Surfacing the Problems with Deep Sea Mining: The Need for a Cautious International Regime

Grayon William Sotir

Abstract

Deep sea mining (DSM) is an increasingly controversial yet seemingly inevitable next step in humankind's collective march toward a greener future. Advocates for DSM insist that the bounties of the ocean floor will help us mitigate the harms of climate change. Critics caution that a strong profit motive has made us careless and that the seemingly inconsequential damages apparent to DSM threaten even greater second-order consequences, not least of which is the elimination of various marine ecosystems. Beyond environmental risks, there exist major ethical concerns about the global distribution of licenses to harvest these underwater metals given that they are overwhelmingly located in international waters. Should mineral rights be distributed in accordance with some objective scheme for the benefit of all humanity, or is the seafloor to become the new "Wild West" where private interests reap all rewards? What of oft-overlooked Indigenous Peoples whose ancestral practices are more threatened by the harms of unfettered sea mineral exploitation? This Comment advances the position that the International Seabed Authority (ISA) has failed to adequately acknowledge the myriad complexities of DSM and advocates plausible legal reform which better addresses these issues in the future.

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I. Introduction: A Brief History

In 1872, the HMS *Challenger* launched on what was to become a four-year mission of oceanographic exploration.[1] Once a vessel of the British Royal Navy, the *Challenger* was modified with funding from the Royal Society of London to perform its newly delegated scientific functions,[2] including investigating (1) the sea's physical conditions, such as depth, temperature, circulation, and penetration of light; (2) the chemical composition of seawater at various depths; (3) the distribution of organic life at different depths and on the deep sea floor; and (4) the physical and chemical character of deep sea deposits and the sources of these deposits.[3] To accomplish these aims, the *Challenger* was redesigned to accommodate two full-service laboratories (one for the study of natural history and one for the study of chemistry),[4] two reels of sounding line (one reel for depth readings and another for temperature readings),[5] and kilometer-long dredging ropes of Italian hemp (outfitted with custom collecting apparatuses to skim the sea floor for minerals and sand).[6]

1. *See generally*, Frédéric Aitken & Jean-Numa Foulc, From Deep Sea to Laboratory 1: The First Explorations of the Deep Sea by H.M.S. Challenger (18721876) (2019).

2. *See* 1 C. Wyville Thomson, The Voyage of the H.M.S. Challenger 1873–1876 Narrative1–2(JohnsonReprintCorp.1965)(1885)https://web.archive.org/web/20131014121006/http://archimer.ifremer.fr/doc/1885/publication-4749.pdf [https://perma.cc/NYS6-T8UP].

3. Aitken & Foulc, *supra* note 1, at 51.

4. Thomson, *supra* note 2, at 2.

5. *Id.*

6. *Id.* at 18; *see also* Bernews, *Bermuda and the Challenger Expedition* (Mar. 29, 2013), http://bernews.com/2013/03/bermuda-and-the-challenger-expedition [https://perma.cc/QBK2–4XX4].

After traveling 68,890 nautical miles[7] and dutifully documenting thousands of findings,[8] a novel and revolutionary compendium of scientific knowledge was published: the *Report of the Scientific Results of the Exploring Voyage of H.M.S. Challenger during the years 1873–76.*[9] The *Challenger*'s findings were so extensive that the project's publications continued for fifteen consecutive years after the termination of the voyage.[10] The report contained 50 volumes and was more than 29,500 pages in length.[11] Within those volumes were the findings of 492 deep sea soundings, 133 bottom dredges, 151 open water trawls, and 263 serial water observations.[12] Perhaps most notable and exciting were the findings of approximately 4,700 new mysterious species of marine life, many of which still captivate the imagination of the world's naturalist community today.[13] The *Challenger*'s publication supervisor, John Murray, claimed that the report was "the greatest advance in the knowledge of our planet since the celebrated discoveries of the fifteenth and sixteenth centuries."[14] Modern scientists now credit the *Challenger* with laying the groundwork for the entirety of oceanography as a distinct academic and research discipline.[15]

It now seems that the most significant of the *Challenger*'s contributions has proven itself more than 150 years later. This finding—a potato-shaped

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7. *See* Loren C. Eiseley, The Immense Journey 38–41 (1st ed. 1957), *https://archive.org/details/immensejourney00eiserich* [https://perma.cc/37AR-EYH4] (records indicate that the *Challenger* made trips to Hong Kong, Tahiti, Portsmouth, Lisbon, Gibraltar, Madeira, the Canary Islands, the Virgin Islands, Bermuda, Cape Verde, Melbourne, Wellington, Yokohama, the Falkland Islands, and very nearly Antarctica, to name a few); *see also* Steven M. Perry and Daphne G. Fautin, *Challenger Expedition (1872–1876)* (Dec. 14 2012), https://archive.ph/20121214200054/http://hercules.kgs.ku.edu/hexacoral/expedition/challenger_1872–1876/challenger.html (for additional information on the voyage trajectory, including a route map).

8. Eiseley, *supra* note 7, at 38.

9. *See* 32 Alexander Buchanet al., Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873–76 under the command of Captain George S. Nares . . . and the late Captain Frank Tourle Thomson, R.N (Edinburgh, Neill, 1880–1895).

10. Peter K. Weyl, Oceanography: An Introduction to the Marine Environment 49 (2d ed. 1970).

11. *Id.*

12. *Id.*

13. *See* Antony Adler, Neptune's Laboratory: Fantasy, Fear, and Science at Sea 35 (Jeff Dean ed., 2019). *See generally*, Julian Anthony Koslow, The Silent Deep: The Discovery, Ecology and Conservation of the Deep Sea (2007) (explaining the history, breadth, and significance of the *Challenger*'s voyage).

14. *See* Doug Macdougall, Endless Novelties of Extraordinary Interest: The Voyage of H.M.S. Challenger and the Birth of Modern Oceanography 241 (Joe Calamia & Susan Laity eds., 2019).

15. *See, e.g.*, Tina Bishop et al., *Then and Now: The HMS Challenger Expedition and the "Mountains in the Sea" Expedition*, Nat'l Oceanic and Atmospheric Admin.: Explorations (2003), https://oceanexplorer.noaa.gov/explorations/03mountains/background/challenger/challenger.html [https://perma.cc/9YYF-YA47].

nodule that could easily be mistaken for a rock by the untrained layperson—has been forming layers of precious metals for millions of years.[16] Countless bounties of these nodules lie on the bottom of the ocean, and some believe that they hold the key to saving the planet from climate catastrophe.[17] The precious metals these nodules contain could be used to revolutionize electric car battery production,[18] alleviate supply chain woes,[19] and even lift developing nations into economic prosperity.[20] But how is this process governed, and what protections are in place to ensure equitable and environmentally-conscious extraction?

This Comment addresses deep sea mining (hereinafter, "DSM") and the pending industrial licensing regime of the International Seabed Authority (hereinafter, "ISA" or "the Authority"). First, we will review the relevant scientific literature to illustrate the complexities of DSM and its undoubted relationship with our environment's health. Although potentially daunting to readers outside of STEM fields, a thorough understanding of the science is necessary in order to understand the numerous blind spots threatening the development of effective DSM regulations. Second, we will turn our attention to an analysis of the ISA's broader legal regime to identify gaps in its efficacy, many of which perpetuate an irresponsible trend towards the hasty permitting of DSM licenses at the expense of countless crucial considerations. Third, we will note additional problems worthy of further contemplation and inquiry. Finally, we will conclude with a list of proposals to improve the existing international regime. These suggestions are offered in an effort to create the best

16. *See* J.R. Hein et al., *Deep-ocean polymetallic nodules as a resource for critical materials*. 1 Nat. Rev. Earth Env't. 158–169 (2020), https://doi.org/10.1038/s43017–020–0027–0 [https://perma.cc/SQ43-M9R7].

17. *See e.g.*, *Deep sea mining could provide materials to help us quit fossil fuels—but at a cost*, NPR (Aug. 5 2022), https://www.npr.org/2022/08/05/1116036146/deep-sea-mining-could-provide-materials-to-help-us-quit-fossil-fuels-but-at-a-co [https://perma.cc/5FJX-H3UY] ("I think the big question we have to ask is, what tradeoffs are we willing to make to fight climate change? You know, moving away from fossil fuels means building a lot of new infrastructure, and deep-sea mining could provide some of the materials to do that. But it could also come at a cost to the health of the ocean.").

18. *Id.*

19. *See generally*, Bureau De Recherches Geologiques Et Minieres, *Critical Minerals for the EU Economy: Foresight to 2030*, The Univ. of Warwick (2013), https://warwick.ac.uk/fac/soc/pais/research/csgr/green/foresight/economy/2013_ec_critical_minerals_for_the_eu_economy_-_foresight_to_2030.pdf [https://perma.cc/7PMK-CEY7] (noting that there is a need to expand current resource acquisition given the current projected increase in mineral use for technological purposes).

20. *See* Luz Danielle O. Bolong, *Into the Abyss: Rationalizing Commercial Deep Sea Mining Through Pragmatism and International Law*, 25 Tul. J. Int'l & Comp. L. 127, 129 (2016), *citing* Rupert Neate, *Seabed Mining Could Earn Cook Islands 'Tens of Billions of Dollars,'* The Guardian (Aug. 6, 2013), http://www.theguardian.com/business/2013/aug/05/seabed-mining-cook-islands-billions [https://perma.cc/T4Y6-S9X8]; *see also* U. N. Convention on the Law of the Sea arts. 82, 150(d), Dec. 10, 1982, 1833 U.N.T.S. 3 [hereafter UNCLOS]; *see also* UNCLOS Annex III art.13(1)(a).

system of licensing and accountability for the benefit of all humankind, with greatest consideration extended to the environment, human rights obligations, and deference to the precautionary principle. The suggestions proffered by this Comment are neither exhaustive nor perfunctory. They are merely a starting point for a larger conversation about the appropriate role of the ISA's regulatory regime in an increasingly complex and interconnected world.

II. The Science

A. *The Process of Deep Sea Mining*

For the purposes of this Comment, we will understand the "deep sea" using the International Union for the Conservation of Nature's definition, which is any depth greater than 200 meters.[21] However, many regions targeted for mining, such as the Clarion-Clipperton Zone, have rich deposits as deep as five and a half kilometers below the ocean's surface.[22] There are also distinct industry-defined categories of DSM, including (1) mining of the abyssal and/or deepwater plains, where the seabed contains the aforementioned slow-growing metallic nodules (containing precious metals such as manganese, cobalt, nickel, and copper); (2) mining the metal-rich crust, including seamounts which can rise thousands of meters above the abyssal plains (containing cobalt, platinum, and molybdenum); and (3) mining mineral deposits located along volcanic ridges of superheated water running through ocean basins (containing copper, lead, zinc, gold, and silver).[23] While all three categories of DSM are invoked by the subject of this Comment, our analysis will rely primarily on the first category to illustrate the mining process, the environmental risks, and the licensing regime.

Before profitable harvesting can commence, companies must first find a region with a density of nodules such that the cost of extraction is offset by the potential yield. This process alone requires detailed information gathering, seabed mapping, and anticipatory calculation of the nodule composition of particular metals.[24] These processes come with substantial physical hurdles. At depths exceeding 1,000 meters, all light disappears and temperatures drop

21. *See* Int'l Union for the Conservation of Nature, *Issues Brief 'Deep-Sea Mining'* (2022), https://www.iucn.org/sites/default/files/2022–07/iucn-issues-brief_dsm_update_final.pdf [https://perma.cc/4VEF-SRT2].

22. *See Deep-sea Mining Interests and the Clarion-Clipperton Zone*, Nat'l Oceanic and Atmosph. Admin. Ocean Expl., (last visited Feb. 2, 2023) https://oceanexplorer.noaa.gov/explorations/18ccz/background/mining/mining.html [https://perma.cc/P968–4S64].

23. *See* Sue Farran, *Deep-sea mining and the potential environmental cost of 'going green' in the Pacific*, 24 Envt'l. L. Rev. 173, 174 (2022), *citing* Int'l Union for the Conservation of Nature, *Issues Brief 'Deep-Sea Mining'* (2022), https://www.iucn.org/sites/default/files/2022–07/iucn-issues-brief_dsm_update_final.pdf [https://perma.cc/4VEF-SRT2].

24. *See Polymetallic Nodules*, Int'l Seabed Auth. (2022), https://isa.org.jm/files/documents/EN/Brochures/ENG7.pdf [https://perma.cc/M83V-MHDG].

below freezing.[25] Here, in the absence of photosynthesis, deep sea creatures have evolved seemingly alien methods of survival.[26] The only visible light at such a depth is the faint twinkling of strange bioluminescent organisms.[27] Food is extremely scarce and animals rely on falling debris comprised of organic materials from the shallower waters above.[28] Given such extreme conditions, the animals that manage to survive there are certainly among the most unique in the animal kingdom. As one of the last ecosystems largely untouched by humans,[29] there are understandable concerns regarding the impact that any mining operation could have on these particularly vulnerable organisms.

Still, dozens of entities now seek innovative ways to surface deep sea nodules and already have contracts permitting exploratory missions to study viable methods of extraction.[30] These entities consist of a mix of both state-owned and private corporations.[31] Of thirty exploratory licenses granted, eighteen are held between seven countries through state-owned companies, government agencies, or ministries.[32] These countries include China, France, Germany, India, Japan, Russia, and South Korea.[33] Another seven contracts are effectively owned by three private companies, including The Metals Company (formerly "DeepGreen," licensee, now merged with the former Sustainable Opportunities Acquisition Corporation [NYSE: SOAC][34]), UK Seabed Resources, and Global Mineral Resources.[35] These exploratory missions have yielded important insights into the economic benefits and environmental impacts of DSM, leading to sustained debate about the risks and rewards of nodule extraction.

Nodules form naturally over millions of years.[36] Simplistically, a nodule is formed when a piece of debris sinks to the oxygen-rich deep sea floor and

25. *See, e.g.*, Craig R. Smith et al., *Deep-Sea Misconceptions Cause Underestimation of Seabed-Mining Impacts*, 35 Trends in Ecology and Evolution 853 (2020).

26. *See generally*, Nat'l Oceanic and Atmosph. Admin., *How far does light travel in the ocean?*, Nat'l Ocean Serv., (Jan. 20, 2023) https://oceanservice.noaa.gov/facts/light_travel.html [https://perma.cc/F4UK-23CF].

27. *Layers of the Ocean*, Nat'l Oceanic and Atmosph. Admin., (Mar. 28, 2023), https://www.noaa.gov/jetstream/ocean/layers-of-ocean [https://perma.cc/9U8Y-ZTUK].

28. *See* Nat'l Oceanic and Atmosph. Admin., *What is marine snow?*, Nat'l Ocean Serv., (Nov. 5, 2020) https://oceanservice.noaa.gov/facts/marinesnow.html [https://perma.cc/HZV7-LF7C].

29. *See* Smith, *supra* note 25, at 855.

30. *See Deep-Seabed Mining The Main Players*, Deep Sea Conservation Coal., https://www.savethehighseas.org/deep-sea-mining/the-main-players [https://perma.cc/5FGG-HADV] (last visited Feb. 4, 2023).

31. *Id.*

32. *Id.*

33. *Id.*

34. *Id.*; *see also Timeline*, The Metals Company, (last visited Feb. 4, 2023) https://metals.co/timeline [https://perma.cc/XJE3-N2FT].

35. Deep Sea Conservation Coal, *supra* note 30.

36. Hein, *supra* note 16, at 159.

metals like nickel, cobalt, and manganese develop on its surface.[37] In a process not unlike the oxidization of rust on metal, layers of oxidized elements form around this debris in an unfathomably slow chemical process.[38] It is estimated that nodule growth is only 1–10 millimeters per million years.[39] This means that in the time since our common ancestors first left Africa, today's deep sea nodules have only oxidized the width of a human hair.[40] The natural process which leads to the slow creation of these nodules strongly impacts the potential value of deep sea real estate.[41] Different percentages of different metals will form depending on the depth that the debris has fallen to, because varying levels of oxygenation exist at different ocean depths.[42] For example, while the majority of all nodule composition contains manganese and iron, nodules closer to the ocean's surface will contain more cobalt while deeper nodules contain more nickel and lithium.[43] Nodule concentrations can be found all over the ocean floor, but are especially concentrated in the Pacific and Indian Oceans because of their temperatures and oxygen levels.[44]

Despite the obvious practical difficulties of DSM, there exist strong economic incentives to make DSM feasible. The calculated long-term supply of minerals from the Earth's known terrestrial reserves is grim. It is estimated that by 2100, the 1.7-billion-ton market demand of copper will come to exceed the 1.6 billion tons of remaining terrestrial deposits.[45] It is therefore anticipated that copper supplies will begin to dwindle in 2030,[46] creating a market shortage. This 2030 timeline also spells shortages for several market alternatives, including silver, antimony (used in nonmetal products like ceramics, glass, and rubber), and antimonial lead.[47] These market pressures have undoubtedly fueled the mining industry's interest in deep sea alternatives. Given the

37. *Id.*

38. *Id.*

39. *Id.*

40. *See* Eduardo Moreno, *The Society of our "Out of Africa" Ancestors*, 4 Communicative Integr. Biol. 163, 164 (2011), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3104569 [https://perma.cc/Z9QD-5UFS] (explaining that our common ancestors began migrating from Africa 70,000–100,000 years ago).

41. Jon Copley, *Deep-sea mining is making the seabed the hottest real estate on Earth*, NewScientist (Nov. 4 2020) https://www.newscientist.com/article/mg24833070–700-deep-sea-mining-is-making-the-seabed-the-hottest-real-estate-on-earth [https://perma.cc/2DE3-S93Y].

42. Hein, *supra* note 16.

43. *Id.* at 163.

44. *See* Christian Bücker et al., *Marine Resources—Opportunities and Risks*, World Ocean Rev., 2014, at 52–93 https://worldoceanreview.com/wp-content/downloads/wor3/WOR3_en_chapter_2.pdf [https://perma.cc/HG3E-XTSM].

45. Bolong, *supra* note 20, at 131; *see also* British Geo. Surv., *Commodities and Statistics Risk List 2015*, MineralsUK (2015), https://www2.bgs.ac.uk/mineralsuk/download/statistics/risk_list_2015.pdf [https://perma.cc/98PA-44JG].

46. Bolong, *supra* note 20, at 131.

47. *Id.*

vast potential yield of DSM, it is projected that successful harvesting processes could easily sustain current consumption trends while simultaneously relieving global supply chain woes.[48] It has been further noted that one of the greatest supply chain stresses currently plaguing the global economy is batteries.[49] This makes DSM a process of tremendous consequence to all sectors of the global economy. Beyond electric vehicles, lithium batteries are commonly used in highly profitable modern necessities, such as smartphones and laptops,[50] and offer many advantages over market alternatives.[51]

To be sure, safe and affordable extraction will require new technologies, but certain technical modifications to existing technologies may create viable extraction methods within one or two years.[52] For example, companies have developed machines that can extract valuable liquids (*i.e.*, oil and gas) from the ocean floor using a remote-controlled seabed rover and a pump mechanism.[53] In theory, these machines could be adapted to instead pump solid materials to the surface by employing one of two methods. The first method is a compressed air injector that would create pressure adequate to surface the nodules.[54] It has been noted, however, that pumping those solid materials using an air injector has incredibly low energy efficiency and would itself create a tremendous deal of energy waste for the extracting corporation.[55] The second method employs submerged centrifugal pumps to surface both the nodules and the seabed "sludge" surrounding it.[56] The real challenge of this method comes from filtering out this sea sludge from the nodule yield. Barring additional innovations, this displaced seabed would have to be dumped back into the ocean where it could pollute multiple layers of natural habitat as it descends.[57] This not only has the potential to harm life on the sea floor, but also life thousands of meters above the extraction point.[58] The first scenario means

48. Bureau De Recherches Geologiques Et Minieres, *supra* note 19; Bolong, *supra* note 20, at 132.

49. Bureau De Recherches Geologiques Et Minieres, *supra* note 19.

50. *See Lithium-Ion Battery*, Univ. of Wash. Clean Energy Inst., https://www.cei.washington.edu/education/science-of-solar/battery-technology [https://perma.cc/Q89E-9YBF] (last visited Feb. 4, 2023).

51. *Id.*

52. *See* Yajuan Kang & Shaojun Liu, *The Development History and Latest Progress of Deep-Sea Polymetallic Nodule Mining Technology*, 11 Minerals 1132 (2021).

53. *See id.*

54. *Id.* at 2.

55. *Id.* at 12.

56. *See* Li Yuanwen et al., *Flow Field and Particle Flow of Two-Stage Deep-Sea Lifting Pump Based on DEM-CFD*, 10 Frontiers in Energy Rsch., May 04, 2022, at 1, 2. https://www.frontiersin.org/articles/10.3389/fenrg.2022.884571/full [https://perma.cc/SXH4-BUL5].

57. *See* Carlos Muñoz-Royo et al., *Extent of impact of deep-sea nodule mining midwater plumes is influenced by sediment loading, turbulence and thresholds*, 2 Commc'ns Earth & Env't, July 27, 2021, at 148. https://doi.org/10.1038/s43247–021–00213–8 [https://perma.cc/2PGR-BJBQ].

58. *Id.* at 3.

a great deal of energy waste, while the second scenario means sludge-bombing numerous interconnected ecosystems.

B. *Environmental Concerns*

Although creative engineering may help mitigate certain environmental harms associated with DSM, it is the actual extraction and removal of deep sea nodules that will have the most impact on the deep sea life that we have not yet had a chance to study.[59] Some deep sea animals have evolved with a special dependence on these nodules.[60] For example, certain species of sea sponge appear to rely on these solid structures to effectively anchor themselves.[61] There are also deep sea octopi that use these nodules as nests to lay and protect their eggs.[62] Perhaps more concerning than our ignorance of deep sea ecosystems is our ignorance of the interconnectivity between deep sea ecosystems and ecosystems closer to the surface.[63] How might the seemingly inconsequential destruction of an unknown species of deep sea starfish impact creatures with which we're more familiar?

These concerns are shared by various NGOs and citizen groups that continue to voice their vehement opposition to DSM.[64] One conglomerate association known as the Deep-Sea Mining Campaign (consisting of NGOs such as Mining Watch Canada, Oxfam Australia, Earthworks, and PNG Groups Against Seabed Experimental Mining) has called for a moratorium on DSM until marine habitats, biodiversity, and ecosystem functions can be adequately protected.[65] Greenpeace, along with citizens groups from the Pacific Islands, Australia, and Canada, have echoed the Deep-Sea Mining Campaign's concerns.[66] Nonprofit corporations dedicated to the protection and restoration of biodiversity across ecosystems (*e.g.*, the Center for Biological Diversity) also oppose DSM, citing the "lenient environmental standards" which may come to govern a process which so acutely risks "irreparable harm" to the environment.[67]

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59. Hein, *supra* note 16, at 165–66; *see also* Meryl Williams et al., Scientific Results to Support the Sustainable Use and Conservation of Marine Life: A Summary of the Census of Marine Life for Decision Makers (Census of Marine Life Int'l Secretariat) (2011).

60. Hein, *supra* note 16, at 166.

61. *Id.*

62. *Id.*

63. *Id.*

64. Bolong, *supra* note 20, at 141.

65. *Id.*

66. *See id.*; *see* Alicia Craw et al., Deep Seabed Mining: An urgent wake-up call to protect our oceans 10–11 (Steve Erwood & Isabel Leal eds., 2013), http://www.greenpeace.org/international/Global/international/publications/oceans/2013/Deep-Seabed-Mining.pdf [https://perma.cc/Y984–8ZMT].

67. *See* Complaint for Declaratory and Other Relief at 5, 16, Center for Biological Diversity v. Pritzker, No. 15–723, (D.D.C. May 13, 2015), 2015 WL 3489849.

Some have suggested that such harms could ultimately devastate consumer fish stocks by disrupting the seamounts where those fish are known to gather.[68] Indigenous communities charge that harm to these fish stocks would further threaten the viability of their sacred coastal traditions, and that this desecration of their ancestral waters would amount to cultural genocide.[69] Experts and advocates have called for additional studies to fully understand the scope of the harms that DSM would have on Indigenous social, cultural, and economic interests (*e.g.*, impacts on Indigenous fishermen).[70] These concerns alone present credible legal challenges to DSM, as Indigenous communities have enumerated human rights protections requiring their consultation before approval of any projects affecting their natural or ancestral resources, especially resources which support spiritual or economic activities.[71]

The fears of DSM's worst-case scenarios are further exacerbated by the lack of research done to fully understand the longevity of DSM's impacts. Indeed, one of the only studies conducted on the impacts of DSM (funded by the German government and conducted off the coast of Peru) found that a harvested seabed's ecosystem showed no signs of recovery even 33 years after the extraction of its nodules.[72] In other words, whatever changes DSM creates to the seabed appear to last a long time, extending the window for additional unintended second-order consequences well in to the future. The potential severity of seabed alterations is heightened by the aforementioned methods of nodule extraction (namely, the compressed air injector and the submerged centrifugal pumps) and their double-displacement effect. The harm to the extraction

68. Bolong, *supra* note 20, at 130.

69. *Id.*

70. *See* Helen Rosenbaum & Francis Grey, *Deep Sea Mining Campaign, Accountability Zero: A Critique of the Nautilus Minerals Environmental and Social Benchmarking Analysis of the Solwara* 1 Project 9 (2015) https://earthworks.org/files/publications/REPORT-AccountabilityZERO.pdf [https://perma.cc/W3EA-Y6H6].

71. *See, e.g.*, G.A. Res. 61/295, U. N. Declaration on the Rights of Indigenous People (Sept. 12, 2007) art. 36 ("1. Indigenous peoples . . . have the right to maintain and develop contacts, relations and cooperation, including activities for spiritual, cultural, political, economic and social purposes, with their own members as well other peoples across borders . . . 2. States, in consultation and cooperation with indigenous peoples, shall take effective measures to facilitate the exercise and ensure the implementation of this right."), art. 25 ("Indigenous peoples have the right to maintain and strengthen their distinctive spiritual relationship with their traditionally owned or otherwise occupied and used lands, territories, waters, and coastal seas and other resources and to uphold the responsibilities of future generations in this regard").

72. *See* The Discol Project, *DISCOL – a DIS-turbance and re-COL-onization experiment* https://www.discol.de/home [https://perma.cc/VD5Q-8X9A] (last visited Feb. 6, 2023); *see also* Erik Simon-Lledo, *Biological effects 26 years after simulated deep-sea mining*, 9 Scientific Reports 8040 (2019). https://www.nature.com/articles/s41598–019–44492-w [https://perma.cc/SHF8-C6SQ].

area is apparent. Less apparent but nevertheless concerning are the probable effects that extraction has on water columns above the extraction zone.[73]

We should also be concerned about any seabed sludge that is pumped back into the ocean. As it descends, this sludge settles in other seabed areas, altering not just the point of extraction, but the new point of settlement that we have no power to preemptively designate. Some studies suggest that the seabed sludge itself may be toxic.[74] If this is true, then its relocation could prove harmful to ocean ecosystems as well as humans.[75] Heavy metals in displaced settlements, once ingested by marine species, can move up the food chain via predators and migratory fish (*e.g.*, tuna).[76] If commercial fish stocks come to be contaminated, it is possible that unforeseen harms will pass to consumers. There may also be different kinds of waste and increased spillage risks associated with DSM, and critics caution the lack of studies on various mine-driven pollutions at various stages of extraction, including "mining, sifting and collecting ore, dewatering, and transporting ore . . . not just the risks that arise during the actual process of mining ore."[77] Furthermore, DSM, like terrestrial mining, produces a specific waste known as a tailing. Tailings are non-minerals separated from minerals that, when discharged into the ocean, alter water composition.[78] There is also an operational need for mining vessels to unload ballast water and brine while floating at sea.[79] These loads can have double the salinity of the ocean water, which may threaten additional harms to the ecosystems beneath.[80] Finally, DSM increases the risk of oil spills. These can occur in a variety of ways throughout the mining process, including seafloor machinery malfunctions, pipe leaks, and fuel transfer spillage.[81]

The only apparent alternative to DSM is surface-level mining on land. Terrestrial mining already comes with tremendous environmental impacts, and some have suggested that DSM is a safer alternative.[82] One study found

73. Benjamin Gillard, *Vertical Distribution of Particulate Matter in the Clarion Clipperton Zone (German Sector)-Potential Impacts From Deep-Sea Mining Discharge in the Water Column*, 9 Marine Science (2022) https://doi.org/10.3389/fmars.2022.820947 [https://perma.cc/C696-PMUT].

74. Tina Hunter & Madeline Taylor, *Deep Sea Bed Mining in the South Pacific: A Background Paper, U. Queensl. Ctr. For Int'l Mines. & Energy L.* 5, 7 (2013), https://www.international-arbitration-attorney.com/wp-content/uploads/arbitrationDeep-Sea-Bed-Mining-in-the-South-Pacific.pdf [https://perma.cc/3AMB-KBHJ].

75. *Id.*

76. *Id.*

77. Bolong, *supra* note 20, at 142.

78. *See generally* Shawncey Webb, Encyclopedia of Environmental Issues 1100–01 (Craig W. Allin ed., 2011).

79. Hunter, *supra* note 74, at 9.

80. *Id.*

81. *Id.*

82. *See* Daina Paulikas, *Life cycle climate change impacts of producing battery metals from land ores versus deep-sea polymetallic nodules*, 275 Journal of Cleaner Production, 1 (Dec. 2020) https://www.sciencedirect.com/science/article/pii/S0959652620338671?via%3Dihub

that DSM of precious metals compared to terrestrial mining of those same metals could reduce CO2 emissions up to 80 percent for nickel, 76 percent for copper, 29 percent for cobalt, and 22 percent for manganese.[83] With such considerations taken into account, some argue that the harms of DSM are outweighed by the harms of current land mining, and that switching to DSM could actually reduce net harm to the environment.[84] While the extent of DSM's environmental risks remain uncertain, some have projected that DSM could offer up to fifteen times higher mineral concentrations at one-sixth the cost with ten to fifteen times less area necessary for operation when compared to terrestrial mining.[85] It is possible that yields of such magnitude could eliminate the need for terrestrial mining altogether. Indeed, this is the longstanding argument of corporations and countries in favor of DSM.[86] DSM advocates also note that many of the untapped mines remaining on land are located in underdeveloped regions of countries like Chile, and that there would be unique environmental harms caused by building the roads and bridges necessary to effectuate terrestrial extraction and transportation.[87] While the types of harms created by DSM and terrestrial mining differ, the harms created by terrestrial mining are more tangibly understood because they impact environments where people live and work, while the harms created by DSM can appear further removed from the everyday lives of those on land. This reality makes environmental accountability and oversight easier to enforce with terrestrial mining.

Having weighed these arguments, several governments and companies have ultimately concluded that between terrestrial mining and DSM, the latter generally poses less environmental and social harm than the former.[88] Environmentalists disagree, and call for a moratorium on DSM until adequate environmental protections can be guaranteed.[89] Some have even cautioned that comparing DSM and terrestrial mining is altogether improper, and have instead suggested that comparing DSM with other maritime development activities more accurately illustrates the environmental risks unique to DSM.[90] However, these comparisons remain a critical consideration for global

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[https://perma.cc/RY6Y-EHDY].

83. *Id.*

84. *Id.*

85. Bolong, *supra* note 20, at 141; *see also* Charles Roche, *Industrial Mining the Deep Sea: Social and Environmental Considerations*, Mineral Pol'y Inst. 7 (May 14, 2015), http://www.mpi.org.au/wp-content/uploads/2015/05/May-2015-Duke-Uni-Webinar-Mining-the-sea-MPI-web-version.pdf [https://perma.cc/Z5XW-GQBN].

86. Bolong, *supra* note 20, at 129; *see also* Nautilus Minerals, Environmental Impact Statement: Solwara 1 Project 1–1 (Sept. 2008) at 10–4, 10–5 [hereafter Nautilus, EIS].

87. *Deep Sea Conservation Coalition, supra* note 30.

88. Bolong, *supra* note 20, at 129; *see also* Nautilus, EIS *supra* note 86, at 10–4, 10–5.

89. *See, e.g*, Greenpeace, *supra* note 66, at 17.

90. Rosenbaum, *supra* note 70; *see also* David Batker & Rowan Schmidt, *Environmental and Social Benchmarking Analysis of the Nautilus Minerals Inc. Solwara 1 Project*

economic policy. States have a sovereign independent right to pursue their economic or developmental interests within their national jurisdictions, including through mining. While some states stand to benefit from DSM, several "[d]eveloping states [already] benefit tremendously from economic rents in terrestrial mining in their national territory."[91] While most states tend to view DSM as complimentary to terrestrial mining,[92] it is difficult to predict how a market shift toward DSM could negatively impact landlocked states who are currently dependent on terrestrial mining for revenue generation.

Beyond harms to deep sea ecosystems themselves, the harms of DSM also stand to impact humankind's potential to discover. Environmental harms to the deep sea may forever hinder our opportunity to learn more about the beginning of the world and the origins of life on our planet.[93] Deep sea vents replicate what scientists suspect are Earth's earliest conditions, and microbes near these vents are believed to have descended from the planet's earliest lifeforms.[94] The knowledge we stand to gain from studying the biology of deep sea life may have further applications in medicine,[95] though these benefits are admittedly speculative. While it is difficult to quantify the impacts of such hypothetical harms, the loss of critical knowledge about our origins is a permanent and profound loss for all, while the potential to learn about and develop life-improving biological agents deserves more serious contemplation when weighing the pros and cons of deep sea resource exploitation.

III. The Current Legal Regime

A. *National Territorial Waters*

While deep sea minerals are overwhelmingly located in international waters, national territorial waters hold reserves as well. Administration of DSM in areas of national jurisdiction remains separate from the administration of DSM in the common international jurisdiction.[96] However, coastal states remain prohibited from unjustifiably interfering with existing high seas

8 (2015), https://mining.com/wp-content/uploads/2015/06/Earth-Economics-Environmental-Social-Benchmarking-Solwara-1–2015.pdf [https://perma.cc/M84V-VCFA].

91. Bolong, *supra* note 20, at 135.

92. *Id.*

93. *See* Smith et al., *supra* note 25, at 853; *see also* Lyle Glowka, *The Deepest of Ironies: Genetic Resources, Marine Scientific Research, and the Area*, 12 Ocean Y.B. 154, 157 (1996).

94. Glowka, *supra* note 93, 159. *See also* David Hartley, *Guarding the Final Frontier: The Future Regulations of the International Seabed Authority*, 26 Temp. Int'l & Comp. L.J. 335 (2012) *citing* William Martin, John Baross, Deborah Kelley & Michael J. Russell, *Hydrothermal Vents and the Origin of Life*, 6 Nature Reviews Microbiology 805 (2008).

95. *See, generally*, NOAA Ocean Explorer, *Do medicines come from the sea?* https://oceanexplorer.noaa.gov/facts/medicinesfromsea.html [https://perma.cc/CD4E-8WF7] (last visited Feb. 6, 2023); *see also* Salvatore Arico & Charlotte Salpin, *Bioprospecting of Genetic Resources in the Deep Seabed: Scientific, Legal and Policy Aspects*, U.N. Univ.-Inst. of Advanced Studies 53 (2005).

96. Bolong, *supra* note 20, at 140; *see also* UNCLOS arts. 160(2)(f)(ii), 165(2)(f).

freedoms[97] and must enact international rules, standards, and recommended practices and procedures that are at least as stringent as applicable international standards.[98] DSM within national jurisdictions may legally commence today, as long as there is corporate compliance with any existing domestic regulations (and, as we will discuss in Section III.C, with customary obligations extended under the precautionary principle). However, DSM outside these jurisdictions remains prohibited subject to the International Seabed Authority's pending regulatory regime.[99] Turning now to the ISA, we will discuss how certain poorly constructed legal instruments threaten the health of both domestic and international waters.

B. *International Waters*

In the 1970s and 1980s, the U.N. set up the International Seabed Authority ("ISA" or "the Authority") in order to effectively organize and control all mineral activities related to the seabed.[100] Part XI of the 1982 *U.N. Convention of the Law of the Sea* (hereafter, "UNCLOS" or "the Convention"),[101] as amended by the 1994 *Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea* ("the Agreement"),[102] established the ISA as an "independent organization to regulate and govern the use of mineral resources on the seabed in areas beyond national jurisdiction."[103] While states retain their rights to resources located on their continental shelves, any seabed territory or resources outside a state's jurisdiction fall under ISA authority and are recognized as "the common heritage of all humankind."[104] The UNCLOS creatively names this common international territory "the Area."[105] The Convention also provides that "all rights and resources of the Area are vested in mankind as a whole, on whose behalf the Authority shall act."[106] Mineral resources contained in the Area are the property "[of] the people and for the people," and states have effectively made a commitment to close financial and technological gaps impacting DSM *vis-à-vis* each other to promote "universal peace and well-being" through DSM.[107]

97. UNCLOS art. 78.

98. UNCLOS arts. 208–10.

99. UNCLOS arts. 160(2)(f)(ii), 162(2)(o)(ii), 165(2)(f).

100. *See* Aline L. Jaeckel, The International Seabed Authority and the Precautionary Principle: Balancing Deep Seabed Mineral Mining and Marine Environmental Protection 4 (2017).

101. U. N. Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397.

102. Agreement Relating to the Implementation of Part XI of the U. N. Convention on the Law of the Sea of 10 December 1982, July 28, 1994, 1836 U.N.T.S. 42 (adopted 28 July 1994, entered into force 28 July 1996).

103. *See* Jaeckel, *supra* note 100, citing UNCLOS, arts. 156, 157.

104. UNCLOS, art. 136.

105. UNCLOS, art. 1(1).

106. UNCLOS, art. 137(2). *See also* art. 153(1).

107. *See* Jaeckel, *supra* note 100; s*ee also* Ram Prakash Anand, Legal Regime of the Sea-Bed and the Developing Countries 247–48 (1976).

It is debatable whether environmental obligations specifically spring from the ISA's mandate in service to this "vest[ment] in [hu]mankind,"[108] but it is clear that there are environmental obligations which spring from UNCLOS Article 145, which requires "necessary measures . . . to ensure effective protection for the marine environment from harmful effects which may arrive" from activity in the Area.[109] The Authority is structured as its own independent entity separate from the United Nations[110] and is comprised of four primary organs: the Assembly, the Council, the Secretariat, and the Enterprise.[111]

The ISA has adopted regulations which independently govern each of the three aforementioned categories of deep sea mineral deposits subject to prospective DSM and exploratory research.[112] For example, the regulation of polymetallic potato-shaped nodules is governed by its own independent document, the *Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area*, adopted in 2000.[113] In accordance with these regulations, a public or private entity seeking to study the viability of nodule extraction receives a contract from the ISA granting exclusive exploratory rights to a designated portion of the Area for 15 years.[114] UNCLOS articles 153(2)(b) and annex III article 4(3) require that a would-be contracting party be sponsored by an ISA member state of which it is a national.[115] This requirement is easily met if the contracting party is a state-owned corporation, agency, or ministry of a member state. After all, in this situation the contracting party operates at the discretion of the member state itself. However, if the contracting party is a private corporation, the contracting party will have to lobby their national government for sponsorship. While the first exploration contracts expired in 2016,

108. In other words, it is not clear if the general language promoting the ISA's vestment in humankind alone creates environmental obligations. I would argue that it does—independent of UNCLOS's subsequent environmental mandates—because the law is trending towards recognizing humankind's collective need for environmental health. *See, e.g.*, Maria L. Banda, Advisory Opinion on the Environment and Human Rights, 112 Am. J. Int'l L. 460 (2018) (finding that the right to a healthy environment is a human right).

109. *See* Jaeckel, *supra* note 100, citing UNCLOS, art. 145.

110. Michael Wood, *International Seabed Authority*, Max Planck Encyclopedia of Public International Law VI 146 (2012).

111. UNCLOS III, arts. 158–170 (generally, the Assembly is the primary legislative body consisting of all members—the Council serves as the Authority's executive body and is constituted of 36 members elected by and from the Assembly for fixed terms—the Secretariat serves as the administrative body governing the internal affairs of the Authority—and finally, the Enterprise carries out activities in the Area under the lawful regulations and permissions of the Authority).

112. *See* Jaeckel, *supra* note 100, at 5.

113. Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, International Seabed Authority Assembly Dec. ISBA/6/A/18 (July 13, 2000), amended by International Seabed Authority Council Dec. ISBA/19/C/17 (July 22, 2013), International Seabed Authority Assembly Dec. ISBA/19/A/12 (July 25, 2013), and International Seabed Authority Assembly Dec. ISBA/20/A/9 (July 24, 2014).

114. *See* Jaeckel, *supra* note 100, at 6.

115. UNCLOS, article 153(2)(b), annex III article 4(3).

the ISA extended those contracts for an additional five years.[116] It is not clear whether outstanding licenses will be renewed in the future, but in at least one case since 2016, the ISA denied license renewal.[117] To be clear, the ISA has not granted any licenses to commence seabed mining, but it has authorized licenses for seabed exploration and research. Several companies are waiting to begin the mining process but cannot for lack of the finalized regulatory instrument.[118]

Unfortunately, the ISA is now rushing to develop refined guidelines for mining after missing its original July 9, 2023 deadline.[119] This push for finalized mining regulations came after the island of Nauru notified the ISA in June 2021 of its intention to start mining the seabed with or without a comprehensive international regime.[120] In announcing this intention, Nauru invoked Section 1(15) of the Annex to the 1994 *Agreement Relating to the Implementation of the UN Convention of the Law of the Sea*.[121] Under Section 1(15), the ISA was obliged to "complete the elaboration and adoption of mining exploitation regulations within two years" of its receipt of Nauru's notification of intent to mine.[122] Now that the ISA has failed to meet this prescribed two-year timeline, it is nevertheless required to consider applications for mineral exploitation, even in the absence of finalized environmental regulations.[123]

These recent developments have created a mixture of great intrigue and panic among member states. On July 13, 2021, the members of the ISA belonging to the African Group submitted a written statement of concern regarding Nauru's invocation of Section 1(15).[124] The statement expressed the view that

116. *See* Jaeckel, *supra* note 100, at 6.

117. *See* Karen McVeigh, *Seabed regulator accused of deciding deep sea's future 'behind closed doors'*, The Guardian (Apr. 1, 2022) https://www.theguardian.com/environment/2022/apr/01/worlds-seabed-regulator-accused-of-reckless-failings-over-deep-sea-mining [https://perma.cc/2WQ4-SFY2] (last visited Feb. 6, 2023).

118. *See id.*

119. *Id.*; *see also* Decision of the Council of the International Seabed Authority on a timeline following the expiration of the two-year period pursuant to section 1, paragraph 15, of the annex to the Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea, International Seabed Authority Council Dec. ISBA/28/C/24 (July 24, 2023).

120. *Id.*

121. *See* 1994 Agreement Relating the to Implementation of the UN Convention of the Law of the Sea.

122. *Id.*; *see also* K. Willaert, *Under pressure: The impact of invoking the two year rule within the context of deep sea mining in the Area* (2021) 36(3) The Int'L. J. of Marine and Coastal L (*IJMCL*) 505, 513.

123. *See* K Willaert, *Under pressure: The impact of invoking the two year rule within the context of deep sea mining in the Area* (2021) 36(3) *International Journal of Marine and Coastal Law* (*IJMCL*) 505–513; *see also* Pradeep Singh quoted in *'What happens when we pull the trigger?' DSM Observer*, (published Nov. 19, 2020) (last visited Feb. 6, 2023) https://dsmobserver.com/2020/11/what-happens -when-we-pull-the-trigger [https://perma.cc/8C5W-3DRP].

124. Pradeep A. Singh, *What Are the Next Steps for the International Seabed Authority after the Invocation of the 'Two-year Rule'*, 37 The Int'L. J. of Marine and Coastal L. 1, 14

certain terms of exploitation contracts, including financial terms and terms regarding the ISA's own independent mining arm (the Enterprise), be determined during the negotiations of exploitation regulations.[125] If the African Group's requests had been honored in compliance with Section 1(15), the ISA would have been forced to decide on the Group's proposed terms within the 1994 Annex's prescribed two-year timeline, despite the onerous constraints already imposed by that timeline. From the environmentalist perspective, it is alarming to think that the current legal regime could pressure such decisions without conclusive scientific consensus of DSM's potential harms and benefits.

These concerns, coupled with the practical difficulties of meeting in person from 2021 to 2022 due to the COVID-19 pandemic, have further slowed progress on the development of regulations.[126] On October 13, 2021, ten member states of the Latin American and Caribbean Group of the ISA submitted their own written statement in response to Nauru's invocation of Section 1(15) explaining that "it is paramount that an adequate and effective regulatory framework be completed before the commencement of exploitation activities . . . consideration must be given to the reality that the Council might not be able to conclude the development and adoption of the required rules, regulations, and procedures within the two-year period."[127] Independent observers also correctly noted the impossibility of adopting a complete set of regulations within the obliged two-year period.[128] Section 1(15)'s two-year timeline was certainly adopted without adequately considering externalities of the magnitude of the COVID-19 pandemic. This fact alone warrants deliberation of an extralegal timeline extension in discord with Section 1(15)'s "two year" textual mandate to prevent the required consideration of applications for mineral exploitation before complete regulations have been adopted.

Outside of environmental obligations, the ISA's pending regulatory framework is further required to meet certain business-friendly UNCLOS obligations. Section 6, on production policy, emphasizes that the development of the resources in the Area shall take place in accordance with "sound commercial principles," that there shall be "no subsidization of activities in the Area," and that "there shall be no discrimination between minerals derived from the Area and from other sources."[129] Section 8, paragraph 1, on financial terms of contracts, requires in part that "[t]he rates of payment under the system

(2022), *citing* ISBA/26/C/40.

125. *Id.*

126. *See* Pradeep A. Singh, *The two-year deadline to complete the International Seabed Authority's Mining Code: Key outstanding matters that still need to be resolved*, Marine Policy 1–10 (2021).

127. *Id.*

128. *Id.*

129. *See* International Seabed Authority, *Towards the Development of a Regulatory Framework for Pollymetallic Nodule Exploitation in the Area (Technical Study: No. 11)* 13 (2013) *citing* 1994 Agreement on the Implementation of UNCLOS Part XI (§§ 6 and 8 of the Annex).

shall be in the range prevailing in respect to land-based mining of the same or similar minerals in order to avoid giving deep seabed miners an artificial competitive advantage or imposing on them a competitive disadvantage."[130] Meeting environmental obligations is one thing, but meeting environmental obligations that do not conflict with these broad noncompete principles adds additional layers of complexity. Indeed, the very notion that DSM is of ultimate benefit to environmental interests is undermined by the idea that regulations must offer no commercial advantage relative to terrestrial mining. If the science could conclusively determine that DSM is more environmentally-friendly than terrestrial mining, would an international regime dedicated to environmental preservation be justified in its adherence to these noncompete principles? Or should it instead choose to advance DSM at the expense of terrestrial mining? This is merely one example demonstrating that obligations to protect economic interests and obligations to advance environmental interests are at conflict within the legal structure of the ISA.

As DSM expert Aline L. Jaeckel notes, "[t]he ISA forms the institutional centre of what started as a bold, and not uncontroversial, approach to managing natural resources in areas beyond national jurisdiction."[131] In the forty or so years since the ISA's creation, there have been periods of heightened debate between member states and business leaders as they've attempted to construct a comprehensive regime for the future. On one hand, the economic potential of DSM has encouraged entrepreneurial interest in deregulating what could easily become a quagmire of licensing requirements.[132] On the other hand, we have the interests of states, the "abstractly equitable inheritors" of these mineral resources under the "common heritage of all humankind" language.[133] In balancing both interests, the ISA and its regulatory scheme can be viewed as "a compromise that classifies the Area and its resources as . . . common . . . while incorporating both communitarian features and market-oriented policies."[134]

While these dual aims are no doubt an admirable attempt at reconciling conflicting business and egalitarian interests, the reality is that the ISA has been unable to meet these competing needs with a comprehensive regime for decades. Similarly, the 1994 Annex's Section 1(15) was adopted with the intention of respecting sovereign states' rights to pursue DSM in the absence of a complete supranational legal regime governing best practices. Indeed, some deference to state sovereignty was likely necessary for member states to embrace and honor the conditions of the 1994 Annex. However, the short-sightedness of such a condition has created another untenable situation—one in which a single state can compel the ISA to prescribe rushed or

130. *Id.*
131. *See* Jaeckel, *supra* note 100, at 113–114.
132. *Id.*
133. *Id.*
134. *Id.*

incomplete regulations in defiance of its central mandate to effectively govern in the best interests of the environment and future generations.

Under Section 1(15)'s time constraints, DSM expert Pradeep A. Singh has noted that there appear to be five options for the ISA moving forward. The ISA might:

> 1. [. . .];
> 2. proceed notwithstanding the two year timeline by taking as much time as needed to draft a sound regulatory framework;
> 3. adopt a provisional (temporary) set of regulations and continue to work on developing a more refined system for long-term mineral exploitation;
> 4. complete elaboration of the regulations within the prescribed time but not adopt them yet and/or adopt them with conditions precedent in relation to their subsequent entry in to force or application;
> 5. adopt a precautionary pause or moratorium on exploitation activities under Article 145 of the UNCLOS requiring the effective protection of the marine environment from the harmful effects of mining activities;
> 6. explore the available judicial avenues, such as submitting a request for an advisory opinion from the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea in accordance with Article 191 of the UNCLOS, and/or by pursuing more contentious proceedings to challenge the invocation of Section 1(15) under Article 187 of the UNCLOS.[135]

Regardless of the avenue chosen, the current constraints on the ISA are barely sustainable in light of the serious challenges presented by DSM. The only responsible path forward is one which somehow prevents DSM from commencing while adequate time is taken to continue studying DSM's potential adverse impacts. It is for these reasons that this Comment advocates the fifth and/or sixth of Singh's proposals, interpreting Article 145 in light of the ISA's precautionary principle obligations.

C. *The Precautionary Principle*

The facial environmental risks of DSM can appear just as numerous as the supposed environmental benefits. On one hand, DSM can increase access to green technologies, like electric car batteries.[136] These technologies have the capacity to reduce CO2 emissions globally and aid humankind in its existential battle with climate change.[137] On the other hand, mining these precious resources comes with potential harms. DSM presents significant risks to deep sea ecosystems and their biodiversity.[138] These effects may even be observable on land, as deep sea ecosystems are thought to play an important role in the

135. *See* Singh, *supra* note 126, at 6–12.

136. NPR, *supra* note 17.

137. *See* Paulikas, *supra* note 82.

138. Jaeckel, *supra* note 100, at 3, citing ECORYS, Study to Investigate the State of Knowledge of Deep-Sea Mining—Final Report to the European Commission under FWC MARE/2012/06—SC E1/2013/04, (28 Aug. 2014).

carbon cycle by buffering greenhouse gases that build in the atmosphere.[139] As the least-explored area on Earth, we know frighteningly little about the deep sea floor and its relationship with our planet's health.[140] With these considerations in the forefront, how must international regimes be compelled to govern in accordance with the law? This Comment argues, in line with the precautionary principle, that when scientific evidence on a given question points to an uncertain conclusion regarding environmental harms, states and international bodies are legally obligated to err on the side of caution and prioritize the environment at the expense of all other legal considerations.

The precautionary principle addresses actions which may come to have environmental harms and addresses the legality of those actions at their earliest stages.[141] It arose from the simple realization that environmental policies adopted to react to environmental harms cannot always adequately address the full breadth of those harms,[142] and from the realization that many activities' environmental harms will not always be understood until the harm committed is too great to adequately redress. It applies "even in situations where there is potential hazard but scientific uncertainty as to the impact of the potentially hazardous activity."[143] The principle has a history of continuous development, especially since June of 1992, when the United Nations Conference on Environment and Development convened in Rio de Janeiro and issued the multilateral Declaration on Environment and Development.[144] Signed by 170 states, the Declaration illustrates a scheme for global environmental accountability. Crucially, Principle 15 of the Declaration states: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities . . . [w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[145]

In the decades following the Declaration's adoption, states have pushed and pulled against this principle to determine the appropriate scale of its

139. David Hartley, *Guarding the Final Frontier: The Future Regulations of the International Seabed Authority*, 26 Temp. Int'l & Comp. L.J. 335 (2012) *citing* William Martin, John Baross, Deborah Kelley & Michael J. Russell, *Hydrothermal Vents and the Origin of Life*, 6 Nature Reviews Microbiology 805 (2008).

140. *Id.*

141. Meinhard Schroder, *Precautionary Approach/Principle*, Max Planck Encyclopedia of International Law 2 (2009).

142. Sumudu A. Atapattu, Emerging Principles of International Environmental Law 203 (2006).

143. Schroder, *supra* note 141, at 2.

144. U. N. Conference on Environment and Development, Rio de Janiero, Braz., June 3–14, 1992, Rio Declaration on Environment and Development, U.N. Doc. A/CONF.151/26 (Vol. I), Annex I, (1992), available at https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf [https://perma.cc/57S6-WS8K].

145. *Id.*

application. Supranational institutions, such as the European Union, have also made an effort to further define how Europe's bureaucracies should apply the principle to concrete policy questions. Article 174(2) of the European Community Treaty states that:

> policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Community . . . [i]t shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at the source and that the polluter should pay."[146]

Subsequent cases, including the *Southern Bluefin Tuna Cases* (New Zealand v. Japan; Australia v. Japan), have illustrated the application of a similarly high standard, finding that parties were bound to act "with prudence and caution to ensure that conservation efforts are taken[.][147]

The International Tribunal for the Law of the Sea ("the Tribunal") has acknowledged that such developments have played a role in defining precautionary principle obligations under customary international law.[148] This means that, per the Tribunal's reasoning, precautionary principle obligations are binding both on independent states and on supranational institutions as a matter of custom. We can therefore identify increasingly specific legal obligations by applying the precautionary principle to the ISA's pending adoption of regulatory instruments governing DSM. For instance, the 2011 Seabed Mining Advisory Opinion acknowledged a connection between "due diligence" and the precautionary principle,[149] as well as a connection between "best environmental practices" and the precautionary principle.[150] That Opinion also details that "the Authority [is] under an obligation to apply the precautionary approach in respect of activities in the Area."[151] This further obligates the ISA to incorporate customary practices in to the adoption of DSM regulations as well as the content of those regulations. "In the absence of a specific reason to the contrary, it may be held that Nodule Regulations should be interpreted in light of the [aforementioned customary] development[s] of the law."[152] These are very high hurdles which seem to demand utmost consideration for the environment in the absence of scientific certainty. We must therefore scrutinize the ISA's legal instruments, especially the 1994 Annex's Section 1(15), by holding it against these binding precautionary principle obligations.

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146. European Community Treaty, Art. 174(2).

147. Advisory Opinion No. 17, § 132 (Feb. 1, 2011), https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf [https://perma.cc/UE6Y-GXEZ].

148. *Id.*, § 136.

149. *Id.* § 131.

150. *Id.* § 136–7.

151. *Id.* § 131.

152. *Id.* § 137.

D. *Enforcing Disparate Perceptions of the Precautionary Principle*

Because these nodules are generally outside of national jurisdictions, their acquisition is not only a question of international commercial regulation, but of international relations as well. Countries like Germany, Peru, Chile, Costa Rica, South Africa, Trinidad and Tobago, Italy, and Spain are vocal participants in the DSM debate (to name a few).[153] Even absent international legal authority to govern DSM, the political participation of states will likely come to influence the applicable international regulations and practices of DSM moving forward. This can be understood in terms of customary international law, or in terms of *realpolitik*. Using either lens, it is clear that each nation's distinct interests in DSM will come to influence the actual enforcement of international regulations moving forward. For example, it has been noted that China currently dominates the lithium-ion battery production market.[154] We may speculate then that states with political or economic incentives to compete with China (*e.g.*, the United States) could choose to advocate legal arguments and practices that are more pro-business and pro-mineral exploitation rather than pro-environment, as DSM presents an opportunity to compete in a market heavily dominated by a geopolitical adversary.

States also have varying levels of economic and political investment in actualizing DSM. While mining companies simply expect that DSM will complement waning terrestrial supplies of precious metals, developing states earnestly maintain that DSM will transition them to developed state status.[155] For example, the government of the Cook Islands has expressed their faith in DSM's capacity to elevate them from a "developing state" to a "developed

153. McVeigh, *supra* note 117; *see also*, Helen Reid, *Germany calls for 'precautionary pause in deep-sea mining*, Reuters (Nov. 1, 2022), https://www.reuters.com/business/sustainable-business/germany-calls-precautionary-pause-deep-sea-mining-2022–11–01 [https://perma.cc/MFT7-XNAK]; *see also* Chloe Farand, *'We are not ready': Divisions deepen over rush to finalise deep sea mining rules*, Climate Change News (Sep. 8, 2022), https://www.climatechangenews.com/2022/08/09/we-are-not-ready-divisions-deepen-over-rush-to-finalise-deep-sea-mining-rules [https://perma.cc/NS7F-C7QY]; *see also* Sharm El-Sheikh, *Germany, France and Spain Create Genuine Possibility for Action on Deep Sea Mining*, Env't Just. Found. (Nov. 8, 2022), https://ejfoundation.org/news-media/germany-france-and-spain-create-genuine-possibility-for-action-on-deep-sea-mining [https://perma.cc/VM45-BEWN].

154. Farran, *supra* note 23, at 2 *citing* John Xie, *'How China Dominates Global Battery Supply Chain'*, VOA News (Sep. 1, 2020), https://www.voanews.com/silicon-valley-technology/how-china-dominates-global-battery-supply-chain [https://perma.cc/5V5Q-MQYV] (Noting that Japan and Korea are also notable producers of manufactured batteries and components but lack the raw materials).

155. *See* Luz Danielle O. Bolong, Into the Abyss: Rationalizing Commercial Deep Sea Mining Through Pragmatism and International Law, 25 Tul. Int'l & Comp. L. 127, 129, *citing* Rupert Neate, *Seabed Mining Could Earn Cook Islands "Tens of Billions of Dollars,'* Guardian (Aug. 5, 2013), http://www.theguardian.com/business/2013/aug/05/seabed-mining-cook-islands-billions [https://perma.cc/JPW8-P3JL]; *see also* UNCLOS arts. 82, 150(d); *see also* UNCLOS Annex III art.13(1)(a).

state."[156] Many developed states also stand to gain significant economic benefit from DSM. The United Kingdom is an excellent example: in only thirty years, DSM is projected to contribute up £40 billion to the nation's economy.[157] Even with different development statuses, many states appear to recognize the common boon that DSM would have on their respective economies. Others see DSM as primarily harmful to their interests, especially where their constituents exercise a greater degree of environmental protectionism. For example, Germany has complained that the ISA's draft mining regulations have failed to include "'specific environmental minimal requirements' for measurable pollution, sediment plumes, biodiversity, and noise and light impacts," and that "the code as it stands would not regulate future mining effectively."[158] In Germany's view, "[t]he current state of knowledge is . . . insufficient to proceed to exploiting mineral resources."[159] Other member states, including Belgium, the Netherlands, Costa Rica, and Chile, have embraced policies of extreme precaution while pointing to gaps in the scientific literature still fueling uncertainty about the nature of the deep sea.[160]

The European Union, a formal signatory of the UNCLOS, has itself adopted a position which demonstrates concern for marine environmental health and biodiversity, even calling for a moratorium on seabed mining until the science is further developed.[161] It argues that marine minerals "cannot be exploited before the effects of deep-sea mining on the marine environment, biodiversity and human activities have been sufficiently researched, the risks are understood and technology and operational practices are able to demonstrate that the environment is not seriously harmed, in line with the precautionary principle."[162] Given the European Community's role in developing the precautionary principle, it is understandable that they would advocate to see their own high standards applied to international commercial practices as well.

In sum, each state's unique circumstances will make the enforcement of consistent environmental standards challenging. A rushed regulatory document and licensing structure may lead to a race to the bottom. States need confidence that the international regulations crafted by the ISA will be respected by other states. What message is conveyed when a regulatory document is hastily imposed rather than being methodically constructed over

156. Rupert Neate, *Seabed Mining Could Earn Cook Islands "Tens of Billions of Dollars,*' Guardian (Aug. 5, 2013), http://www.theguardian.com/business/2013/aug/05/seabed-mining-cook-islands-billions [https://perma.cc/JPW8-P3JL].

157. *Id.*

158. McVeigh, *supra* note 117.

159. *Id.*

160. *See id.*; *see also* European Commission, *Biodiversity strategy for 2030*, https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm.

161. McVeigh, *supra* note 117.

162. *See id.*, *see also European Commission joins calls for moratorium on deep-sea mining*, Seas at Risk (June 4, 2020) https://seas-at-risk.org/general-news/european-commission-joins-calls-for-moratorium-on-deep-sea-mining [https://perma.cc/XP39-W2AT].

whatever time is necessary to honor core tenants of international law, including the precautionary principle? The ISA serves a geopolitical role as an institutional leader and must consider the diplomatic optics of rushing regulations which undermine their ultimate aims as environmental stewards under Article 145 of the UNCLOS.[163]

IV. Additional Recommendations

A. *Transparency*

It cannot be said that the ISA has operated with flawless internal procedure. Institutional transparency is a recurring concern. Although the executive/policy body of the ISA ("the Council") is legally charged with developing regulations for the fledgling DSM industry, environmental advocates have felt excluded from their oversight roles.[164] In April 2022, an independent body which reported on ISA DSM regulatory negotiations, the Earth Negotiations Bulletin ("ENB"), did not have its contract renewed and was subsequently absent from negotiations.[165] The presence of the ENB would have created a "permanent independent record of proceedings" and the absence of the ENB at this meeting was described as a "huge loss" for stakeholders.[166] These concerns have been echoed by national governments. Germany has also expressed real dissatisfaction with the lack of stakeholder comments and "mark-ups" on regulatory drafts available on ISA committee websites.[167] They further charge that these draft mining codes lack "binding and measurable normative requirements" for marine protection,[168] which evidences the absence of meaningful dialogue between ISA committees and environmental advocates.

For example, as an internal committee organ of the ISA's Assembly, the Legal and Technical Commission's (LTC's) responsibility for developing environmental standards and guidelines makes it an entity of global public interest. Nevertheless, the LTC not only maintains that its meetings and deliberations remain confidential, but also argues that certain environmental data, including impact statements disclosed to the Commission by DSM operators, must similarly remain confidential.[169] In fact, the majority of documents reviewed by the LTC are not even shared with the ISA Council, the latter of which ultimately grants DSM licenses.[170] This seems functionally problematic when

163. UNCLOS art. 145.

164. McVeigh, *supra* note 117.

165. *Id.*

166. *Id.*

167. *Id.*

168. *Id.*

169. *See* Todd Woody, *Seabed Mining: The 30 People Who Could Decide the Fate of the Deep Ocean, Deep Sea Conservation Coal* (Sept. 6, 2017) https://deeply.thenewhumanitarian.org/oceans/articles/2017/09/06/seabed-mining-the-24-people-who-could-decide-the-fate-of-the-deep-ocean [https://perma.cc/88Z2-LFQV].

170. *See, e.g.*, Deep Sea Coalition, *Briefing on the International Seabed Authority for the*

one considers that the Council relies on the LTC's policy recommendations without access to the evidence weighed by the LTC to inform those policy recommendations.[171] In other words, the LTC works as a subcommittee of the Council, but the Council and third-party environmental groups all lack the capacity to review the scientific studies informing the policy proposals of the LTC. Perhaps more concerning is that one-fifth of the LTC's 30 members work for contractors of DSM companies, which unnecessarily fuels distrust between opposing business and environmental stakeholders.[172] Moving forward, it is important that the ISA's internal procedures foster confidence in the capacity for oversight by environmental watchdogs.

B. *Indigenous Peoples' Rights*

To address the more profound environmental harms that DSM will have on Indigenous Peoples and other underrepresented populations, there have been calls for local community involvement in state DSM project-design.[173] Such involvement might include a right to veto a state's sponsored DSM project, as well as a right for independently verified research supporting the rational conclusion that neither communities nor ecosystems would suffer long-term environmental harms.[174] Others have suggested that the ISA could easily incorporate free, prior, and informed consent (FPIC) requirements into the DSM regulatory regime by instituting some kind of consultative mechanism (*e.g.*, institutionalization of independent representatives of Indigenous groups with participation and observation status, not unlike the U.N. Permanent Forum on Indigenous Issues).[175] Outside the ISA, states who are themselves sponsoring DSM projects should identify at-risk Indigenous groups and begin FPIC consultation procedures ahead of mining by employing public hearings, comment periods, and discussions with representatives of impacted communities within their own jurisdictions.[176] This would ensure that states meet their existing human rights obligations under all applicable treaties and conventions.[177]

24th Session 16–27 July 2018, 5 https://www.savethehighseas.org/wp-content/uploads/2018/07/DSCC-ISA-briefing-2018-FINAL.pdf [https://perma.cc/AG44-DVHS]; *see also* Jeff Ardrona, et al., *Incorporating Transparency into the Governance of Deep-Seabed Mining in the Area beyond national jurisdiction*, 89 Marine Pol'y (2018), 58, 63.

171. *See id.*

172. McVeigh, *supra* note 117.

173. *See* The Ocean Foundation: Project Deep Sea Mining Campaign (last visited Dec. 8, 2023) https://oceanfdn.org/projects/deep-sea-mining-campaign [https://perma.cc/3DXE-H6T7].

174. *Id.*

175. Julian Aguon & Julie Hunter, *Second Wave Due Diligence: The Case for Incorporating Free, Prior, and Informed Consent into the Deep Sea Mining Regulatory Regime*, 38 Stan. Env't. L.J. 3, 53. (2018).

176. *Id.*

177. Rosenbaum & Grey, *supra* note 70.

C. *Benefit Sharing*

Beyond transparency and human rights concerns, there is an apparent lack of equitable benefit sharing across the global community as required under Article 140 of the UNCLOS.[178] It is required that the revenue generated from DSM be equitably shared between nations, with particular consideration for the development of underdeveloped states.[179] There have been several schemes proposed to accomplish this, including a royalties system with a percentage increase effectuated gradually over time.[180] However, such systems have been strongly opposed by forty-seven African member states, who project the annual payout per annum per country to be less than $100,000.[181]

Beyond traditional revenue-sharing models, there have been proposals for a new regime which grants locations, habitats, and/or ecosystems "Rights of Nature" which would bring an entirely different perspective to the law.[182] This concept is largely foreign to Western legal traditions, but has precedent in Indigenous traditions.[183] For example, New Zealand's Te Urewera Forest and Whanganui River (or "Te Awa Tupua") are formally defined legal entities holding "all the rights, powers, duties, and liabilities of a legal person."[184] A similar system of legal protections extending Rights of Nature was introduced to Ecuador's constitution in 2008.[185] While this concept has yet to be extended to international waters, some have suggested that granting Rights of Nature to the ocean is not only plausible, but is actually the natural next step following jurisprudential trends in environmental law.[186] If applied to the deep sea, this

178. UNCLOS art. 140.

179. *Id., see generally* Kathryn A. Miller, *An Overview of Seabed Mining Including the Current State of Development, Environmental Impacts, and Knowledge Gaps*, 4 Front. Mar. Sci. (2018), 5 (discussing the current state of development of aspiring seabed mining states).

180. Lisa A. Levin, et al., *Challenges to the Sustainability of Deep-Seabed Mining*, 3(10) Nature Sustainability, 784, 789 (2020) https://nature.com/articles/s41893–020–0558-x ("An initial royalty of 2% (rising later to 6%) has been proposed under an economic model by ISA consultants, based on contractor profits and data").

181. The African Group, *Statement by Algeria on Behalf of the African Group to the International Seabed Authority* (25 February 2019). Washington DC: The African Group.

182. *See* S. Borras, *New transitions from human rights to the environment to the rights of nature*, 5 Transnat'l Env't L. (2016) 113, 143.

183. *Id.*; *see also, e.g.*, Rights of Nature in Indian Country, https://bioneers.org/rights-of-nature (last visited Feb. 16, 2024).

184. *See* Te Urewera Act (2014), https://www.legislation.govt.nz/act/public/2014/0051/latest/whole.html [https://perma.cc/7689–2UCV] (last visited Feb. 6, 2022); *see also* Te Awa Tupua (Whanganui River Claims Settlement) Act 2017, https://www.legislation.govt.nz/act/public/2017/0007/latest/whole.html [https://perma.cc/E75S-H3AP] (last visited Feb. 6, 2022).

185. *See* Republic of Ecuador, *Constitution of the Republic of Ecuador (*October 20, 2008). Available online at: http://pdba.georgetown.edu/Constitutions/Ecuador/english08.html (last visited Dec. 15, 2022).

186. *See, e.g.*, V. David (2017). La nouvelle vague des droits de la nature. La personnalité juridique reconnue aux fleuves Whanganui, Gange et

framework would recognize the ocean as a rights-bearing entity rather than a region to be owned, exploited, controlled,[187] or even shared. Indeed, this framework so radically undermines the Global North's existing understanding of property law that a successful transition would require a total conceptual readjustment of our most significant moral principles—"a true transition from ownership to guardianship of the natural world."[188]

V. Conclusion

This Comment shines a light on the great uncertainties remaining in the science of DSM and its environmental impacts. The benefits of DSM may or may not outweigh the costs, but in this uncertainty, customary international law compels the precautionary principle to govern. For this reason, invocation of Section 1(15) violates primary legal obligations inherent in the ISA's mandate to govern for the benefit of the environment and of all humankind. Throughout this analysis, we have also identified additional policy considerations which must be adequately addressed by any future regulatory regime. In highlighting several of this Comment's most important findings, we would like to reiterate the following:

1. *Exploitation of deep sea minerals undermines the scientific origins of their discovery.* The *Challenger*'s scientific mission was an exploration of the benefits that deep sea knowledge could have for humanity. Among its discoveries was the polymetallic nodule, whose pending harvest now ironically threatens our potential to learn even more about the deep sea.[189] While we can only speculate as to the knowledge that further deep sea exploration will generate, further insight into the origins of life on Earth and knowledge which could benefit future medical research are significant scientific opportunities.[190] In keeping with the aims of the original *Challenger* mission, we may yet further advance humankind through exploration, even at the expense of more precious metals.

2. *The science and processes of DSM are underdeveloped.* Oceanographers, biologists, and geologists still disagree about the benefits of DSM relative to the costs. What studies do exist demonstrate that potential harms to deep sea ecosystems are long-lasting and incalculably far-reaching.[191] The

Yamuna. Revue Juridique L'environnement 42, 409, 424. "De Tongariro ou des Himalaya, tous ces sacrés fleuves nous mènent aux droits de l'Océan . . . ." **Translated: *See, e.g.*, David, V. (2017). The new wave of nature rights. The recognized legal personality of the Whanganui, Ganges and Yamuna Rivers. Env't L.Rev. 42, 409, 424. "From Tongariro or the Himalayas, all these sacred rivers lead us to the rights of the Ocean . . . " https://www.cairn.info/revue-juridique-de-l-environnement-2017–3-page-409.htm [https://perma.cc/GDU7-UQBV].

187. *See* Borras, *supra* note 182.

188. *Id.*

189. Smith, *supra* note 25, at 853.

190. Hartley, *supra* note 94.

191. U. N. Declaration on the Rights of Indigenous People, *supra* note 71.

mechanics and technology of eco-friendly deep sea extraction are as of yet unproven. There is no need to begin an inherently risky process that is so underdeveloped.

3. *The capacity for states to force the ISA's distribution of licenses even in the absence of a regulatory scheme threatens the ocean.* The 1994 Annex's Section 1(15) requires the ISA to adopt policies even if those policies are rushed. This violates UNCLOS Article 145 obligations requiring that the ISA protect the environment and creates an untenable situation in which one state can force a timeline on the global DSM market.

4. *The ISA's deference to an invocation of Section 1(15) violates the ISA's precautionary principle obligations.* Adherence to the precautionary principle, especially the incorporated obligations of "due diligence" and "best environmental practices,"[192] demands that the invocation of Section 1(15)'s two-year timeline be disregarded as inconsistent with the ultimate aims of the ISA in light of its mandate to protect the Area and the interests of future generations.

5. *There exists a lack of transparency between the LTC, the ISA Commission, and environmental watchdogs.* The practices of the LTC have not inspired confidence in the environmentalist community. The LTC considers reports that are kept from the Commission as well as the general public.[193] The ISA must strengthen its relationships with its harshest critics to adequately protect the environment.

6. *There must be adequate consideration of existing human rights obligations and the need for indigenous involvement.* Indigenous communities are a global minority, and their needs are often overlooked. Important human rights protections exist that must be weighed heavily when creating any future regulatory regime.

7. *Benefit sharing models should consider innovative legal structures.* Granting rights to the ocean may be the ultimate safeguard against any one state's domination of deep sea interests. Adopting less traditional legal approaches could preserve these rights indefinitely for the benefit of all humankind.

192. European Community Treaty, *supra* note 146, at art. 137.

193. Woody, *supra* note 169.