2016) 9 Conservation Letters 398.

99 Kendall R Jones et al, "The Location and Protection Status of Earth's Diminishing Marine Wilderness" (2018) 28:15 Current Biology 2506 at 2508.

100 See Thomas Dux, *Specially Protected Marine Areas in the Exclusive Economic Zone (EEZ): The Regime for the Protection of Specific Areas of the EEZ for Environmental Reasons* (New Brunswick, NJ: Transaction, 2011); UN, *The Sustainable Development Goals Report: 2018* (New York: UN, 2018) (the report estimates that, as of January 2018, 16 percent of waters under national jurisdiction were "covered by protected areas" at 11). Of course, mere coverage does not equate to effective protection.

101 Enric Sala et al, "Assessing real progress towards effective ocean protection" (2018) 91 Marine Policy 11 at 12.

102 Graham J Edgar et al, "Global conservation outcomes depend on marine protected areas with five key outcomes" (2014) 506 Nature 216.

103 See David A Gill et al, "Capacity shortfalls hinder the performance of marine protected areas globally" (2017) 543 Nature 665.

104 Sala, *supra* note 101 at 11.

105 See e.g. Edward B Barbier et al, "The value of estuarine and coastal ecosystem services" (2011) 81:2 Ecological Monographs 169; Alison L Green et al, "Designing Marine Reserves for Fisheries Management, Biodiversity Conservation, and Climate Change Adaptation" (2014) 42:2 Coastal Management 143.

106 Callum M Roberts et al, "Marine reserves can mitigate and promote adaptation to climate change" (2017) 114:24 PNAS 6167 at 6171–72.

107 Howard et al, "MPA design and management", *supra* note 22 at 101.

108 *Ibid* at 100; see also Barbier et al, *supra* note 105.

109 Roberts et al, *supra* note 106 at 6172–73.

The mitigative potential of blue carbon habitat is a nascent policy priority for government officials and MPA managers.[110] Thus, efforts to understand how best to integrate blue carbon into MPA design and management are both ongoing and crucial during this formative time period. Jennifer Howard et al's work on this topic offers guidance on incorporating blue carbon into the MPA planning process:

- → Climate mitigation via blue carbon maximization can be included in MPA objectives and targets.
- → Threats to blue carbon ecosystems can be identified and targeted for reduction.
- → MPA size, location and boundaries can be assessed to protect critical blue carbon habitat.
- → Management actions needed to restore, maintain or improve blue carbon habitat can be taken.
- → Monitoring to detect climate-induced changes and adaptive management to respond to climate-induced changes can be incorporated into MPA implementation.
- → Economic evaluation of the costs associated with MPA delivery can be measured against the predicted and actualized blue carbon benefits associated with the project.
- → Broader social considerations linking climate action and local stakeholder concerns can be incorporated into the MPA process.[111]

Key high seas blue carbon ecosystems, including those that are habitat for diatoms, ocean calcifers, krill and *Sargassum*, are just as important as — and, arguably, as a matter of scale, even more important than — coastal blue carbon ecosystems. Like their coastal counterparts, these ecosystems would also benefit from a climate-informed MPA designation and implementation process. To date, work analogous to Howard et al's investigation of climate-informed MPAs in the coastal context has yet to be conducted for the high seas.

110 RJ Brock, E Kenchington & A Martínez-Arroyo, eds, *Scientific Guidelines for Designing Resilient Marine Protected Area Networks in a Changing Climate* (2012), online: Commission for Environmental Cooperation <www3.cec.org/islandora/en/item/10820-scientific-guidelines-designing-resilient-marine-protected-area-networks-in-changing-en.pdf>.

111 Howard et al, "MPA design and management", *supra* note 22, at 101–8.

The Unrealized Potential of High Seas MPAs as a Climate Mitigation Tool: A Climate-essential Development

New linkages between global climate action and ocean governance are urgently required.[112] Consider, for example, the restricted consideration of ocean-based conservation in the UNFCCC and its related instruments. Starting with the UNFCCC, treatment of ocean conservation is limited to the broad principle of maintaining and enhancing all "sinks and reservoirs" of greenhouse gases in article 4(1)(d). The Kyoto Protocol does not raise ocean management directly at all, while the Paris Agreement reconfirms the importance of ocean carbon sinks in article 5 and, in the preamble, declares "the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity."[113] Over two and a half decades, the products of formalized international climate negotiations have largely excluded the oceans. Moreover, even when the oceans receive some specific treatment, it is limited to hortatory declarations. More optimistically, there is mounting evidence that supports increasing interest in ocean-based climate action. For example, negotiations for the Paris Agreement included a number of side events focused on ocean conservation and involved a heightened presence and participation of ocean scientists, and while express treatment of ocean conservation was limited in the Paris Agreement, a number of negotiating states produced the influential Because the Ocean Declaration.[114] Additionally, ocean mitigation and adaptation goals are included in more than 70 percent of nationally determined contributions.[115]

112 See Tim Stephens, "Warming Waters and Souring Seas: Climate Change and Ocean Acidification" in Donald R Rothwell et al, eds, *The Oxford Handbook of the Law of the Sea* (New York: Oxford University Press, 2015) 777 at 797.

113 *Paris Agreement, supra* note 12.

114 Natalya D Gallo, David G Victor & Lisa A Levin, "Ocean commitments under the Paris Agreement" (2017) 7:11 Nature Climate Change 833 at 833.

115 *Ibid*.

A purposive interpretation of article 4(1)(d) of the UNFCCC or article 5 of the Paris Agreement suggests that cooperative conservation of high seas carbon sinks is, at least in theory, obligatory for states parties. The high seas definitely qualify as an important carbon sink that would benefit from conservation and management. Furthermore, this interpretation can be reconciled with the obligations imposed upon all states by Part XII of the LOSC to protect and preserve the marine environment in all maritime zones, inside or outside of national jurisdiction.[116] Specifically, states are obliged to "protect and preserve the marine environment" (article 192), which, substantively, necessitates the avoidance of future environmental harm, as well as the positive obligation to actively maintain or improve environmental conditions.[117] A corresponding — and similarly fundamental obligation — is the duty to cooperate globally or regionally "directly or through competent international organizations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features."[118] Article 194(5) indicates that the measures states can take under Part XII "shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life." These measures can extend beyond actions that seek to control marine pollution to also include associated measures (such as MPAs) designed to protect and preserve "rare or fragile ecosystems."[119] The LOSC defines "pollution of the marine environment" to mean "the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities"; carbon dioxide likely qualifies.[120]

Climate-informed high seas MPAs would be a novel link between global climate action, impelled largely by the UNFCCC regime, and by the duty to protect and preserve the marine environment under Part XII of the LOSC. Importantly, because the UNFCCC regime is primarily oriented toward terrestrial activity and is principally focused on areas under national jurisdiction, it is logical for future action to be led by institutional structures associated with the LOSC. Accordingly, it is important to determine which forum (or fora) is most appropriately situated to initiate climate-informed MPA work.

Incorporating Blue Carbon into Future High Seas MPA Action

Institutional Options for Climate-informed High Seas MPAs

The process of establishing high seas MPAs involves a number of steps. Candidate sites have to be identified and proposed, reviewed and assessed, and then formally proposed in a forum that has the mandate and jurisdiction to legally establish MPAs. Then, the MPA must be implemented, which involves the promulgation of regulatory measures designed to achieve the protected site's goals. Finally, the MPA must be monitored and compliance and enforcement initiatives to iteratively assess the success of the MPA and to alter regulatory measures established as required.[121]

At present, few treaty regimes can designate high seas MPAs. The limitations of relying on these fora of institutionalized cooperation for the coherent development of climate-informed high seas MPAs are readily apparent. First, the

116 *Request for an Advisory Opinion Submitted by the Sub-Regional Fisheries Commission (SRFC)*, Advisory Opinion of 2 April 2015, International Tribunal for the Law of the Sea (ITLOS) Reports 2015 at para 120.

117 *South China Sea Arbitration (Philippines v People's Republic of China)* (2016), PCA No 2013-19 at paras 940–41 [*South China Sea Arbitration*].

118 *The MOX Plant Case (Ireland v United Kingdom) Provisional Measures*, Order of 3 December 2001, ITLOS Reports 2001 No 10 at para 82.

119 *South China Sea Arbitration*, *supra* note 117 at para 945; *Chagos Marine Protected Area Arbitration (Mauritius v United Kingdom)* (2015) PCA No 2011-03 at para 538.

120 William CG Burns, "Potential Causes of Action for Climate Change Impacts Under the United Nations Fish Stocks Agreement" (2007) 7:2 Sustainable Development L & Policy 34 at 36.

121 See Pew Charitable Trusts, *Marine Protected Areas Beyond National Jurisdiction* (March 2016) at 5, online: <www.pewtrusts.org/-/media/assets/2016/03/high-seas-mpa-policy-brief.pdf>.

Barcelona Convention, CAMLR and the OSPAR Convention, as supported by the Regional Seas Programme, are geographically constrained;[122] moreover, the capacity for regional institutions to construct globally coherent "ecologically connected networks of MPAs" is inherently limited.[123] Second, while one can look to the LOSC and the CBD for guidance,[124] a "standalone declaration of principles for ABNJ does not yet exist."[125] Third, "[t]he MPA concepts used in the various global and regional conventions primarily differ because they echo the scope and purpose of their underlying instrument."[126] Fourth, existing approaches are ill-suited to deliver climate-informed MPAs that exist alongside contemporaneous developments in the delivery of other ABMT, marine spatial planning, or environmental impact assessment.[127] Finally, and most germane to this analysis, existing regimes lack the capacity to designate high seas MPAs that relate specifically to the important blue carbon ecosystems and organisms (introduced in the section above entitled "The Case for Climate-informed High Seas MPAs"). The only exception to this is the CCAMLR, which has designated MPAs that restrict or eliminate krill harvest.[128] The United Nations General Assembly (UNGA) is, in fact, the "only global political arena with a clear mandate to consider the question [of future conservation and sustainable use of marine biodiversity in the ABNJ] as a whole."[129] In December 2017, the UNGA resolved to convene an intergovernmental conference to "elaborate" the text of a legally binding international agreement under the LOSC "on the conservation and sustainable use of marine biodiversity" in the ABNJ "as soon as possible."[130] An organizational meeting occurred in April 2018, the first negotiating session convened in September 2018 and the second in March–April 2019.

The initiation of the negotiations for a BBNJ instrument is the culmination of 14 years of formalized work, started in 2004 with the UNGA establishing the Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction.[131] This working group started to make recommendations to the UNGA in 2010 and, in 2011, articulated key gaps and four foundational themes for a possible "package deal" in the form of a new multilateral instrument: "marine genetic resources, including questions on the sharing of benefits, *measures such as area-based management tools, including marine protected areas,* and environmental impact assessments, capacity-building and the transfer of marine technology."[132] In January 2015, the working group recommended to the UNGA that it initiate negotiations for a legally binding implementing agreement under the LOSC addressing BBNJ that "shall address the topics identified in the package agreed in 2011."[133] After approving the working group's recommendations, the UNGA established a Preparatory Committee that met four times between 2016 and 2017 to organize recommendations on elements of a draft text.[134] Adopted by consensus by the UNGA, the Preparatory Committee's work informed the UNGA's 2017 resolution to initiate negotiations on those topics contained in the 2011 package.[135]

122 See Dire Tladi, "Ocean Governance: A Fragmented Regulatory Framework" in Pierre Jacquet et al, eds, *Oceans: The New Frontier – A Planet for Life* (Delhi: TERI Press, 2011).

123 IDDRI, *supra* note 32 at 32; Bethan C O'Leary et al, "Addressing Criticisms of Large-Scale Marine Protected Areas" (2018) 68:5 BioScience 359.

124 See David Freestone, "Principles Applicable to Modern Oceans Governance" (2008) 23:3 Intl J Marine & Coastal L 385; Kristina M Gjerde & Anna Rulska-Domino, "Marine Protected Areas beyond National Jurisdiction: Some Practical Perspectives for Moving Ahead" (2012) 27:2 Intl J Marine & Coastal L 351.

125 IDDRI, *supra* note 32 at 31.

126 Drankier, *supra* note 90 at 341.

127 *Ibid* at 341–43; IDDRI, *supra* note 32; Robin Warner, "Oceans in Transition: Incorporating Climate-Change Impacts into Environmental Impact Assessment for Marine Areas Beyond National Jurisdiction" (2018) 45:1 Ecology LQ 31.

128 CCAMLR, *supra* note 57.

129 IDDRI, *supra* note 32 at 40. See also COP10 to the CBD, *Marine and coastal biodiversity,* Dec X/29 at para 33, where the "slow progress in establishing marine protected areas (MPAs) in areas beyond national jurisdiction, and the absence of a global process for designation of such areas" is observed.

130 *BBNJ Resolution, supra* note 19.

131 For a full history, see IDDRI, *supra* note 32.

132 *Letter dated 30 June 2011 from the Co-Chairs of the Ad Hoc Open-ended Informal Working Group to the President of the General Assembly,* UNGAOR, 66th Sess, UN Doc A/66/119 (30 June 2011) at para 1(b) [emphasis added].

133 *Letter dated 13 February 2015 from the Co-Chairs of the Ad Hoc Open-ended Informal Working Group to the President of the General Assembly,* UNGAOR, 69th Sess, UN Doc A/69/780 (13 February 2015), Annex at para 1(f).

134 *BBNJ Resolution, supra* note 19 at para 1; IDDRI, *supra* note 32 at 43–44.

135 *BBNJ Resolution*, *supra* note 19 at para 2.

It is encouraging that ABMTs, and MPAs in particular, are a priority for negotiations of the BBNJ instrument. Ideally, negotiations on this topic will consider: "(i) criteria used to identify potential areas for protection; (ii) proposal and adoption of MPAs; (iii) implementation of management measures; and (iv) enforcement."[136] Procedurally, negotiating states must also attend to "the process for coordination and consultation on proposals; mechanisms for scientific assessment of proposals; and procedures for decision-making."[137] The negotiations that occurred at the ABMT working group of the first negotiating session indicate that all of these issues are on the negotiating table, but also that reaching agreement is likely to be quite difficult. For example, at the first negotiating session, a clear divergence of opinion emerged regarding whether a BBNJ instrument should create a new institutional structure, with associated scientific and technical committees, that is capable of assessing, designating and monitoring MPAs (favoured by most of the Group of 7 countries and China), whether global oversight should be limited to cooperative coordination with existing regionally focused organizations (favoured by the United States, the Russian Federation and Japan), or some hybrid intermediary (favoured by New Zealand and Chile).[138] This tension eased somewhat at the second negotiating session where support for global institutional oversight grew, although not without reservations from Iceland and the Russian Federation.[139] Myriad other issues have already arisen, including tensions between competing perspectives on the extent to which high seas activities and freedoms such as fishing or shipping should be restricted through MPAs, the scale and type of MPAs that are justified, the process for endorsing or adopting MPAs, and how to best address monitoring and compliance. These negotiations remain a unique and unparalleled opportunity to recognize and account for climate-informed perspectives, which, as recently demonstrated by Howard et al in the coastal MPA context, are relevant and critical at every stage of MPA planning and implementation.

Climate-informed MPAs are an essential development that could link high seas governance and international climate action at an unprecedented scale. While it is beyond the scope of this paper to suggest how climate change should be accounted for at each stage of the process, it will contribute to current thinking on how climate could feature in MPA design as a critical dimension of the scientific site-selection criteria that are utilized pursuant to the new BBNJ instrument.

Existing Scientific Criteria for High Seas MPA Site Selection

Identifying which areas of the high seas ought to be protected is a more difficult task than analogous terrestrial or near coastal conservation efforts, where critical spaces (for example, rare or important habitat) are often readily identifiable. Strictly basing high seas protection on rare "features" would likely result in criterion that capture unique habitats, such as sea mounts, ridges and hydrothermal vents, but neglect other important criteria that capture benefits associated with various forms of open ocean habitat, including carbon mitigation.

With reference to the important blue carbon ecosystems and organisms canvassed in this paper, the habitats deserving of protection include the areas of the ocean where diatoms and ocean calcifers bloom, krill swarm and *Sargassum* mats, creating spatially and temporally distributed regions of high biological productivity that disproportionately contribute to carbon mitigation. Additionally, this habitat must be conceived of three-dimensionally because the surface activity, and the corresponding carbon pathways that this activity helps mediate, cascades through ocean zones below, including the ocean floor.[140] Table 1 aggregates existing scientific criteria used for high seas

136 IDDRI, *supra* note 32 at 57.

137 *Ibid.*

138 IISID Reporting Services, "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: 4–17 September 2018" (2018) 25:179 Earth Negotiations Bull 1 at 6–8 [IISID Reporting Services, "First Session"].

139 IISID Reporting Services, "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: 25 March–5 April 2019" (2019) 25:195 Earth Negotiations Bull 1 at 6 [IISID Reporting Services, "Second Session"].

140 This further supports the position that MPA designation and implementation must be coordinated not only with existing sectoral regulatory regimes impacted by associated regulatory or management measures associated with the MPA, but also with other ABMTs and EIA/marine spatial planning processes.

Table 1: Criteria Used to Identify Possible High Seas MPA Sites by International Regimes

Regime	Framework	Criteria
Barcelona Convention	Specially Protected Areas of Mediterranean Importance (SPAMI)[141]	Criteria may include: → uniqueness; → natural representativeness; → diversity; → naturalness; → presence of habitats that are critical to endangered, threatened or endemic species; and → cultural representativeness.
Antarctic Treaty Madrid Protocol	Antarctic Specially Protected Area (ASPA)[142]	ASPAs may include: → areas kept inviolate from human interference to allow future comparisons; → representative examples of major terrestrial and marine ecosystems; → areas with important/unusual species assemblages; → the type locality or only known habitat of any species; → areas of particular interest to ongoing or planned scientific research; → examples of outstanding geological, glaciological or geomorphological features; → areas of outstanding aesthetic and wilderness value; → sites or monuments of recognized historic value; and → other areas as may be appropriate to protect key values (environment, science, history, aesthetics or wilderness).
	Antarctic Specially Managed Area (ASMA)[143]	ASMAs may include: → areas where activities pose risks of mutual interference or cumulative environmental impacts; and → sites or monuments of recognized historic value.

141 *Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean*, 10 June 1995, OJ, L 322, Annex I ("Common Criteria for the Choice of Protected Marine and Coastal Areas that Could be Included in the SPAMI List").

142 *Protocol on Environmental Protection to the Antarctic Treaty*, 4 October 1991, 30 ILM 1455 (entered into force 14 January 1998), Annex V, art 3.

143 *Ibid*, art 4.

Regime	Framework	Criteria
CBD	Ecologically or Biologically Significant Marine Area (EBSA)[144]	Criteria may include: → uniqueness or rarity; → special importance for life-history stages of species; → importance for threatened, endangered or declining species and/or habitats; → vulnerability, fragility, sensitivity, or slow recovery; → biological productivity; → biological diversity; and → naturalness.
CCAMLR	General Framework for the Establishment of CCAMLR Marine Protected Areas[145]	Criteria may include: → "the protection of representative examples of marine ecosystems, biodiversity and habitats at an appropriate scale to maintain their viability and integrity in the long term"; → "the protection of key ecosystem processes, habitats and species, including populations and life-history stages"; → "the establishment of scientific reference areas for monitoring natural variability and long-term change or for monitoring the effects of harvesting and other human activities on Antarctic marine living resources and on the ecosystems of which they form part"; → "the protection of areas vulnerable to impact by human activities, including unique, rare or highly biodiverse habitats and features"; → "the protection of features critical to the function of local ecosystems"; and → "the protection of areas to maintain resilience or the ability to adapt to the effects of climate change."
OSPAR Commission	OSPAR Network of Marine Protected Areas[146]	→ Ecological criteria may include: threatened or declining species and habitats/biotopes, important species and habitats/biotopes, ecological significance, high natural biological diversity, representativity, sensitivity and naturalness. → Practical considerations may include: size, potential for restoration, degree of acceptance, potential for successful management measures, potential damage to the area by human activities and scientific value.

144 *EBSA, supra* note 94.

145 CCAMLR, *General framework for the establishment of CCAMLR Marine Protected Areas,* Conservation Measure 91-04 (2011) at para 2 (CCAMLR, *General framework*).

146 *Guidelines for the Identification and Selection of Marine Protected Areas in the OSPAR Maritime Area* (17 March 2003), Ref A-4.44 b(i), Annex 10, Appendix I ("OSPAR Criteria").

Regime	Framework	Criteria
United Nations Educational, Scientific and Cultural Organization (UNESCO)	World Heritage List[147]	Criteria may include: → "Superlative natural phenomena" or "exceptional natural beauty and aesthetic importance"; → "Outstanding examples representing major stages of earth's history"; → "Outstanding examples representing significant on-going ecological and biological processes"; and → "The most important and significant natural habitats for in-situ conservation of biological diversity."
FAO	VME[148]	Criteria may include: → uniqueness or rarity; → functional significance of the habitat; → fragility; → life-history traits of component species that make recovery difficult; and → structural complexity.

Source: Author.

MPA designation, which will be assessed relative to their capacity to effectively capture the sort of climate-informed high seas MPAs envisioned in this paper.

The ABMT Working Group, at the first negotiating session for the BBNJ instrument, considered the question of MPA site-selection criteria as part of a broader ABMT discussion. A range of preferences emerged. While there was general support for the proposition that site-selection criteria are an important aspect of utilizing MPAs effectively, the Group of Seventy-Seven (G77) and China emphasized "uniqueness, variability, fragility and biological productivity and diversity" and site selection based on "best available evidence"; Mexico identified "rarity, vulnerability, and interconnectedness"; Argentina and Thailand pointed to the utility of the existing site-selection criteria, including EBSAs and VMEs; Mauritius proposed inclusion of "level of threat" and "size of area affected"; and the European Union favoured the development of "general criteria" for site selection.[149] At the second negotiating session, the G77 and China, Sri Lanka, the African Group, Singapore and the like-minded Latin American countries proposed a "non-exhaustive list of standards and criteria," meaning that sites could be designated without meeting every listed criteria.

In short, the list of potential criteria provided in Table 1 comprehensively captures the list of potential criteria that were canvassed during discussion; practically, this means that climate-specific criteria were not meaningfully negotiated.[150] Strikingly, with the exception of one condition

147 United Nations Educational, Scientific and Cultural Organization (UNESCO), *Operational Guidelines for the Implementation of the World Heritage Convention* (12 July 2017), WHC.17/01 at paras 77–78 (used to identify sites suitable for inclusion on the World Heritage List, established pursuant to the *Convention Concerning the Protection of the World Cultural and Natural Heritage*, 23 November 1972, 1037 UNTS 151 [entered into force 15 December 1975]). While no UNESCO sites have been designated for the high seas, it is an idea attracting considerable attention. See UNESCO, "Exploring the World Heritage Convention for High Seas Conservation", online: <whc.unesco.org/en/marine-programme/#exploring> (identifying for priority areas, one of which being exploration of "the potential of the 1972 World Heritage Convention in the High Seas").

148 FAO, *supra* note 95 at para 42.

149 IISID Reporting Services, "First Session", *supra* note 138 at 7.

150 The exception to this is that Australia, Singapore, Japan and the Russian Federation disagreed with including criteria pertaining to "the adverse impacts of climate change and ocean acidification." This opposition seems to stem from the Marshall Islands' proposal that "the adverse effects of climate change and ocean acidification" be included as a general principle of the BBNJ instrument, which was advanced at the Informal Working Group on cross-cutting issues (IISID Reporting Services, "Second Session", *supra* note 139 at 16). Additionally, there is no evidence that the negotiators considered the CCAMLR, *General framework*, *supra* note 145.

in the CCAMLR criteria, none of the scientific criteria, nor their explanatory notes, explicitly reference climate adaptation or mitigation. Climate is, arguably, implicit to certain recurring criteria, most notably: reference to sites where habitat or species are threatened as a result of human activity and disturbance or that are otherwise vulnerable to future disruption; and reference to sites that demonstrate high levels of biological productivity, which is a measure of the accumulation of organic matter, carbon, or energy in a specified location and over a defined period of time. The ocean's biological productivity is linked through "nested cycles of carbon" and can be used to understand the movement of carbon through ecosystems.[151]

On June 25, 2019, the president of the conference released the 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" to "facilitate further progress in the negotiations."[152] Draft article 16(2) lists the criteria for identifying MPAs and other ABMTs. As expected in a compromise document, the list is comprehensive and includes criteria such as "biological productivity" and "vulnerability." Most notable is the inclusion of the following criteria: "important ecological processes occurring therein" and "the adverse impacts of climate change and ocean acidification"/"vulnerability to climate change."[153] Notably, unless climate mitigation is understood to be implicit to "ecological processes," these criteria are limited to climate adaptation.

Articulating Climate Criteria to Influence High Seas MPA Site Selection

Climate change adaptation, mitigation and resilience should be included among the overarching objectives for the suite of ABMT currently under negotiation for the BBNJ instrument. Once agreed that this is a suitable objective, high seas MPAs do not necessarily have to be selected and protected based *solely* on their blue carbon contribution in order to help protect the ocean's climate mitigative potential; rather, the criteria endorsed or adopted pursuant to the BBNJ instrument should include blue carbon and climate mitigation *among* those factors that must be examined when proposing a site's suitability for MPA designation and protection. For this reason, it would be imprudent for the BBNJ instrument to simply defer to existing site-selection criteria.

Turning to the articulation of criteria that capture the blue carbon contribution of high seas ecosystems and organisms, the two logical courses of action are to isolate and state explicitly the climate aspects that are currently implicit in existing criteria, or to develop novel, standalone climate-related criteria. Regarding the former, this could be accomplished by elucidating the ways in which climate change interacts with either site vulnerability or how it can be accounted for as a dimension of biological productivity. Extrapolating vulnerability to account for climate change would likely focus on the impact of climate-related changes to the ocean environment (for example, warming and acidity metrics) or its ability to multiply existing threats. Biological productivity could be expounded to explicitly reference the climate mitigative potential of important blue carbon ecosystems and species, including those surveyed in the introduction of this paper. To a certain extent, this option has been followed by the inclusion of "vulnerability to climate change" in the draft text.

The second option, and the author's preferred course of action, would be to include distinct standalone climate criteria. The CCAMLR's recognition of the need to protect "areas to maintain resilience or the ability to adapt to the effects of climate change" in its general framework "for the establishment of CCAMLR Marine Protected Areas" is a useful starting point and seems to resound in the draft text's "adverse impacts of climate change" criteria.[154] From the climate-adaptive perspective, the proposed criteria should be expanded to account for a site's importance in buffering the ocean's living resources against climate-related threats, based on the best available scientific evidence. From the climate-mitigative perspective, inclusion of climate mitigation and blue carbon potential criteria is an essential

151 Daniel M Sigman & Mathis P Hain, "The Biological Productivity of the Ocean" (2012) 3:6 Nature Education 1 at 1.

152 *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* (25 June 2019) at 2, online: <www.un.org/bbnj/sites/www.un.org.bbnj/files/draft_text_a.conf_.232.2019.6_advanced_unedited_version.pdf>.

153 *Ibid* at 16. These criteria appear in square brackets in the draft text, signalling that they have received limited negotiation.

154 CCAMLR, *General framework*, *supra* note 145.

development, and one that is currently absent from proposed criteria, that would account for a particular site's blue carbon potential, based on best available scientific evidence. This exercise necessarily turns on the scientific ability to perform "carbon accounting" for various ecosystems, which "is well established,"[155] especially in the coastal context.[156] Ongoing improvements in remote sensing, especially through real-time satellite observation, support the feasibility of translating this process to the high seas in an appropriately tailored spacio-temporal manner.

Currently, existing international regimes and the criteria used to select and assess the suitability of high seas sites for potential MPAs are incapable of maximizing the blue carbon potential of important ecosystems and living marine resources (surveyed in the section above entitled "The Case for Climate-informed High Seas MPAs"). These living marine resources share important features that make them suitable candidates for climate-informed MPA protection: they aggregate at discernible spacio-temporal scales that measurably and significantly mediate important biological and chemical carbon pathways that ultimately contribute to long-term carbon sequestration. For this reason, ensuring that climate-based criteria are included in the framework that is endorsed for the BBNJ instrument is a climate-essential development that would facilitate novel deployment of high seas MPAs.

Developing and recognizing these novel criteria is only the starting point for climate-informed high seas MPAs. Even if these criteria help identify key geospatial regions of the high seas that frequently host significant diatom or calcifer blooms, krill swarms, or *Sargassum* mats, the process would then also have to address practical considerations (for example, MPA size); the development of associated conservation measures (for example, restrictions on extractive and non-extractive activities); funding mechanisms; and the ever-vexing tasks of monitoring, enforcement and compliance. Additionally, realizing the benefits of climate-informed high seas MPAs is predicated on working to close knowledge gaps in our understanding of the magnitude and permanence of existing blue carbon stocks, our ability to assess and predict which ecosystems might increase in importance in the future, and continued identification and prioritization of those threats that reduce carbon uptake or diminish assimilative capacity of important blue carbon ecosystems. The science is settled enough[157] to justify the inclusion of criteria that can inform future efforts at climate-based high seas site selection — a necessary first step toward recognizing the open ocean's full mitigative potential.

Conclusion

Toward the end of his tenure as UN Secretary-General, Ban Ki-Moon repeatedly stated that meeting the climate challenge required "all hands on deck."[158] Post Paris Agreement, his words have been interpreted as a requirement to harness the collective activities of both the private and public sector to drive adaptation and mitigation efforts, including decarbonization.[159] In view of the IPCC's alarmingly clear statement that humanity has a short period of time to aggressively pursue mitigation pathways to avoid serious harms, our collective response must ensure that every feasible solution is canvassed and that each climate-essential development is identified.

155 Howard et al, "MPA design and management", *supra* note 22 at 111.

156 IUCN, "Next steps for carbon accounting from coastal 'blue carbon' ecosystems" (10 May 2017), online: <www.iucn.org/news/climate-change/201705/next-steps-carbon-accounting-coastal-"blue-carbon"-ecosystems>; United Nations Environment Programme (UNEP) & Center for International Forestry Research (CIFOR), *Guiding principles for delivering coastal wetland carbon projects* (Nairobi, Kenya & Bogor, Indonesia: UNEP & CIFOR, 2014).

157 Laffoley et al, *supra* note 17 at 6, stating that "[o]ften the science is incomplete and sometimes aspects are missing, with important topics yet to be fully investigated, but we already know enough at a broad level to recognize the significance of these ocean carbon processes, pool and sinks."

158 UN News, "Climate Summit: 'All hands on deck' declares Ban, calling for leadership, concrete action" (23 September 2014), online: <news.un.org/en/story/2014/09/478172-climate-summit-all-hands-deck-declares-ban-calling-leadership-concrete-action>; UN, "All Hands on Deck Needed to Combat Climate Change, Secretary-General Tells Lima Conference, Urging Increased Investment, Universal Agreement" (9 December 2014), UN Doc SG/SM/16406-ENV/DEV/1477; UN Sustainable Development Goals, "Paris Climate Agreement to enter into force on 4 November" (5 October 2016), online: <www.un.org/sustainabledevelopment/blog/2016/10/paris-climate-agreement-to-enter-into-force-on-4-november/>.

159 Thomas Hale, "'All Hands on Deck': The Paris Agreement and Nonstate Climate Action" (2016) 16:3 Global Environmental Politics 12; Connor P Spreng, Benjamin K Sovacool & Daniel Spreng, "All hands on deck: polycentric governance for climate change insurance" (2016) 139:2 Climate Change 129.

Protecting the biological components of open ocean ecosystems that maintain the high seas' climate-regulating service is a climate-essential development. Scientifically, important ecosystems and organisms located in the high seas are a critical, yet undervalued, component of the earth's climate system. Legally, there are gaps at the intersection of climate action and oceans management that must be closed to effectively capture the benefits of the high seas. Practically, climate-informed high seas MPAs represent a reasonably straightforward and cost-effective nature-based solution, and the ongoing negotiation of the BBNJ instrument is the appropriate place to initiate development of the necessary regulatory framework.

The high seas are the final frontier for oceans governance and for marine wilderness. The ABNJ is "the last, the final, major issue still to remain unresolved under the regime of the 1982 Law of the Sea Convention"[160] and also host to the majority of the ocean's remaining wilderness, buffered against some of humanity's environmental impacts by virtue of its geographical remoteness. In the intervening 36 years since the LOSC opened for signature, climate change has emerged as the defining environmental threat of our time.[161] Novel linkages between international climate action and oceans governance are urgently required; climate-informed high seas MPAs hold considerable potential in this regard and, accordingly, deserve immediate attention during the ongoing negotiation of the BBNJ instrument.

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160 David Freestone, "The Final Frontier: The Law of the Sea Convention and Areas beyond National Jurisdiction" in Harry N Scheiber, Moon Sang Kwon & Emily A Gardner, eds, *Securing the Ocean for the Next Generation*, Papers from the Law of the Sea Institute–Korea Institute of Ocean Science and Technology Conference held in Seoul, Korea (2012) 1 at 15.

161 See Kristina M Gjerde et al, "Protecting Earth's last conservation frontier: scientific, management and legal priorities for MPAs beyond national boundaries" (2016) 26:S2 Aquatic Conservation: Marine & Freshwater Ecosystems 45 at 48.

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