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Protecting the Oceanic Gardens of Eden: International Law Issues in Deep-Sea Vent Resource Conservation and Management

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I. INTRODUCTION

Even while marine fortune hunters prowling the oceans for precious metals and archeological treasures entombed in shipwrecks on the seabed capture international headlines, activities surrounding more valuable, and in many ways more ancient, seabed treasures are increasingly thrusting their way onto the global agenda. Those seabed treasures are the remote deep-sea vent communities scattered across the ocean basins. One such vent field—the *Garden of Eden*—located on the equatorial Eastern Pacific seabed, suggests the pristine and almost mythical quality of these deep-sea communities. The field takes its name from the spectacular garden-like display of sinuous white tubeworms adorned by crimson, gill-like crowns, which marveled its first aquanaut visitors. Yet the value of the deep-sea vent resources plainly transcends the aesthetics of the Eden-like displays of tubeworms. Early estimates of the commercial value of the hydrothermal vent genetic resources were in the range of US $3 billion/year.[1] The value of the mineral resources at hydrothermal vent fields may be much higher.[2] The non-market value to global biological diversity and the research community is incalculable.

The discovery of rich biological communities and strategic mineral deposits at these seabed vents has generated keen interest on the part of marine scientific researchers, the biotechnology industry, mining companies, and at least one deep-sea submersible operator hoping to develop interest within the high-end

1. Lyle Glowka, *The Deepest of Ironies: Genetic Resources, Marine Scientific Research, and the Area*, *in* 12 OCEAN Y.B. 154, 160 (1996) (relying in part on William T. Burke, *State Practice, New Ocean Uses, and Ocean Governance Under UNCLOS*, *in* OCEAN GOVERNANCE: STRATEGIES AND APPROACHES FOR THE 21st CENTURY 219-34 (Thomas A. Mensah ed., 1996)).

2. *Ocean/Seas: Trillions of Dollars Just Lying Around*, INTER PRESS SERV. Nov. 16, 1994, *available at* 1994 WL 2796568.

eco-tourist market.[3] The shared, yet inevitably conflicting, interests in these undersea oases will present a significant challenge for marine policy analysts and law specialists in the twenty-first century. While science and technology, in their capacity to induce change, often evolve with dizzying speed, legal and policy regimes tend to lag behind. The gap is particularly evident in the deep ocean. Though it must be acknowledged that the global legal paradigms are progressively evolving, through innovations such as the common heritage principle, the emerging precautionary approach, and the mandate to sustain and conserve the planet's rapidly shrinking pool of biological diversity, the existing international legal regime still fails to address adequately the conservation and management needs of the newly-discovered deep-sea vent fields in the coming decades.

The response to a legal regime that remains uncertain, incomplete, and fractured ranges from the modest to the revolutionary. Some international law scholars recommend a fundamentally different approach to the law of the sea and its treatment of the seas' natural resources.[4] A 1998 report by the Independent World Commission on the Oceans recommended that ocean areas beyond national jurisdiction and their resources be placed under a public trust for the benefit of all humanity, perhaps to be managed by the United Nations Trusteeship Council.[5] A prominent ocean policy analyst advocates broadening Part XI of the 1982 Law of the Sea Convention to include certain living and genetic marine resources within the convention's "common heritage" of humankind regime and bringing their management within the International Seabed Authority's regulatory ambit.[6] A few vent scientists have, more modestly, proposed that selected vent fields be designated as self-imposed "reserves," where access would be governed by consensus decision-making for the common good.[7] Charting still another course, Canada has designated a pilot marine protected area for a frequently visited vent field within its jurisdiction.[8] Exporting the Canadian approach from national waters to the international commons, an advisory body for the Convention on Biological Diversity advocates that consideration be given

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3. Accounts of vent discoveries and explorations are available in WILLIAM J. BROAD, THE UNIVERSE BELOW: DISCOVERING THE SECRETS OF THE DEEP SEA (1997) and CINDY LEE VAN DOVER, DEEP-OCEAN JOURNEYS: DISCOVERING NEW LIFE AT THE BOTTOM OF THE SEA (1996).

4. Phillip Allott, Note, *Mare Nostrum: A New International Law of the Sea*, 86 AM. J. INT'L L. 764 (1992) (calling for "a reconceiving of the theoretical basis of the law of the sea").

5. *See* INDEP. COMM'N ON THE OCEANS, THE OCEAN OUR FUTURE 45-46 (1998). U.N. Secretary-General Kofi Annan suggested the approach in 1997. *See Renewing the United Nations: A Programme for Reform*, ¶¶ 84-85, U.N. Doc. A/51/950 (1997).

6. ELISABETH MANN BORGESE, THE OCEANIC CIRCLE: GOVERNING THE SEAS AS A GLOBAL RESOURCE 188, 199 (1998) [hereinafter BORGESE, THE OCEANIC CIRCLE].

7. Lauren Mullineaux et al., *Deep-Sea Hydrothermal Vents Reserves: A Position Paper*, INTERRIDGE NEWS, Apr. 1998, at 15.

8. *See* Press Release, Canadian Dept. Fisheries & Oceans, Minister of Fisheries and Oceans Announces Two Offshore Pilot Marine Protected Areas (Dec. 8, 1998), *available at* Endeavor Vent Springs Area, http://www.ncr.dfo.ca/communic/DiscPap/index_e.htm (last visited Jan. 26, 2001).

to designating selected vent fields on the deep-seabed as marine protected areas,[9] an approach advocated by some international law scholars,[10] environmentalists,[11] and the Marine Section of the IUCN World Commission on Protected Areas.[12] The stakes are high, and other approaches will no doubt be suggested.

This article seeks to stimulate the nascent discussion on legal questions presented by access to, and use of, deep-sea hydrothermal vent sites and resources and to help guide ocean policy analysts in their efforts to formulate and implement appropriate conservation and management measures adapted to the unique multiple-use conflicts posed by the vent phenomena. The inquiry is timely and important for the vent communities, some of which are already showing signs of the human footprint—a footprint that may in the not too distant future include the tracks of submarine bulldozers as they set about the job of seabed mining. The article begins with a brief description of the nature of the vents in Part II and their existing and expected uses in Part III. Part IV of the article then provides an overview of the components of the legal regime applicable to vents on the outer continental shelf or deep seabed, focusing primarily on the 1982 U.N. Convention on the Law of the Sea (LOSC) and the 1992 Convention on Biological Diversity (CBD). Parts V and VI focus on the legal issues that are likely to arise in the context of the seabed hydrothermal vents and their living and genetic resources under the LOSC and CBD respectively. The article closes with some preliminary conclusions and an assessment of the implications of those conclusions for seabed vent conservation and management options.

II. NATURE OF DEEP-SEA VENTS

In 1977, a multi-institution marine science expedition led by the Woods Hole Oceanographic Institution discovered densely populated faunal communities along seabed hydrothermal vents two hundred miles northwest of Ecuador's Galapagos Islands.[13] The vents were located along a rift in the East Pacific Rise, in ocean waters nearly two miles deep. Later expeditions to other seabed sites in the northeast Pacific, the western Pacific, along the Mid-Atlantic Ridge,[14] and the

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9. *See* U.N. Environment Programme, *Report by the Executive Secretary, Subsidiary Body on Scientific, Technical and Technological Advice, Conservation and Sustainable Use of Marine and Coastal Biological Diversity*, ¶ 53, UNEP/CBD/SBSTTA/3/4 (1997) [hereinafter *1997 SBSTTA Report*].

10. *See* Lyle Glowka, *Testing the Waters: Establishing a Legal Basis to Conserve and Sustainably Use Hydrothermal Vents and their Biological Communities*, INTERRIDGE NEWS, Fall 1999, at 45.

11. *See* COLIN S. WOODWARD, OCEAN'S END: TRAVELS THROUGH ENDANGERED SEAS 234 (2000) (advocating MPAs as part of a wider ecosystem management approach to the ocean environment).

12. The IUCN proposal grew out of a March 1999 joint meeting between the IUCN and the UNESCO/ Intergovernmental Oceanographic Commission in Montpellier, France (copy of proposal on file with the author).

13. *See* ROBERT KUNZIG, THE RESTLESS SEA: EXPLORING THE WORLD BENEATH THE WAVES 133-34 (1999).

14. The principal sites are listed in CINDY LEE VAN DOVER, THE ECOLOGY OF DEEP-SEA HYDROTHERMAL VENTS, tbl. 2.A (2000), and William E. Seyfried & Michael J. Mottl, *Geologic Setting & Chemistry of Deep-Sea*

Indian Ocean soon demonstrated that vent phenomena were by no means unique to the Galapagos Rift. Interest in deep-sea vent communities soon spread through the popular media, where the public learned about these "oases of the deep," with evocative names like *Strawberry Fields, Clam Acres, Rose Garden* and *Snake Pit.*[15]

Hundreds of specially adapted organisms have been discovered at seabed vent sites, including chemoautotrophic microbes, symbiotic tubeworms, a variety of mollusks, and ghostly-white, eyeless shrimp and crabs. Some scientists suggest that the vents may hold the key to understanding the origin of life on Earth and might even guide "astrobiologists" in their search for other life in our solar system and beyond.[16] Whether vent microbes will help point the way toward extraterrestrial life or not, it would not be too extravagant to suggest that the discovery of deep-sea vent communities might ultimately prove to be as significant to the life sciences as was the development of the global plate tectonics theory for the earth sciences.

A. GEOLOGY AND CHEMISTRY OF DEEP-SEA VENTS

In the early decades of the twentieth century, Alfred Wegener formulated his now famous "continental drift" theory.[17] Wegener hypothesized that all of the modern continents emerged from a single supercontinent he called *Pangaea.* Wegener was, however, unable to identify the mechanism that drove the original supercontinent apart, and his theory was scorned by most of his contemporaries. It was not until the late 1960s that scientists, building on echo-sounding data, seismology and geomagnetism studies, and marine cartography, were finally able to identify the mechanics of plate tectonics and volcanism as the forces that drove Wegener's continental drift, thereby lending credibility to the continental drift theory.[18]

The ocean basins cover nearly sixty percent of the Earth's surface. The basins' most prominent feature is the Mid-Ocean Ridge, a 40,000-mile long continuous mountain range that girds the globe at an average depth of about 1.5 miles and width of 1200 miles. The ocean basins are also lined with deep trenches and fracture zones, which mark geologically active basin areas. The basins have been shaped over the planet's history by a combination of geologic processes and sedimentation from inorganic and organic sources. The geologic processes are

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Hydrothermal Vents, *in* THE MICROBIOLOGY OF DEEP-SEA HYDROTHERMAL VENTS, tbl. 1, at 5 (David M. Karl ed., 1995).

15. *See* VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, tbl. 2.A.

16. *Id.* ch. 13; John A. Baross & Sarah E. Hoffman, *Submarine Hydrothermal Vents and Associated Gradient Environments as Sites for the Origin and Evolution of Life*, 15(4) ORIG. LIFE 327 (1985) (hypothesizing that life on Earth originated about 4.2 billion years ago at the site of sea-floor hydrothermal vents).

17. ALFRED L. WEGENER, THE ORIGIN OF CONTINENTS AND OCEANS ch. 2 (1966).

18. *See generally* ADOLPHE NICOLAS, THE MID-OCEANIC RIDGES: MOUNTAINS BELOW SEA LEVEL (1995).

best explained by the theory of plate tectonics (including sea-floor spreading and continental drift) and volcanism, which combine to continuously reshape the seafloor. The plate tectonics theory views the lithosphere (the Earth's outer layer) as a set of seven major and five or more minor plates made up of crustal rock and, to a lesser extent, mantle. These relatively cool plates "float" on the planet's hot inner core.

The crust that underlies the oceans' basins is formed by molten basalt along the so-called "spreading centers" in rifts along the mid-ocean range at divergent plate boundaries.[19] At convergent plate boundaries, plates come together and old lithospheric material is destroyed (some would say recycled) through subduction under the abutting continental landmass, forming submarine trenches. Plates slide past each other along faults, occasionally with destructive seismic effects. Hydrothermal vents have been discovered in both divergent and convergent zones.[20] Heat, primarily from magma within the Earth's crust, provides the energy that drives the hydrothermal circulation responsible for the vents. Where the right conditions are found, dense seawater percolates down into magma chambers close to the surface of the ocean crust where it is heated, reacts with surrounding minerals and is then reléased through fissures and fractures in the newly formed lithosphere.[21] The heated water, now less dense and therefore buoyant, emerges rich in reduced chemical compounds, dissolved gases (hydrogen sulfide, hydrogen, and carbon dioxide) and, it is now believed, microbes that reside in subseabed biotopes. As the mineral-rich water is cooled by the surrounding seawater the metal sulfides precipitate out, forming deposits at some vent sites.[22] The polymetallic sulfide deposits contain iron, copper, and zinc sulfides, as well as other minerals, including, in some cases, high concentrations of gold and silver.

Seabed vent fields range in size from a few hundred up to a few million square meters.[23] Vent fauna and sulfide deposits typically cover about twenty to fifty percent of the field. Vent communities have been discovered in virtually all the oceans.[24] Early discoveries in the Pacific Ocean were soon followed by discoveries in the Atlantic and Indian Oceans. In 1994, scientists discovered the "TAG" field, located on the Mid-Atlantic Ridge.[25] The TAG field, nicknamed "the mother of all vent fields," lies in waters roughly two miles deep, about 2000 miles

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19. John R. Delaney et al., *The Quantum Event of Oceanic Crustal Accretion: Impacts of Diking at Mid-Ocean Ridges*, 281 SCIENCE 223, 223 (1998).

20. *See generally* Susan E. Humphris, *Hydrothermal Processes at Mid-Ocean Ridges*, *available at* http://earth.agu.org/revgeophys/humphr01/humphr01.html (last visited June 15, 2000).

21. VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, ch. 2.

22. *Id.* ch. 2-4; FILLMORE C.F. FEARNEY, MARINE MINERAL RESOURCES 85-86 (1990).

23. Seyfried & Mottl, *supra* note 14, at 4.

24. Eve C. Southward, *Vent Communities in Atlantic Too*, 317 NATURE 673 (1985).

25. "TAG takes its name from an early survey of the region, the 'Trans-Atlantic Geotraverse.' " Peter Rona et al., *Black Smokers, Massive Sulfides, and Vent Biota at the Mid-Atlantic Ridge*, 321 NATURE 33-37 (1986).

east of the Florida coast.[26] Vent communities have also been found at "cold seeps" along sea-floor factures in the Gulf of Mexico, on the Florida Escarpment, off the coasts of Oregon and Japan, and in the Monterey Canyon off northern California.[27]

The scientific community's understanding of hydrothermal vents developed rapidly over the past two decades, yet it remains quite limited.[28] It is known that the chemical composition and temperature of the vent fluids and gases generally vary substantially from field to field and over time within any particular field.[29] Most seabed hydrothermal vents, particularly those in the Northeast Pacific and along the East Pacific Rise, are subject to rapid change and eventual extinction, owing to the fitful, episodic nature of the underlying geologic, hydrologic, and volcanic processes.[30] Several have erupted violently, with effects on surrounding fauna that provoke barbequesque metaphors.[31] Initial findings indicate that vents remain active for a period of years or even decades. When the vent's water discharge ceases, as mineral deposits choke off the conduits, or when earthquakes or changes in the volcanic process disrupt the underlying geologic pattern, the original biological community is extinguished, or its composition is substantially altered, and the mineral deposits oxidize and eventually crumble.

B. BIOLOGY AND ECOLOGY OF DEEP-SEA VENT COMMUNITIES

Until 1977, scientists widely believed that all deep-sea fauna ultimately depended on photosynthesis in the upper ocean layers for their existence and, that, for the most part, deep ocean fauna existed only in dispersed populations.[32] Discovery of biological "oases" in the lightless deep of the Galapagos Rift shattered the existing paradigm. Marine biologists have now identified a veritable cornucopia of vent fauna at lightless depths in excess of 2000 meters, including, among others, tubeworms, clams, mussels, barnacles, snails, anemones, limpets, shrimp, crabs, fish, and an essentially unquantifiable biomass of microbes.[33] The

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26. *See* RICHARD ELLIS, DEEP ATLANTIC: LIFE, DEATH, AND EXPLORATION IN THE ABYSS 83-84 (1996).

27. *See* Ian R. MacDonald & Charles Fisher, *Life Without Light*, 190 NAT'L GEOGRAPHIC 86 (1996) (documenting Gulf of Mexico expedition that discovered chemosynthesis-based food web based on methane emissions); VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, tbl. 2.A.

28. *See generally* Rita R. Colwell, *Biocomplexity and the Ocean Sciences*, SEA TECH., Jan. 2000, at 22 (Dr. Colwell concludes that "both the microbial and macrobiological communities at the bottom of the sea are virtually unknown to us"); Seyfried & Mottl, *supra* note 14, at 1-35.

29. Seyfried & Mottl, *supra* note 14, at 9-11.

30. John M. Edmond & Karen Von Damm, *Hot Springs on the Ocean Floor*, SCI. AM., Apr. 1983, at 78, 78-93. Researchers describing the "before-and-after" scene at the site of an eruption at 10° North characterized the biotic existence as one governed by the dictum "Live fast, die young." Richard A. Lutz & Rachel M. Haymon, *Rebirth of a Deep-Sea Vent*, 186 NAT'L GEOGRAPHIC 114, 122 (1994).

31. Lutz & Haymon, *supra* note 30, at 114-26.

32. *See generally* CLARENCE P. IDYLL, ABYSS: THE DEEP-SEA AND THE CREATURES THAT LIVE IN IT (1976).

33. *See* JOHN D. GAGE & PAUL A. TYLER, DEEP SEA BIOLOGY: A NATURAL HISTORY OF ORGANISMS AT THE DEEP SEA FLOOR (1991); Holger W. Jannasch, *Life at the Sea Floor*, 374 NATURE 676-77 (1995); Richard A. Lutz, *The Biology of Deep-Sea Vents and Seeps*, 34 OCEANUS 75, 75-83 (1991).

composition of vent biotic communities varies over time and geography, though some species are common to more than one site. Tubeworms have so far been found only at the Pacific Basin sites; north-central Atlantic Ridge sites are dominated variously by mussels or shrimp. It is not yet clear how new vent sites are colonized by their highly specialized fauna. The editors of *Nature* magazine were recently prompted to ask whether the sea-floor hydrothermal vents may serve as "inter-ocean faunal highways,"[34] raising questions about what might happen if the "highway" were disrupted by anthropogenic activities, like seabed mining, to such an extent that the inter-ocean highway was insurmountably interrupted.

Although the total biomass of the vent fields is relatively small, it is often densely concentrated. Since the discovery of the first vent field in 1977, research has begun to reveal the genetic and metabolic diversity of the hydrothermal vent communities. Biodiversity over the fields is greater than expected,[35] and is considered to be so vast that most of it is still largely undiscovered.[36] As a result, diversity within microbe species and the smaller invertebrates is yet to be fully assessed. Some place the vent macrofaunal inventory at more than 300 species, most of which are new to science.[37] It is not the number of distinct macrofaunal and microbial species that is likely to attract attention, however, as much as it is their unique adaptation to the vents' "extreme" environment. More important to those concerned with marine biodiversity, many of the vent macrofaunal organisms are believed to be endemic to vents; that is, they have so far been found only at vent sites.[38]

Among the vent microfaunal inhabitants are the Archaea—ancient microbes often found in extreme environments and now known to comprise a third biotic domain.[39] Current research suggests that Archaea may well be the first life form on Earth.[40] Some have concluded that methanogenic Archaea produced most of the methane in the outer few kilometers of the Earth's crust.[41] Such organisms

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34. Cindy Lee Van Dover, *Vents at Higher Frequency*, 395 NATURE 437 (1998). The editors' cover tag line for Professor Van Dover's article suggests the "inter-ocean highway" question.

35. J. Frederick Grassle & Nancy J. Maciolek, *Deep-Sea Species Richness: Regional and Local Diversity Estimates from Quantitative Bottom Samples*, 139 AM. NATURALIST 313-41 (1992); *see also* NATIONAL RESEARCH COUNCIL, UNDERSTANDING MARINE BIODIVERSITY 44-45 (1995). *But see* VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, at 325-28 (concluding that species diversity at vent sites is low); BOYCE THORNE-MILLER, THE LIVING OCEAN: UNDERSTANDING AND PROTECTING MARINE BIODIVERSITY 105 (2d ed. 1999) (coming to same conclusion).

36. John A. Baross & Jody W. Deming, *Growth at High Temperatures: Isolation and Taxonomy, Physiology, and Ecology*, *in* THE MICROBIOLOGY OF DEEP-SEA HYDROTHERMAL VENTS, *supra* note 14, at 171.

37. Raymond A. Binns & David L. Dekker, *The Mineral Wealth of the Bismarck Sea*, *in* THE OCEANS, SCI. AM., NOV. 1998, at 92, 96.

38. VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, at 313.

39. The other two domains are the Bacteria and Eukarya. *See* Virginia Morell, *Microbiology's Scarred Revolutionary*, 276 SCIENCE 699 (1997) (describing Carl Woese's discovery of the Archaea).

40. *Id.* at 700.

41. *See* Norman R. Pace, *A Molecular View of Microbial Diversity and the Biosphere*, 276 SCIENCE 734, 736 (1997).

probably constitute a large component of the planet's biomass,[42] and might one day serve as an inexhaustible source of renewable energy.[43]

Specially adapted microorganisms that rely on chemosynthesis constitute the primary producers in seabed hydrothermal vent ecosystems.[44] In contrast to photosynthesis, which relies on energy from sunlight to form organic compounds, chemosynthesis is fueled by chemical energy provided by sulfur from the vent hydrogen sulfide emissions (or methane, in the case of cold seeps[45]). The origin of the critical chemoautotrophic microbes is uncertain, but there is mounting evidence that an enormous microbe community exists within the Earth's crust.[46] Other fauna within the vent community exploit the microbes' primary production of organic carbon through a variety of means. Some rely on a symbiotic relationship with the microbes for their existence, similar in many respects to the relationship between coral polyps and their resident zooxanthellae. Endosymbiotic tubeworms of the *vestimentifera* phylum are one such group.[47] Worms in the phylum, which includes the *riftia* and *ridgeia*, grow to lengths of up to three meters. The worms have no eyes, mouths, or gut, and no means of locomotion. Scientists now know that the worms (and some species of vent mollusks, including the large clams *calyptogena*, found at cold seeps) depend on an endosymbiotic relationship with the chemosynthetic microbes.[48] The host tubeworms provide the microbes with shelter and assist in nutrient acquisition and synthesis, while consuming energy and organic compounds produced by the microbes. Zooplankton in the surrounding waters also feed on the chemosynthetic microbes and provide the food base for filter-feeding clams and mussels, some of which also rely in part on endosymbiosis. Other microbes collect in mats, which are fed upon by benthic worms, mollusks, and other grazing fauna. Still higher in the food web, shrimp, crabs, lobster, fish, and even octopus have been observed preying or scavenging on lower life forms in the vent community. These organisms survive, even thrive, in a lightless environment characterized by

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42. *See generally* James K. Fredrickson & Tullis C. Onstott, *Microbes Deep Inside the Earth*, SCI. AM., APR. 1996, at 68.

43. Pace, *supra* note 41, at 736.

44. *See generally* VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, ch. 6.

45. Like their hydrothermal vent analogues, cold seep biotic communities depend on chemosynthetic bacteria for primary production in the food chain. However, the cold seep bacteria rely on methane seeping from the sea-floor factures, rather than on hydrogen sulfide, for their chemosynthesis processes. Seyfried & Mottl, *supra* note 14, at 2.

46. *See generally* Richard A. Kerr, *Life Goes to Extremes in the Deep Earth—and Elsewhere*, 276 SCIENCE 703 (1997); Jody W. Deming & John A. Baross, *Deep-Sea Smokers: Windows to a Subsurface Biosphere?*, 57 GEOCHIMICA ET COSMOCHIMICA ACTA 3219 (1993).

47. *See* Colleen M. Cavanaugh, *Symbiotic Chemoautrophic Bacteria in Marine Invertebrates from Sulphide-Rich Habitats*, 302 NATURE 58 (1983); James J. Childress et al., *Symbiosis in the Deep Sea*, SCI. AM., May 1987, at 115.

48. VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, ch. 6.

extreme temperature, pressure, and pH—an environment often laced with high levels of radioactive elements, heavy metals, and a veritable "soup" of toxins.[49]

III. POTENTIAL MULTI-USE CONFLICTS AT DEEP-SEA VENT FIELDS

Although a few bold writers have attempted to estimate the economic value of the oceans,[50] most would agree that the true value of the oceans and their resources is incalculable. At the same time that these precious oceans are coming under mounting pressure from a variety of human uses, the effects of climate change on the oceans are becoming increasingly manifest.[51] Ocean and seabed uses of concern include marine scientific research, oil and gas exploration and development, hydrographic surveying, submarine cable and pipeline laying and maintenance, hard mineral mining, waste disposal, ocean energy production, and exploitation of the seas' living marine resources. In addition, cultural and recreational resources of the seas and seabed are gaining long-neglected international recognition. As technological developments permit deeper and more extensive intrusions into the oceans, the pressures imposed by those uses are likely to increase significantly—particularly in those active vent sites located closest to the principal research institutions.

Despite the technological obstacles and tremendous costs,[52] a number of vent fields are already subject to multiple uses, some of which can lead to conflicts. In discussing the need for marine protected areas (MPAs) around hydrothermal vent sites, for example, the U.N. Secretary-General observed in his 1999 Report on Oceans and the Law of the Sea that any MPA proposal for such sites would have to take into account the fact that there may be competing interests in the area, including exploration and exploitation of polymetallic sulfide deposits and prospecting for genetic resources.[53] Similarly, oceanographers have noted the growing potential for conflict over access to vent sites within the scientific community itself and the correlative need for a management regime.[54]

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49. *Cf.* David R. Dixon et al., *Toxic Vents and DNA Damage*, INTERRIDGE NEWS, 2000, at 13.

50. Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital*, 387 NATURE 253, tbl. 2 (1997). Costanza and his colleagues estimated the flow value of the marine ecosystems to be nearly US $21 trillion per year.

51. *See generally* MYRES S. MCDOUGAL & WILLIAM T. BURKE, THE PUBLIC ORDER OF THE OCEANS, xxvii-xxxiv (1987).

52. One estimate put the cost of a deep-ocean scientific expedition at up to US $30,000 per day. U.N. Environment Programme, *Bioprospecting of Genetic Resources of the Deep Sea-Bed: Report by the Subsidiary Body on Scientific, Technical and Technological Advice*, ¶ 44, UNEP/CBD/SBSTTA/2/15 (1996) [hereinafter *SBSTTA Bioprospecting Report*].

53. U.N., *Oceans and the Law of the Sea: Report of the Secretary-General*, U.N. GAOR, 54th Sess., Agenda Items 40(a), (c), at 78, ¶ 509, U.N. Doc. A/54/429 (1999). [hereinafter *1999 U.N. S-G Report on Oceans and the Law of the Sea*], *available at* U.N., Division for Ocean Affairs and the Law of the Sea, *Oceans and the Law of the Sea: Report of the Secretary-General*, http://www.un.org/Depts/los/a54_429.htm (last visited May 1, 2000).

54. Mullineaux, *supra* note 7, at 15-16.

A. MARINE SCIENTIFIC RESEARCH ACTIVITIES

"The deep ocean floor is one of the richest, but at the same time one of the least known, ecosystems in the planet."[55] It is, therefore, fitting that marine scientific research is, so far, the most common activity at hydrothermal vent sites. Scientific expeditions to the oceans' vent fields seek to gain an understanding of such phenomena as global plate tectonics, heat loss and transfer processes within the Earth, marine chemistry and mineral deposit formation, marine biodiversity and ecology, the origin and evolution of life and its physical limits, and the possible existence of a deep microbial biosphere within the Earth. These scientific findings may prove invaluable in efforts to predict volcanic and seismic events. The benefits to earthquake-prone regimes, such as the U.S. west coast, are potentially enormous. Research in the United States is supported in part by the National Science Foundation, through its Ridge Inter-Disciplinary Global Experiments (RIDGE) Program,[56] and the National Oceanic and Atmospheric Administration's (NOAA) VENTS program, established in 1984 to conduct research on the oceanic impacts and consequences of submarine volcanoes and hydrothermal vents.[57]

Vent researchers have adopted several exploratory mechanisms, including surface ships, towed sleds fitted with sensors, video cameras and sample collection apparati, unmanned submersibles and, of course, manned submersibles like the now legendary *Alvin*. Increasingly, scientists are turning to fixed sensors to learn about the seafloor. The marine scientific research community received a boon in 1993 when the U.S. government granted selective access to real-time and historical data from the U.S. Navy's Sound Surveillance System (SOSUS) network.[58] SOSUS now permits scientists to listen in on marine seismic events as they occur. Similarly, the New Millennium Observatory (NeMO), located in 1500 meters of water roughly 300 miles off the Oregon-Washington coast, provides an opportunity for a multi-year monitoring and sampling program on the summit of an active seabed volcano. The observatory uses a variety of sampling, sensing, and photographic equipment to examine and record the relationships between volcanic events, and the chemistry and distribution of hydrothermal vents, and the biologic communities that depend on them.[59] By 2005, North Pacific seabed

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55. *1999 U.N. S-G Report on Oceans and the Law of the Sea*, *supra* note 53, ¶ 530.

56. RIDGE is presently hosted by Oregon State University. *See* Oregon State University, College of Oceanic and Atmospheric Sciences, *RIDGE*, *available at* http://ridge.oce.orst.edu/ (last visited June 15, 2000).

57. NOAA, Pacific Marine Environmental Laboratory, *Vents Program*, *available at* http://www.pmel.noaa.gov/vents/ (last visited June 15, 2000). NOAA's Vents Program focuses on sites in the northeast Pacific Ocean.

58. William J. Broad, *Navy is Releasing Treasure of Secret Data on World's Oceans*, N.Y. TIMES, Nov. 28, 1995, at B5. SOSUS, a global network of sea-floor microphones, was built by the Navy at a cost of US $16 billion. *See* BROAD, THE UNIVERSE BELOW, *supra* note 3, at 52-53.

59. *See* NOAA, Pacific Marine Environmental Laboratory, *Vents Program: NeMo*, *available at* http://newport.pmel.noaa.gov/nemo/ (last visited June 15, 2000); *see also 1999 U.N. S-G Report on Oceans and the Law of the Sea*, *supra* note 53, ¶ 539.

research efforts may be enhanced by the "NEPTUNE" project, which would establish a system of high speed, submarine fiber-optic cables to connect remote, interactive experimental sites with land-based laboratories and classrooms along the west coast of the United States and Canada.[60]

Although limited by extreme water depths, at least one seabed drilling expedition has obtained core sample from a vent field.[61] Seafloor dives by manned and unmanned submersibles have enabled scientists to obtain seabed, water, mineral, and biological samples. The samples are later analyzed, studied, and correlated with data from other sources, and the results are published, posted on the Internet or some other electronic network, or otherwise shared with other marine scientists. Samples taken from the vents may be placed in a specimen "bank" and made available to researchers outside the collecting institutions.[62]

Despite their obvious beneficent purposes, research activities must be seen as a "use" of the ocean and seabed, which may add to the anthropogenic footprint.[63] In 1998, for example, a joint U.S.-Canada expedition used a submersible "chain saw" to remove four black smoker chimneys from the Endeavor Segment of the Juan de Fuca Ridge, now a proposed pilot MPA. Three of the chimneys were put on display in the American Museum of Natural History.[64] Scientists also acknowledge that some research activities, particularly those involving time-series observations at fixed locations, will prove to be incompatible with other research projects, and that more cooperation and coordination among researchers will be required to avoid conflicts.[65] The problems are likely to be especially acute at certain sites on the Mid-Atlantic Ridge, the East Pacific Rise, and in the Northeast Pacific that have become cynosures for vent research activity.

B. OIL AND GAS EXPLORATION AND EXPLOITATION

The move to deep-water oil and gas activities is well underway. Seeking to meet the seemingly insatiable demand for hydrocarbon energy sources, offshore

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60. NEPTUNE is the acronym for Northeast Pacific Time-integrated Undersea Networked Experiments. *See* University of Washington, *NEPTUNE: A Fiber-Optic Telescope to Inner Space*, *available at* http://www.neptune.washington.edu/ (last visited Aug. 15, 2000); David Malakoff, *Academy Panel Backs Sea-Floor Observatories*, 289 SCIENCE 522 (2000).

61. Robert Cooke, *Journey Through the Bottom of the Sea*, NEWSDAY (Aug. 29, 1995), *available at* 1995 WL 5120114 (describing JOIDES Endeavor expedition to Atlantic vent field during which seventeen core samples were obtained from a depth of 12,000 feet).

62. The InterRidge group provides a variety of database services. *See, e.g.*, InterRidge, *Hydrothermal Fauna Database*, *available at:* http://triton.ori.u-tokyo.ac.jp/~intridge/db.cgi?db=faunal&uid=default (last visited Sep. 11, 2000); InterRidge, *Hydrothermal Biological Samples Database*, *available at* http://triton.ori.u-tokyo.ac.jp/~intridge/samp-db.htm (last visited Jan. 26, 2001).

63. *See* David Christie, *Life on the RIDGE*, 10 RIDGE EVENTS No. 1, at 2, 4 (1999) (concluding that "scientific study continues to represent the biggest potential risk to [vent] sites").

64. *See* Constance Holden, *Deep-Sea Curios*, 281 SCIENCE 639 (1998). The Museum information is available at American Museum of Natural History, *Expeditions: Black Smokers at Juan de Fuca Ridge*, *available at* http://www.amnhonline.org/expeditions/blacksmokers/ (last visited June 20, 2000).

65. Mullineaux, *supra* note 7, at 15.

oil and gas explorations are already being conducted at depths of more than 2500 meters.[66] As oil and gas exploration and production activities move increasingly seaward, the potential for conflicts with vent research or resource exploration and exploitation activities on the deep ocean floor will increase. Accordingly, any regime governing access to, and conservation and management of, vent resources must anticipate the need to provide a means for resolving conflicts involving offshore oil and gas activities.

C. SEABED MINERAL MINING

Seabed mineral mining prospecting, exploration, and exploitation activities will likely occur in the foreseeable future at or near active or extinct hydrothermal vent fields. The principal deep-sea minerals of interest to mining companies include polymetallic (manganese) nodules, cobalt crusts,[67] and polymetallic sulfide (PMS) deposits.[68] Sources of each have been located within and beyond areas of national jurisdiction. None of the minerals beyond national jurisdiction are currently mined, nor is mining activity in the Area expected in the immediate future.[69] In fact, some experts have concluded that land deposits of the same minerals are adequate for the coming century.[70] Nevertheless, because deep seabed mining appears virtually inevitable within the century, and within areas under national jurisdiction much sooner, and because many of the potential mining sites overlap with or are adjacent to vent fields, any governance regime for the resources must address the very real potential for conflicts between mining and other vent related activities.

1. Polymetallic (Manganese) Nodules Mining

For many years, deep-sea mining interest focused on the vast deposits of polymetallic nodules[71] first discovered by the *H.M.S. Challenger* expedition in 1873. Polymetallic nodules (often called manganese nodules) are found in abyssal areas of the seabed at depths of 4000 to 6000 meters. Although the origin of the nodules is not fully understood, it is believed they precipitate from

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66. *See generally 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶¶ 325-326; Walt Rosenbusch, *MMS: Challenges for the New Millennium*, SEA TECH., Aug. 2000, at 29.

67. Cobalt crusts, containing manganese, cobalt, nickel and platinum, have been located in waters between 500 meters and 2000 meters deep. The deposits precipitate out of seawater and form crusts up to 40 cm thick on rocky seabed elevations such as seamounts, flanks of islands and plateaus. *See generally* F.T. Manheim, *Marine Cobalt Resources*, 232 SCIENCE 600 (1986).

68. *See generally 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶¶ 336-337.

69. *See generally* HANDBOOK OF MARINE MINERAL DEPOSITS (David S. Cronan ed., 2000); Conrad G. Welling, *Mining of the Deep Seabed in the Year 2010*, 45 LA. L. REV. 1249 (1985).

70. Carol Ann Hodges, *Mineral Resources, Environmental Issues, and Land Use*, 268 SCIENCE 1305 (1995).

71. *See generally* Roy S. Lee, *Machinery for Seabed Mining: Some General Issues Before the Geneva Session of the Third United Nations Conference on the Law of the Sea*, *in* LAW OF THE SEA: CARACAS AND BEYOND 117 (Francis T. Christy, Jr. et al. eds., 1975).

seawater over a period of millions of years.[72] Mineral components and concentrations of those nodules vary, but generally include economically valuable manganese, cobalt, nickel, and copper.

Among the more attractive nodule mining sites is the 1.35 million square mile Clarion-Clipperton Fracture Zone seafloor area between Mexico and Hawaii, where a number of U.S.-based consortia have already conducted extensive research.[73] Under the provisions of the 1982 LOSC, manganese nodule exploration plans for several pioneer investors from other nations have been approved by the International Seabed Authority (ISA) for activities in the Clarion-Clipperton area.[74] It is worth noting that several active hydrothermal vent sites have been discovered in the vicinity of the Clarion-Clipperton Fracture Zone.[75] Mining companies are also exploring possible manganese nodule sites within areas of national jurisdiction. A Norwegian deep-sea mining group, for example, is presently working with the Cook Islands to reach agreement to mine nodules within the Cook Islands EEZ.[76] Thus, the potential for conflicts between manganese nodule mining and hydrothermal vent research and exploration in some regions is likely to grow.

2. Methane Hydrates Mining

Many believe the seabed's vast methane hydrate deposits will play a vital role in the planet's energy future—if only the technological and environmental risks of recovery can be overcome.[77] These whitish, ice-like hydrates composed of water and methane have been found on the seabed at depths between 100 and 1200 meters and embedded in the seabed up to three kilometers deep.[78] Methane, a known greenhouse gas, is also a potent energy source. The supply of methane in gas hydrates worldwide is conservatively estimated to represent the equivalent of

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72. *See* Dep't of Commerce, National Oceanic & Atmospheric Administration, *Deep Seabed Mining: Report to Congress* (Dec. 1993); Allen L. Hammond, *Manganese Nodules: Mineral Resources of the Deep Seabed (pt. 1)*, 183 SCIENCE 502 (1974); Allen L. Hammond, *Manganese Nodules: Prospects for Deep Sea Mining (pt. 2)*, 183 SCIENCE 644 (1974).

73. The United States issued Deep Seabed Mining Exploration Licenses to several companies in the early 1980s. *See, e.g.*, 56 Fed. Reg. 37,344 (NOAA 1991).

74. *See* International Seabed Authority, *Report of the Secretary-General of the International Seabed Authority under article 166, paragraph 4, of the United Nations Convention on the Law of the Sea (Third Annual Report, July 1998 to July 1999)*, ISA/5/A/1 [hereinafter *Third Report of the ISA*], *available at* http://www.un.org/Depts/los/Docs/Agencies/isa.htm (last visited Sept. 1, 2000).

75. *See* Seyfried & Mottl, *supra* note 14, tbl. 1, at 5.

76. The Cook Islands, with a landmass of ninety square miles, has claimed an EEZ of approximately one million square miles, much of it reportedly rich in manganese nodules. *See* Taylor A. Prior, *New Described Super-Nodule Resource*, SEA TECH., 1995, at 17; *see also 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶ 337.

77. Kevin Krajick, *The Crystal Fuel*, 106 NAT. HIST. 26 (1997); T. Appenzeller, *Fire and Ice Under the Deep-sea Floor*, 252 SCIENCE 1790 (1991); *see generally* U.S. Geological Survey, *Meeting U.S. Energy Resource Needs: The Energy Resources Program of the U.S. Geological Survey* 27-28 (1999).

78. Krajick, *supra* note 77, at 27.

10,000 gigatons of carbon, twice the amount of all fossil fuels on the planet.[79] Deposits within the U.S. EEZ alone are estimated to be the equivalent of 320,000 trillion cubic feet of natural gas; enough to supply U.S. energy needs at current consumption rates for the next 64,000 years.[80] On May 2, 2000, the U.S. Congress enacted a five-year, US $47.5 million gas hydrate research and development program for the United States.[81]

Methane hydrate deposits have already been discovered in waters off the U.S. Atlantic, Pacific, and Gulf of Mexico coasts.[82] Hydrothermal and cold seep vent biotic communities have been discovered in some of those same areas. Indeed, some of the cold seep vent communities are located on top of hydrate deposits,[83] and hydrate deposits are known to serve as "feed stock" for some chemosynthetic-based ecosystems.[84] Thus, any regime for seabed vent communities should account for conflicts likely to be generated by hydrate research, prospecting, and exploitation.

3. Polymetallic Sulfide Deposit Mining

No activity is more certain to create conflicts over hydrothermal vent fields than the mining of polymetallic sulfide deposits produced by the vents themselves. Marine geologists have amply documented the existence of metal sulfide deposits at many active and extinct hydrothermal vents sites.[85] "Massive" sulfide deposits—that is dense deposits containing, among other minerals, copper, zinc, silver, and gold—have been found at many active hydrothermal vent sites.[86] The ore bodies of economic interest measure up to hundreds of cubic meters and may exceed one million metric tons in mass. The deposits remain behind at extinct sites; however, they eventually oxidize and crumble.

The U.N. Secretary-General's 1999 Report on Oceans and the Law of the Sea highlighted the growing international interest in mining seabed PMS deposits.[87] At the same time, the report concluded that the technology for PMS mining has

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79. U.S. Dep't of Interior, Minerals Management Service, *An Assessment of the Undiscovered Hydrocarbon Potential of the Nation's Outer Continental Shelf: A Resource Evaluation Program Report*, MMS 96-0034 (1996).

80. *See 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶ 332 & n.93.

81. Methane Hydrate Research and Development Act of 2000, PUB. L. NO. 106-193, 114 Stat. 234 (2000).

82. Richard L. Hill, *Ocean's Gas Rocks May Fill Energy Needs*, SEATTLE POST-INTELLIGENCER, Nov. 22, 1996, at C2.

83. *Id.*

84. Krajick, *supra* note 77, at 30 (describing ecosystems based on methanogenic Archaea).

85. *See generally* HANDBOOK OF MARINE MINERAL DEPOSITS, *supra* note 69, ch. 11-14; FEARNEY, *supra* note 22, at 85-89; Peter A. Rona, *Mineral Deposits from Sea-Floor Hot Springs*, SCI. AM., Jan. 1986, at 84.

86. *See* HANDBOOK OF MARINE MINERAL DEPOSITS, *supra* note 69, at 309 & 348, fig. 13.1 (map of sites with massive PMS deposits); FEARNEY, *supra* note 22, at 85-89; VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, tbl. 2.A & § 2.5.2.

87. *1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶ 338.

not yet been developed.[88] Nevertheless, there is good reason to believe that the question is not whether the massive sulfide deposits will be mined, but rather, when it will begin, which vent fields will be targeted, and how the mining will be carried out. Developments at two potential sites within national jurisdictions (discussed below) reveal the magnitude of the legal and technical problems that are likely to accompany PMS mining.

a. The Gorda Ridge PMS Mining Site

The U.S. Department of Interior's (DOI) efforts to promote PMS mining on the Gorda Ridge in the 1980s provides convincing testimony of the difficulties vent field mining proponents are likely to face, at least within the United States. In the early 1980s, the DOI announced its intent to lease up to 70,000 square miles of the Gorda Ridge area seabed off the Northern California-Oregon coast for PMS mining. The announcement followed a series of journal articles that advocated an aggressive PMS mining approach within U.S. jurisdiction.[89] Mining advocates estimated the potential worth of the minerals at "hundreds of billions of dollars."[90] In proclaiming the U.S. Exclusive Economic Zone (EEZ) in 1983, President Reagan cited the need to secure sources of minerals in the sulfide deposits lying within 200 miles of the U.S. baseline as one of the nation's goals.[91]

Considerable doubt over DOI's legal authority to issue such leases soon emerged.[92] No U.S. legislation provided authority for the licensing or regulation of exploration or exploitation of minerals other than manganese nodules in areas beyond U.S. jurisdiction.[93] It was also questionable whether the Outer Continental Shelf Lands Act (OCSLA) provided the DOI with authority over PMS leasing within seabed areas under U.S. jurisdiction.[94] Additional doubts centered on

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88. *Id.*; *see also* S.D. Scott, *Polymetallic Sulfide Riches from the Deep: Fact or Fallacy?*, *in* USE AND MISUSE OF THE SEAFLOOR 87 (K. J. Hsu & J. Thiede eds., 1992).

89. Alexander Malahoff, *The Ocean Floor, Our New Frontier: A Scientific Viewpoint*, 16 MARINE TECH. SOC'Y J. 3 (1982); Conrad G. Welling, *Polymetallic Sulfides: An Industry Viewpoint*, 16 MARINE TECH. SOC'Y J. 5 (1982); David B. Duane, *Elements of a Proposed Five-Year Research Program on Polymetallic Sulfides*, 16 MARINE TECH. SOC'Y J. 87 (1982).

90. *State's Next 'Gold Rush' May in Hills at Sea's Bottom*, SAN DIEGO UNION-TRIBUNE, Dec. 18, 1983, at A3, *available at* 1983 WL 2009814.

91. Statement Accompanying Proclamation of Exclusive Economic Zone (Proclamation 5030, Mar. 10, 1983), 19 WEEKLY COMP. OF PRES. DOCS. 383 (1983) [hereinafter Ocean Policy Statement] (adverting to "recently discovered deposits" of "strategic minerals" within 200 miles of the U.S); *see also* National Research Council, Committee on Seabed Utilization in the Exclusive Economic Zone, *Our Seabed Frontier: Challenges and Choices* (1989) (analyzing importance of EEZ proclamation to development of marine mineral mining).

92. The DOI attempted to answer the question through an elaborate legal opinion. *See* Solicitor, U.S. Dep't of Interior, *Authority to Issue Outer Continental Shelf Mineral Leases in the Gorda Ridge Area* (Mem. MMS.ER.0057, May 30, 1985), 92 Interior Dec. 459, *available at* 1985 WL 264296 (D.O.I.).

93. The Deep Seabed Hard Minerals Resources Act, for example, extends only to manganese nodules. *See* 30 U.S.C. § 1403(6) (1994) (defining hard minerals as "nodules which include one or more minerals, at least one of which contains manganese, nickel, cobalt, or copper").

94. *See* 43 U.S.C. § 1331(q) (1994) (defining "minerals" under the Act); Donna Darm, Comment, *The*

whether the seaward extent of the agency's leasing authority under the OCSLA was extended by the President's EEZ Proclamation in 1983. Without congressional action to implement the Proclamation, some concluded that existing federal statutes provided no agency authority over non-living resource activities beyond the geologic continental shelf.[95]

Despite doubts over its statutory authority over PMS mining and industry interest that was at best tepid, the DOI proceeded through an extended National Environmental Policy Act (NEPA) review process.[96] In an attempt to halt the agency's action, California Representative Douglas Bosco introduced bills in 1985 and 1987 to ban any PMS mining on the Ridge.[97] Faced with Congressional hostility to its lease plans, an apparent lack of industry interest, and a very discouraging 1987 report by the Office of Technology Assessment,[98] the DOI's Minerals Management Service concluded in 1988 that the Gorda Ridge would not be a potential target for commercial mining development for several more decades and abandoned the initiative.[99]

b. The Papua-New Guinea PMS Mining Site

In late 1997, the interest in mining marine polymetallic sulfide crusts appeared to finally move beyond government offices and company boardrooms and onto the ocean floor, when the government of Papua-New Guinea (PNG) granted Nautilus Minerals Corporation a license to explore for minerals in two sites totaling more than 1900 square miles. The exploration sites are located on the Manus Basin sea-floor in the Bismarck Sea, within the Papua-New Guinea EEZ.[100] The sulfide deposits at the site consist of numerous sulfide-rich smokers up to twenty meters tall, which project from sulfide mounds twenty to thirty

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Outward Limit of the Department of Interior's Authority over Submerged Land—The Effect of Customary International Law on the Outer Continental Shelf Lands Act, 60 WASH. L. REV. 673 (1985); *Gorda Ridge: A Seafloor Spreading Center in the United States' Exclusive Economic Zone*, *in* PROCEEDINGS OF THE GORDA RIDGE SYMPOSIUM, May 11-13, 1987 (Gregory R. McMurray ed., 1990).

95. *See* Darm, *supra* note 94, at 695.

96. *See* U.S. Dep't of Interior, Minerals Management Services, *Draft Environmental Impact Statement: Proposed Polymetallic Sulfide Minerals Lease Offering, Gorda Ridge Area Offshore Oregon and Northern California* (Dec. 1983).

97. *See* H.R. 787, 100th Cong. (1987), 133 CONG. REC E290-03(1987), (extended remarks on bill by Rep. Bosco); H.R. 2048, 99th Cong. (1985), 131 CONG. REC. E2059-02-03 (1985) (extended remarks on bill by Rep. Bosco).

98. OFFICE OF TECHNOLOGY ASSESSMENT, CONGRESS OF THE UNITED STATES, MARINE MINERALS: EXPLORING OUR NEW OCEAN FRONTIER (1987).

99. *See Ocean Offers Wealth of Minerals*, AM. METAL MARKET 14, Jan. 21, 1994, *available at* 1994 WL 2894268 (excerpts from testimony by John W. Padan, U.S. Minerals Management Service, before Senate Energy & Natural Resources Subcommittee).

100. Binns & Dekker, *supra* note 37, at 92-97; *Seafloor Massive Sulfides*, 330 MINING J. No. 8467, Feb. 13, 1998, at 123.

meters across. The commercial value of the deposits has been estimated to be about US $2000 per cubic meter.

The Bismarck Sea deposits are thought to provide three advantages over other potential PMS mining sites. First, the deposits are located in relatively shallow water (about 2000 meters), reducing the technological challenges and costs of prospecting and recovery. Second, because the deposits lie within a nation's EEZ, miners arguably stand to benefit from a stable legal regime, free from many of the disincentives to mining in the deep seabed. Finally, the Bismarck Sea deposits are relatively rich in minerals of particular interest.[101] Before Nautilus will be allowed to commence mining, however, it must demonstrate to the PNG government that the mining will not harm the surrounding biota—a potentially daunting challenge, given that scientists have counted as many as 5000 organisms in a single square meter of chimney wall taken from the site.[102] Unfortunately, the record of inadequate, if not non-existent, government control over terrestrial mining operations in PNG provides little reason to hope that seabed mining will be conducted responsibly.[103]

4. Seabed Mining and the Marine Environment

Though the threats posed by mining the sea-floor are not fully understood, preliminary studies indicate a number of risks.[104] Pursuant to its mandate under the DSHMRA,[105] NOAA conducted a Deep Ocean Mining Environmental Study (DOMES) to determine the potential environmental effects of manganese nodule mining.[106] The DOMES study area overlapped a number of hydrothermal vent fields along the East Pacific Rise.[107] An international

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101. Sulfide crusts found in subduction zones like the Bismarck Sea are generally richer in commercially important minerals than those found in divergent zones. *See* Binns & Dekker, *supra* note 37, at 93.

102. *Id.* at 96. Ironically, a coral reef in the Madang Lagoon in Papua-New Guinea has been singled out for its prodigious biodiversity. James D. Thomas, *Using Marine Invertebrates to Establish Research and Conservation Priorities*, *in* BIODIVERSITY II: UNDERSTANDING AND PROTECTING OUR BIOLOGICAL RESOURCES 357, 363-66 (Marjorie L. Reaka-Kudla et al. eds., 1997) (observing that "Madang reefs are some of the most biologically diverse reefs yet documented").

103. *See generally* JEAN MICHAEL COUSTEAU, PAPUA NEW GUINEA JOURNEY (1989) (describing the devastation wrought by the Panguna mining operation in PNG); *see also* Tamuasi v. Rio Tinto, PLC, No. C-00-3208-SC (N.D. Cal. 2000) (suit under Alien Tort Claims Act, 28 U.S.C. § 1350, by indigenous peoples of PNG against mining company alleging "violations of international environmental rights").

104. ENVIRONMENTAL CONSEQUENCES OF DEEP SEABED MINING (Stig Berge et al. eds., 1991); U.S. Dep't of Commerce, National Oceanic & Atmospheric Administration, *Deep Seabed Mining (Report to Congress)* (1987); MICHAEL S. BARAM ET AL., MARINE MINING AND THE CONTINENTAL SHELF: LEGAL, TECHNICAL AND ENVIRONMENTAL CONSIDERATIONS ch. 5 (1978).

105. Deep Seabed Hard Mineral Resources Act, 30 U.S.C. § 1419 (1994).

106. U.S. Dep't of Commerce, National Oceanic & Atmospheric Administration, *Deep Seabed Mining, Final Programmatic Environmental Impact Statement*, (1981) (EIS Order 810762).

107. The DOMES study area was a rectangle bounded by 5° North and 20° North latitude and 110° West and 180° West longitude. *Id.* at xiv, 57. The area overlaps with several East Pacific Rise vent fields. *See* VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, tbl. 2.A.

workshop in Mandang, Papua-New Guinea, in 1999, which focused on the plans for PMS mining in the Bismarck Sea, included environmental analyses in its agenda.[108] In the course of its NEPA analysis in preparation for leasing mineral exploration sites on Gorda Ridge, the DOI discovered a number of rare life forms within the proposed mining site, which would almost surely be affected by any mining operations.[109] These environmental studies and discussions, though incomplete, leave little doubt that the impacts of seabed mining activities on the surrounding ecosystems could be substantial.[110]

Scientists predict that releasing high concentrations of sulfides into upper water levels could seriously diminish the level of oxygen available to the surrounding biota.[111] Free sulfides, particularly hydrogen sulfide, are toxic at low concentration levels to most fish, crustaceans, polychaetes, and a variety of benthic microinvertebrates.[112] Suspended sediments produced by mining activities would increase turbidity, impairing the transmission of sunlight to lower water levels, before eventually settling to the bottom, and potentially burying the resident benthos. Even the sonic energy generated by submarine mining must be evaluated, because such "pollution" might affect the behaviors of marine mammals or other sound-sensitive organisms.

The nature and extent of the environmental effects of PMS mining will, of course, depend in large part on the method used and on which sites are mined. One possible mining method envisions developing the equipment to pulverize the sulfide deposits on the seabed, separating the ores magnetically (rather than by use of reagents), then pumping the desired ores to the surface.[113] However, the technology for such an *in situ* process does not yet exist. Another suggested strategy would limit mining operations to the sulfide deposits found at inactive or extinct vent sites to avoid destruction of the rich biotic communities found at active sites. Although inactive sites would likely present less of a temperature and corrosion problem for mining equipment than active sites, and may in fact have superior mineral composition, a major drawback to that alternative is the increased difficulty in locating inactive site deposits without the benefit of the telltale thermal plume that marks the active

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108. *See 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶¶ 340 & 342. It is difficult, however, to assess the true level of concern by the Papua-New Guinea government for the potential environmental effects of the proposed seabed mining.

109. *See Deep Sea Divers Report Finding Exotic Life*, N.Y. TIMES, July 29, 1984, at I24.

110. *See* International Seabed Authority, Legal and Technical Commission, *Recommendations from the Workshop to Develop Guidelines for the Assessment of the Possible Environmental Impacts Arising from Exploration for Polymetallic Nodules in the Area*, Annex, ISA/5/LTC/1 (1999).

111. *See* BARAM, MARINE MINING, *supra* note 104, at 111.

112. *Id.*

113. *See Trillions of Dollars Just Lying Around*, *supra* note 2.

vents.[114] Moreover, even sites that are hydrologically "inactive" may support unique ecosystems.

On July 13, 2000, the Assembly of the ISA approved its Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area, commonly referred to as the "mining code."[115] In addition, at the request of the Russian government, the ISA is developing a mining code for polymetallic sulfide deposits and cobalt crusts.[116] The PMS mining code planning process began with a workshop convened by the ISA in the summer of 2000.[117] The U.N. Secretary-General observed that environmental issues occupy a "significant position" in the mining code for manganese nodules.[118] The report goes on to conclude that the present period, before commercial mining production on the seabed begins, may present an opportunity to apply the precautionary approach to the potential environmental impacts of this future industry.[119] The pre-mining period also presents a window of opportunity to develop a comprehensive legal regime for the vent fields and all their resources, and to determine how the ISA can meet its obligation to protect and preserve the marine environment, and ensure that rare and fragile ecosystems are afforded appropriate protection from mining activities.

D. BIOTECHNOLOGY AND BIOLOGICAL PROSPECTING

Whether biotechnology[120] is viewed as a source of nutritional and medicinal salvation or an unspeakable Faustian compact, neither the industry nor its products is likely to disappear from the global scene in the foreseeable future. Biotechnology applications for the living, biochemical, and genetic resources of the sea are numerous.[121] Roughly eighty-five companies are engaged in marine

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114. Binns & Dekker, *supra* note 37, at 96. Findings from a 1994 JOIDES drilling expedition revealed that ores from extinct sites have far less anhydrite (calcium sulfate) than active sites. *See* BROAD, THE UNIVERSE BELOW, *supra* note 3, at 269-71.

115. International Seabed Authority, *Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area*, ISA Doc. ISA/6/A/18 (2000) [hereinafter *ISA Mining Code for Nodules*].

116. *See Third Report of the ISA*, *supra* note 74, ¶ 46.

117. *1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶ 341.

118. *Id.* ¶ 342 (citing ISA, *Regulations on Prospecting and Exploration for Polymetallic Nodules*, ISA Doc. ISA/5/C/4 and Add. 1).

119. *Id.* ¶ 343. Seeking to strike an appropriate balance between developmental interests and environmental concerns, the report goes on to urge that "caution needs to be exercised so that burdensome requirements, environmental or otherwise, do not prevent this industry from coming into being altogether." *Id.*

120. "Biotechnology" has been defined as any technique that uses living organisms or parts of organisms to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. It includes, for example, recombinant DNA, cell fusion, and novel bioprocessing techniques. Congress of the United States, Office of Technology Assessment, *Commercial Biotechnology: An International Analysis*, OTA-BA-218 (1984).

121. Biliana Cicin-Sain et al., *Emerging Policy Issues in the Development of Marine Biotechnology*, *in* 12 OCEAN Y.B. 179 (1996); Rita R. Colwell, *Marine Biotechnology—A Potential Being Realized*, SEA TECH., 1995, at 27; Anne Simon Moffat, *Microbial Mining Boosts the Environment Bottom Line*, 264 SCIENCE 778 (1994);

biotechnology research and development in the United States.[122] Subjects under study include genetic, biochemical, and physiological processes of marine organisms. The benefits of marine biotechnology research may accrue to the medicinal, pharmaceutical, agricultural, food processing, and industrial sectors. Marine organisms may also be used in bioremediation and marine pollution treatments, and in the mining, mineral processing, mariculture, and aquaculture sectors.

The discovery of "extremophiles,"[123] including the ancient Archaea and a number of equally unique bacteria, which thrive under extreme conditions or in toxic concentrations of compounds like hydrogen sulfide, have opened new frontiers in applied microbiology. Enzymes (biochemical catalysts) from extremophiles are increasingly finding applications that take advantage of the enzymes' ability to operate under extreme conditions. Extremophiles and their enzymes, some of which can work at temperatures of 100°C and/or extremely low or high pH values, may have broad applications in chemical and food processing, the production of pharmaceutical products, and toxic waste reduction and processing. Japanese researchers working with the DEEPSTAR project[124] have identified microbes that thrive in toluene, benzene, and kerosene.[125] The microbes' ability to degrade crude oil and polyaromatic hydrocarbons may offer potential new methods for combating oil spills. An enzyme obtained from the *Thermoplasma* bacterium may provide a means of producing a hydrogen fuel source from glucose.[126] The needed glucose raw materials may in turn be produced from common cellulose products using an enzyme from the *Pyrococcus furiosus* ("flaming fireball") microbe. Both microbes, which together may provide an environmentally sound and economical fuel source for the future, are found at deep-sea hydrothermal vents.[127]

The commercial value of marine biotechnology applications is now attracting considerable attention.[128] Because genetically engineered microbes are generally patentable under U.S. law, the financial rewards for biotechnology applications involving hydrothermal vent microfauna are potentially quite large.[129] The *Taq*

Faye Flam, *Chemical Prospectors Scour the Seas for Promising Drugs*, 266 SCIENCE 1324 (1994); *see also* Rita R. Colwell & Jack R. Green, *Biotechnology and the Sea*, 17 OCEAN DEV. & INT'L L. 163 (1986).

122. Rita R. Colwell, *Marine Biotechnology Trends and Applications*, 107 MAR. STUD. 1, 3 (1999).

123. "Extremophiles" are organisms that exist under extreme conditions. Michael T. Madigan & Barry L. Mars, *Extremophiles*, SCI. AM., Apr. 1997, at 82.

124. "DEEPSTAR" is the acronym for the Deep-Sea Environment Exploration Program: Suboceanic Terrane Animalcule Retrieval. Frederick Shaw Meyers & Alun Anderson, *Microbes from 20,000 Feet Under the Sea*, 255 SCIENCE 28 (1992).

125. Elizabeth Pennisi, *In Industry, Extremophiles Begin to Make Their Mark*, 276 SCIENCE 705 (1997).

126. John Newell, *Send for the Slayer Archaea*, LONDON INDEPENDENT, July 28, 1996, *available at* 1996 WL 10948380.

127. *Id.*

128. Constance Holden, *Money for Extremophiles*, 275 SCIENCE 623 (1997).

129. *See* Diamond v. Chakrabarty, 447 U.S. 303 (1980) (holding that a live, human-made, genetically-engineered microorganism is patentable subject matter under 35 U.S.C. § 101, which provides for issuance

(*Thermus aquaticus*) polymerase enzyme, derived from microbes found in thermal pools in Yellowstone National Park and used in the Polymerase Chain Reaction (PCR) DNA replication method, has been the subject of a dispute over patent rights and US $80 million in annual sales.[130] A superior DNA polymerase enzyme, later named "Deep Vent," is now produced from a microbe discovered at a hydrothermal vent in 1988.[131]

Like potential mineral mining activities, biological prospecting raises complex questions over access rights and environmental impacts, potentially implicating a variety of international and national laws. For example, a controversial agreement between the U.S. government and a California biotechnology company granting the company bioprospecting rights within Yellowstone National Park was recently suspended by a federal court after an environmental NGO persuaded the court that the government had failed to meet its environmental impact assessment obligations under NEPA.[132] Moreover, the risks associated with biotechnology applications must be carefully considered if they carry a risk that potentially harmful genetically modified organisms (GMOs) could be intentionally or accidentally released into the marine environment.

E. ECO-TOURISM SUBMERSIBLE ACTIVITIES

Will future marine scientific expeditions and bioprospectors be forced to coordinate their activities with privately operated submersibles carrying eco-tourists to deep-ocean vents? Perhaps. Already, Aegraham DeepSea Voyages, a multinational firm which earlier conducted tours of the wreck of the *Titanic* in the *MIR* submersibles (reportedly for US $32,500 per person[133]), has carried a team of eco-tourists to the Rainbow hydrothermal vent site on the Mid-Atlantic Ridge.[134] The announcement provoked mixed feelings within the research community. Although eco-tourism activities could serve important public education needs, thus stimulating greater interest in, and concern for, the vent communities, unregulated dives by tour company submersibles might disrupt research activities and have a negative impact on vent organisms and their habitat.[135] Thus, although such private submersibles are unlikely to pose a significant problem in the immediate future, eco-tourism uses should be addressed in any access regime for vents accessible by such submersibles.

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of a patent to a person who invents or discovers "any" new or useful "manufacture" or "composition of matter").

130. The story of TAQ's development is told in BROAD, THE UNIVERSE BELOW, *supra* note 3, at 278-79.

131. *Id.* at 280.

132. Edmonds Inst. v. Babbitt, 42 F. Supp. 2d 1 (D.D.C. 1999) (opinion and order on cross motions for summary judgment); Colin Macilwain, *Court Suspends Pioneering Gene Deal in Yellowstone*, 398 NATURE 358 (1999).

133. Carl Levitin, *Titanic Tourists Given a 'Scientific' Identity*, 395 NATURE 417 (1998).

134. *See* Lauren Mullineaux, *Biology Working Group Update*, INTERRIDGE NEWS, Fall 1999, at 10.

135. *Id.*

IV. THE EXISTING INTERNATIONAL LEGAL FRAMEWORK

The legal framework for seabed vent sites consists principally of customary international law, the 1982 U.N. Convention on the Law of the Sea (LOSC),[136] the Convention's 1994 Part XI Implementation Agreement,[137] the rules promulgated by the ISA, and the instruments produced at the 1992 U.N. Conference on Environment and Development (UNCED).[138] These legal authorities and soft law instruments will provide the basis for analyzing the legal classification of the vents' resources and activities. Because the vents of interest are located either on one or more nation-State's continental margin,[139] the deep seabed beyond national jurisdiction, or straddle both such areas, this analysis focuses on those zones, and omits any treatment of regimes applicable only within the territorial seas or on the submerged lands lying beneath those seas.

A. 1982 U.N. CONVENTION ON THE LAW OF THE SEA

The 1982 U.N. Convention on the Law of the Sea, which entered into force in 1994, has been acclaimed by many as the most comprehensive international law project ever completed. Despite the Convention's nearly universal acceptance, the United States is not yet a party. President Reagan declared in 1983 that most of the convention provisions codify customary international law,[140] which the United States will follow; however, the United States refused to sign the Convention, citing objections to its deep-seabed mining regime. In 1994, after the U.N. General Assembly approved an "Implementation Agreement" amending the seabed mining provisions of the Convention (discussed below), President Clinton presented the LOSC and the associated Implementation Agreement to the Senate for its advice and consent.[141] For nearly seven years, the LOSC has languished there.

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136. United Nations Convention on the Law of the Sea, *opened for signature* Dec. 10, 1982, U.N. Doc. A/CONF.62/122 (1982), 1833 U.N.T.S. 397 [hereinafter LOSC], *reprinted in* OFFICIAL TEXT OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA WITH ANNEXES AND INDEX, U.N. Sales No. E.97.V.10 (1997).

137. *Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982*, G.A. RES. 263, U.N. GAOR, 48th Sess., Supp. No. 49A, at 7, U.N. Doc. A/RES/48/263/Annex (1994) [hereinafter Part XI Implementation Agreement], *reprinted in* UNITED NATIONS, OFFICIAL TEXT OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA WITH ANNEXES AND INDEX, U.N. Sales No. E.97.V.10 (1997).

138. *See generally* THE EARTH SUMMIT: THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED) (Stanley P. Johnson ed., 1992).

139. The continental margin includes the continental shelf, continental slope, and continental rise. *See* LOSC, *supra* note 136, art. 76(3).

140. *See* Ocean Policy Statement, *supra* note 91; *see also* Jonathan I. Charney, *U.S. Provisional Application of the 1994 Deep Seabed Agreement, in Law of the Sea Forum: The 1994 Agreement on Implementation of the Seabed Provisions of the Convention on the Law of the Sea*, 88 AM. J. INT'L L. 687, 705 (1994); RESTATEMENT (THIRD) FOREIGN RELATIONS LAW OF THE UNITED STATES pt. V, intro. note at 5-9 (1987) [hereinafter RESTATEMENT].

141. The President forwarded the Convention and the Part XI Implementation Agreement to the Senate for its advice and consent on October 7, 1994. *President's Message to Congress Transmitting United Nations*

The position of the United States, as a non-party to the LOSC, with respect to the deep seabed provisions in Part XI of the Convention, is not entirely clear. The United States has never asserted that Part XI represents customary international law. Indeed, in rejecting the Convention in 1982, President Reagan was particularly critical of the Part XI seabed mining regime.[142] A decade later, however, the United States became a leader in efforts to reform Part XI of the Convention, and ultimately signed the 1994 Part XI Implementation Agreement produced by the reformers.[143] However, the United States has not yet ratified the Agreement. Under customary law, as reflected in Article 18 of the Vienna Convention on the Law of Treaties, the United States appears to be under a legal obligation not to defeat the object and purpose of the Part XI Implementation Agreement unless it makes its intention "clear" that it will not become a party to the Agreement.[144] On the other hand, the Part XI Implementation Agreement expressly provides that no nation is bound by the Agreement unless it also bound by the LOSC. It may be argued, therefore, that because the United States is not a party to the LOSC, it cannot be held to the obligation otherwise recognized in Article 18 of the Vienna Convention on the Law of Treaties respecting the Part XI Agreement.[145]

1. Regime for Conducting Marine Scientific Research and Technology Transfer

Recognizing the need to promote better understanding of the oceans and their processes, Part XIII of the LOSC prescribes an extensive regime for the conduct of marine scientific research (MSR).[146] To appreciate the balance struck by the convention's MSR regime, it is important to bear in mind that not all nations consider all MSR activities to be universally beneficial. Some developing nations view MSR as the nearly exclusive province of a few developed nations—one that is often conducted solely for the benefit of the sponsoring nations.[147] Accordingly, the LOSC articles on MSR

Convention on the Law of the Sea, with Annexes, Dec. 10, 1982, S. TREATY DOC. 39, 103d Cong., 2d Sess. (1994), *reprinted in* 34 I.L.M. 1309.

142. *See id.*; *see also* Ocean Policy Statement, *supra* note 91.

143. *See generally* LAWRENCE JUDA, INTERNATIONAL LAW AND OCEAN USE MANAGEMENT 256-58 (1996).

144. Vienna Convention on the Law of Treaties, *opened for signature* May 23, 1969, art. 18, U.N. Doc. A/CONF.39/27 (1969), 1155 U.N.T.S. 331 [hereinafter Vienna Convention] (providing that a State is obliged to refrain from acts which would defeat the object and purpose of a treaty when it has signed the treaty, subject to later ratification, unless and until it makes its intention clear not to become a party to the treaty, or it has expressed its consent to be bound by the treaty pending its entry into force).

145. *See* Part XI Implementation Agreement, *supra* note 137, art. 4(2) (providing that no State may establish its consent to be bound by the Implementation Agreement unless it has previously established, or establishes at the same time, its consent to be bound by the LOSC).

146. *See* LOSC, *supra* note 136, pt. XIII; *see generally* ALFRED A.H. SOONS, MARINE SCIENTIFIC RESEARCH AND THE LAW OF THE SEA (1982); U.N. Office for Ocean Affairs and the Law of the Sea, *Marine Scientific Research: A Guide to Implementation of the Relevant Provisions of the United Nations Convention on the Law of the Sea*, U.N. Sales No. E.91.V.3 (1991) [hereinafter MSR IMPLEMENTATION GUIDE].

147. *See* ROBIN R. CHURCHILL & ALAN V. LOWE, THE LAW OF THE SEA 403-04 (3d ed. 1999); George Cadwalader, *Freedom for Science in the Oceans*, 182 SCIENCE 15, 18 (1973).

represent a compromise, generally encouraging MSR, while at the same time qualifying the right to engage in MSR activities in coastal State waters or on their continental shelves on actual or tacit coastal State consent. The consequences for oceanographers and for progress in marine science are less than ideal.

Under the LOSC, all States have a duty to facilitate MSR and to promote international cooperation in such activities.[148] As with other "uses" of the oceans and seabed, the LOSC provisions for MSR generally adopt a "zonal" approach, under which respective State rights and obligations vary according to the location of the activity. All such MSR activities are, however, subject to Part XII of the Convention, which establishes the obligation for all States to protect and preserve the marine environment. Some have concluded that the provisions of Part XIII of the LOSC (and the Convention on Biological Diversity) limit the extent to which one can acquire intellectual property claims from MSR in areas beyond national jurisdiction,[149] a question examined briefly in Part V of this article.

The right to engage in MSR in the waters of the high seas is expressly recognized under the 1982 Convention, subject to relevant restrictions in Parts VI and XII of the Convention.[150] Such MSR activities are limited to those designed for peaceful purposes and must be conducted in compliance with regulations adopted in conformity with the Convention, including those for the protection and preservation of the marine environment.[151] MSR on the deep seabed beyond national jurisdiction (the Area) is subject to Part XI of the Convention, which requires that such MSR activities be carried out for the common benefit of all mankind.[152] Moreover, the Convention requires all States to promote international cooperation in MSR in the Area by effectively disseminating the results of research and analysis when available, through the International Seabed Authority or other international channels.[153] Under Article 143 of the LOSC, the ISA has a duty to promote and encourage MSR in the Area, and to coordinate and disseminate the results of that research when available. Although the ISA is

148. LOSC, *supra* note 136, arts. 239, 242.

149. Montserrat Gorina-Ysern, *Marine Scientific Research Activities as the Legal Basis for Intellectual Property Claims?* 22 MAR. POL'Y 337, 338-40 (1998); *see also* Ian Walden, *Preserving Biodiversity: The Role of Property Rights*, *in* INTELLECTUAL PROPERTY RIGHTS AND THE BIODIVERSITY CONVENTION 176 (Timothy Swanson ed., 1995); Ian Walden, *Intellectual Property Rights and Biodiversity*, *in* INTERNATIONAL LAW AND THE CONSERVATION OF BIOLOGICAL DIVERSITY 171 (Michael Bowman & Catherine Redgwell eds., 1995).

150. LOSC, *supra* note 136, art. 87; RESTATEMENT, *supra* note 140, § 521, cmt. h. Although MSR was not one of the enumerated high seas freedoms in article 2 of the 1958 Convention on the High Seas, the International Law Commission concluded that MSR was a recognized high seas freedom. *See Report of the International Law Commission to the General Assembly*, U.N. GAOR, 8th Sess., Supp. (No. 9), art 27, ¶ 2, U.N. Doc. A/CN.4/Ser.A/1956/Add.1 (1956) (noting that the Commission was aware that there exist high seas freedoms other than those enumerated in Article 2 of the 1958 Convention on the High Seas, "such as the freedom to undertake scientific research on the high seas"), *reprinted in* [1956] 2 Y.B. INT'L L. COMM'N 276, 278; *see generally* 4 MARJORIE M. WHITEMAN, DIGEST OF INTERNATIONAL LAW, ch. X, § 2 (1963).

151. LOSC, *supra* note 136, art. 240.

152. *Id.* art. 143(1).

153. *Id.* art. 143(3).

authorized by the Convention to conduct MSR activities in the Area, it does not have jurisdiction over MSR activities conducted by others.[154] If, however, research activities take the form of prospecting or exploring for, or exploiting, the mineral resources of the Area, such activities fall within the regulatory ambit of the ISA.[155]

Coastal States have the exclusive right to regulate MSR activities that involve seafloor drilling anywhere on their juridical continental shelf.[156] More generally, coastal State consent is required for any MSR within its exclusive economic zone or on its continental shelf.[157] The consent regime favors "pure" research over "applied" research.[158] Generally, coastal States are obliged to grant consent for pure scientific research in their EEZ or on their continental shelves, but they may withhold consent for research projects of direct significance for the exploration and exploitation of natural resources.[159] It is not entirely clear whether "bio-prospecting"[160] will fall within the MSR regime or within the articles governing the exploration and exploitation of living marine resources. The question is taken up in Part V of this article.

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154. *Id.* arts. 143(2) & (3). Such activities must, however, be "developed through the Authority or other international organizations as appropriate for the benefit of developing States and technologically less developed States . . ." *Id.* art. 143(3).

155. Exploring for and exploiting mineral resources in the Area constitute "activities in the Area." *See id.* art. 1(3). Although "prospecting" for mineral resources is not an "activity in the Area," it is nevertheless regulated by the ISA. *See id.* Annex III, arts. 2-3; *see also ISA Mining Code for Nodules*, *infra* note 115, reg. 1(a), (b) & (e) (defining prospecting, exploring and exploitation).

156. LOSC, *supra* note 136, art. 81; RESTATEMENT, *supra* note 140, § 515, cmt. d.

157. LOSC, *supra* note 136, art. 56 (coastal State jurisdiction over MSR in EEZ); *id.* art. 246(1) (continental shelf); *see also* RESTATEMENT, *supra* note 140, § 514, cmt. h (MSR within EEZ) & § 515, cmt. d & note 2 (MSR on the continental shelf). In proclaiming its EEZ in 1983, the United States declined to assert jurisdiction over MSR activities within the EEZ. *See* Ocean Policy Statement, *supra* note 91. Very few nations followed the U.S. example. See JUDITH FENWICK, INTERNATIONAL PROFILES ON MARINE SCIENTIFIC RESEARCH 182, 184, tbl. 5 (1992) (finding that of 116 nations that assert jurisdiction over MSR activities in their coastal waters, only 9 limit such jurisdiction to 12 NM or less).

158. LOSC, *supra* note 136, art. 246(5). The LOSC does not use the terms "pure" or "applied" research. It does, however, distinguish between research carried out "exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind," *id.* art. 246(3), and MSR activities that are of "direct significance for the exploration and exploitation of natural resources." *Id.* art. 246(5)(a); *see also* MSR IMPLEMENTATION GUIDE, *supra* note 146, at 12 (concluding that the latter phrase refers to projects "which can reasonably be expected to produce results enabling resources to be located, assessed and monitored with respect to their status and availability for commercial exploitation"). The distinction may not be easy to apply in practice. *See* CHURCHILL & LOWE, *supra* note 147, at 402 (observing that "[w]hat may begin and may be intended as 'pure' research may, once the research has actually been undertaken and its results analyzed, turn out to have significant practical application"); *see also id.* at 406 (concluding that the distinction is clearer under the 1982 LOSC).

159. LOSC, *supra* note 136, art. 246(5). The coastal State may withhold its consent on other grounds as well. *See id.* art. 246(5)(b)–(d).

160. "Bioprospecting" may be an unfortunate term in this context. Within the deep seabed mineral regime, "prospecting" generally refers to activities that precede exploration and exploitation, both of which require consent by the ISA. *See* LOSC, *supra* note 136, Annex III, art. 2; CHURCHILL & LOWE, *supra* note 147, at 248. The term "bioprospecting" is not used in the LOSC.

MSR activities within another nation's waters must be carried out in a manner to avoid unjustifiably interfering with the coastal State's exercise of its sovereign rights in their EEZ,[161] and in accordance with the obligations imposed by the LOSC and the coastal State.[162] The coastal State may require, for example, that it be allowed to participate in the research, that it be provided with copies of the research reports, that it be provided access to all data and samples and an assessment of those samples or data, that any installations or equipment installed for the project be removed upon completion of the research, and that the research results be made available internationally as soon as practicable.[163] At the same time, the Convention recognizes the right of the coastal State to condition access for MSR in its EEZ or on its continental shelf on an agreement by the researchers to withhold publication of any research results of a project of direct significance for the exploration and exploitation of natural resources.[164]

All States enjoy the right to lay submarine cables across another nation's continental shelf,[165] including those for use in MSR activities such as the proposed NEPTUNE project. However, a coastal State over whose continental shelf the cables are laid may require that such cable projects comply with reasonable measures to facilitate exploration of the shelf and exploitation of the coastal State's resources and to protect the marine environment.[166] Presumably, that would include such coastal State laws as the U.S. National Environmental Policy Act,[167] Coastal Zone Management Act,[168] Marine Mammal Protection Act,[169] and the Endangered Species Act.[170]

The LOSC articles prescribing the MSR regime must be read in conjunction with Part XIV of the Convention, which prescribes a framework for transferring technology for the benefit of developing nations. Under the LOSC, States are to cooperate in promoting the development and transfer of marine science and

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161. *Id.* art. 246(8).

162. *See id.* arts. 240, 248-250.

163. *Id.* art. 249(1).

164. *Id.* art. 249(2).

165. *Id.* art. 79. The right extends to laying submarine pipelines as well, though pipelines are subject to greater coastal State control. *See id.* art. 79(3) (coastal State consent required for delineation of the course of pipelines).

166. *Id.* art. 79(2).

167. *See* 42 U.S.C. § 4332 (1994) (requiring a detailed assessment of the environmental impacts of any major federal action which may significantly affect the quality of the human environment); *see also* Exec. Order No. 12,114 § 2-3(a), 44 Fed. Reg. 65,560 (1979), 3 C.F.R. 356, 357 (1980) (requiring NEPA compliance in cases where "major Federal actions significantly affecting the environment of the global commons outside the jurisdiction of any nation (e.g., the oceans or Antarctica)"); Environmental Defense Fund, Inc. v. Massey, 986 F.2d 528 (D.C. Cir. 1993) (holding that E.O. 12,114 extends NEPA to a federal project in Antarctica).

168. *See* 16 U.S.C. § 1456(c)-(d) (1994).

169. *See* 16 U.S.C. §§ 1361-1421h (1994).

170. *See, e.g.*, 16 U.S.C. § 1536(a)(2) (1994) (requiring ESA Section 7 consultation to ensure that any action authorized, funded or carried out by a federal agency does not jeopardize the continued existence of any endangered or threatened species or its critical habitat).

technology on fair and reasonable terms and conditions.[171] Toward that end, States are to promote the establishment of guidelines, criteria, and standards for marine technology transfer.[172] In promoting cooperation in marine technology transfer, States are to have due regard for all legitimate interests, including the rights and duties of holders, suppliers, and recipients of marine technology.[173] Measures to promote technology transfer may include technical cooperation programs, exchanges of scientists and technologists, public conferences, and establishment of marine science and technological research centers.[174]

2. Regime for Non-Living Marine Resources

The LOSC establishes distinct legal frameworks for access to non-living marine resources (NLMRs) within and beyond areas of national jurisdiction. Exploration and exploitation of NLMRs on the seabed or subsoil within areas of national jurisdiction may be governed by either the continental shelf or EEZ regimes. Activities beyond national jurisdiction are governed by Part XI of the Convention, as modified by the 1994 Part XI Implementation Agreement.[175]

a. Regime for Mining Within National Jurisdiction

It is often said that the modern ocean enclosure movement, through which coastal States asserted jurisdiction or even sovereignty over ever increasing areas of the ocean, began with the Proclamation on the Continental Shelf issued by President Truman in 1945.[176] In the Proclamation, the United States asserted "jurisdiction and control" over the natural resources of the adjacent continental shelf.[177] The U.S. continental shelf claim was widely followed, even exceeded,

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171. LOSC, *supra* note 136, art. 266.

172. *Id.* art. 271.

173. *Id.* art. 267.

174. *Id.* arts. 269, 275-277. *See generally* Krishan Saigal, *Regional Centres for Marine Science and Technology*, *in* OCEAN GOVERNANCE: SUSTAINABLE DEVELOPMENT OF THE SEAS 183-93 (Peter Payoyo ed., 1994) (examining regional centers established pursuant to articles 276 and 277). Since 1961, international exchange is facilitated through the UNCESCO Intergovernmental Oceanographic Commission's International Oceanographic Data and Information Exchange System. *See About IODE, available at* http://ioc.unesco.org/iode/ (last visited June 21, 2000).

175. Part XI Implementation Agreement, *supra* note 137. For a commentary, see Bernard H. Oxman, *The 1994 Agreement and the Convention, in Law of the Sea Forum: The 1994 Agreement on Implementation of the Seabed Provisions of the Convention on the Law of the Sea*, 88 AM. J. INT'L L. 687 (1994).

176. Proclamation No. 2667, 3 C.F.R. 67 (1943-1948 Comp.), *and in* 59 Stat. 884 [hereinafter Continental Shelf Proclamation]; *see also* Statement Accompanying Continental Shelf Proclamation, *reprinted in* 13 U.S. DEP'T OF ST. BULL. 484 (1945); *see generally* 4 WHITEMAN, DIGEST OF INTERNATIONAL LAW, *supra* note 150, at 752-64.

177. Continental Shelf Proclamation, *supra* note 176; *see generally* Ann L. Hollick, *U.S. Oceans Policy: The Truman Proclamations*, 17 VA. J. INT'L L. 23 (1976). The U.S. offshore mining regime was implemented principally by the Outer Continental Shelf Lands Act of 1953, 43 U.S.C. §§ 1331-1338 & 1340-1356 (1994 & Supp. III 1997).

by other coastal States and was substantially codified by the 1958 Convention on the Continental Shelf.[178]

The 1982 LOSC, which supersedes the 1958 Geneva Conventions on the Law of the Sea, including the Convention on the Continental Shelf,[179] recognizes a coastal State's sovereign right to explore the continental shelf and exploit its natural resources.[180] The natural resources contemplated by the shelf regime include mineral and other non-living resources of the seabed and subsoil, along with sedentary species of living resources.[181] As a matter of international law, the State's rights in the continental shelf do not depend on proclamation, legislation, or occupation.[182] The coastal States' continental shelf rights are exclusive in that if the State does not explore the shelf or exploit its resources no other State may do so without the coastal State's consent.[183] It follows that such activities are subject to any relevant law governing continental shelf activities enacted by the coastal State.[184]

Under the LOSC (and customary law[185]), a nation's juridical continental shelf begins at the outer limit of the territorial sea[186] and extends seaward for a distance of at least 200 nautical miles (NM) from the baseline.[187] Additionally, under Article 76 of the Convention (and, at least in the opinion of the United States, customary law[188]), if a State's geologic continental margin

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178. Convention on the Continental Shelf, *done* at Geneva, Apr. 29, 1958, 15 U.S.T. 471, T.I.A.S. No. 5578, 499 U.N.T.S. 311.

179. *See* LOSC, *supra* note 136, art. 311(1).

180. *Id.* art. 77; *see also* RESTATEMENT, *supra* note 140, § 515.

181. LOSC, *supra* note 136, art. 77(4).

182. *Id.* art. 77(3); *see also* Cases (F.R.G. v. Den./F.R.G. v. Neth.) 1969 I.C.J. 3, 23 (Feb. 20). State action is, however, required to perfect continental shelf claims extending more than 200 nautical miles (NM) from the baseline. *See* LOSC *supra* note 136, art. 76(8) & Annex II. Such claims must be submitted to the Commission on the Limits of the Continental Shelf not later than 10 years from the Convention's entry into force for that State. *Id.* Annex II, art. 4.

183. LOSC, *supra* note 136, art. 77(2); RESTATEMENT, *supra* note 140, § 515, cmt. b; *cf.* United States v. Ray, 423 F.2d 16, 21-22 (5th Cir. 1970) (applying the 1958 Convention on the Continental Shelf and holding that consent of the United States is required to construct an artificial island on corals reefs located on the U.S. continental shelf).

184. Within the United States, the relevant laws include, for example, the Outer Continental Shelf Lands Act, *supra* note 177, and, with respect to applicable living marine resources, the Magnuson-Stevens Fishery Conservation and Management Act, 16 U.S.C. §§ 1801-1883 (1994) [hereinafter "MSA"].

185. *See* Continental Shelf (Libyan Arab Jamahiriya v. Malta), 1985 I.C.J. 13, 29-36 (June 3).

186. The coastal State is sovereign over the submerged lands beneath the State's territorial sea. *See* LOSC, *supra* note 136, art. 2. Accordingly, such submerged lands are not included within the juridical continental shelf. *See id.* art. 76(1). Within the United States, the adjacent states have title to the submerged lands lying beneath the seas within three miles. *See* Submerged Lands Act of 1953, 43 U.S.C. § 1311 (1994).

187. *Id.* art. 76(1); *see also* Continental Shelf Case, 1985 I.C.J. at 33 (recognizing, as a matter of customary law, coastal State's sovereign rights to natural resources of a juridical continental shelf out to a minimum of 200 NM, regardless of the geologic extent).

188. *See* ASHLEY ROACH & ROBERT W. SMITH, UNITED STATES RESPONSES TO EXCESSIVE MARITIME CLAIMS 201-03 (2d ed. 1996) (quoting United States Policy Governing the Continental Shelf of the United States of America, Attachment to Memorandum from John D. Negroponte, Assistant Secretary, to

extends more than 200 NM from the baseline, as does the U.S. margin in several areas,[189] the State may extend its continental shelf claim beyond the presumptive 200 NM limit.[190] Under such circumstances, however, the coastal State is, with limited exceptions, obliged to share the revenues generated by exploitation of the continental shelf resources beyond 200 NM with the international community.[191] Moreover, the coastal State may not withhold its consent to marine scientific research on the shelf beyond 200 NM on the ground that the project is of direct significance for the exploration and exploitation of natural resources, unless exploration or exploitation has already begun in the area, or will begin within a reasonable time.[192] Finally, any activities in the superjacent waters beyond 200 NM fall within the Convention's high seas articles.[193]

In addition to any rights obtained under the 1982 LOSC's continental shelf regime, coastal States possess the sovereign right to explore and exploit the seabed, subsoil, and superjacent waters within an exclusive economic zone (EEZ) up to 200 NM seaward of the baseline.[194] The continental shelf and EEZ regimes will overlap in respect of coverage for natural resources of the seabed or subsoil out to the 200 NM limit in those nations that claim EEZ rights out to that distance.[195] Although the President of the United States proclaimed, as a matter of international law, an EEZ extending 200 NM seaward in 1983,[196] Congress has yet to enact implementing legislation.

Elizabeth Verville, Deputy Legal Advisor (Nov. 17, 1987), State Dept. File No. P89 0140-0428). *But see* Ted L. McDorman, *The Entry into Force of the 1982 LOSC and the Article 76 Outer Continental Shelf Regime*, 10 INT'L MARINE & COASTAL L. J. 165, 165 & n.10 (1995) (concluding that "[i]t is difficult to accept that either the technical criteria of Article 76 or the formal processes of the provision have emerged as customary international law").

189. The U.S. continental margin arguably extends more than 200 NM from the baseline in areas of the Bering Sea off Alaska, two areas of the Gulf of Mexico and in the southeast region of the Blake Plateau. *See* Statement of Otho E. Eskin, U.S. Dept. of State, Office of Law & Policy, *quoted in* 24(3) OCEAN SCI. NEWS 1 (Jan. 18, 1982).

190. LOSC, *supra* note 136, art. 76(2)–(10). Article 76 imposes several limits on claims beyond 200 NM. First, no State claim may extend more than 350 NM seaward from the baseline or 100 NM seaward of the 2500-meter isobath, whichever is further. To avoid any claims out to, for example, the Mid-Atlantic Ridge and similar ridges in other oceans, the Convention provides that the coastal State must observe the 350 NM limit, and may not assert a greater claim based on the 2500M isobath-plus-100 NM alternative. *Id.* art. 76(6); RESTATEMENT, *supra* note 140, § 511, n. 8; Bernard H. Oxman, *The Third United Nations Conference on the Law of the Sea: The Eighth Session*, 74 AM. J. INT'L L. 1, 19-22 (1979).

191. LOSC, *supra* note 136, art. 82; RESTATEMENT, *supra* note 140, § 515, cmt. a.

192. LOSC, *supra* note 136, art. 246(6); RESTATEMENT, *supra* note 140, § 515, cmt. a.

193. LOSC, *supra* note 136, art. 78(1).

194. *Id.* art. 56; RESTATEMENT, *supra* note 140, § 514. The EEZ regime has become part of customary law. Continental Shelf (Libyan Arab Jamahiriya v. Malta) 1985 I.C.J. 13, 33 (June 3).

195. See RESTATEMENT, *supra* note 140, § 511, cmts. c & j, & § 515, cmt. a; CHURCHILL & LOWE, *supra* note 147, at 145.

196. Proclamation No. 5030, 48 Fed. Reg. 10,601 (March 10, 1983), *reprinted in* 3 C.F.R. 2 (1983 Comp.).

b. Regime for Mining Beyond National Jurisdiction

The LOSC defines "the Area" as the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction.[197] Part XI of the Convention declares that the Area and its resources are the "Common Heritage of Mankind" (CHM).[198] The Convention fails, however, to fully define the contours of the CHM concept. "Resources" of the Area include "all solid, liquid or gaseous mineral resources *in situ* in the Area at or beneath the seabed, including polymetallic nodules"; however, living marine resources are not included.[199] No State may claim or exercise sovereignty or sovereign rights over any part of the Area or its resources, nor may any State or private entity appropriate any part of the Area or its resources, except as provided by the Convention.[200] "Activities" within the Area—defined by the Convention as "all activities of exploration for, and exploitation of, the resources of the Area"[201]—come under the jurisdiction of the Authority.[202] Such activities shall be carried out for the common benefit of all mankind[203] and exclusively for peaceful purposes.[204]

The LOSC charges the ISA with developing rules to implement the deep seabed mining regime established by Part XI of the Convention.[205] In carrying out its implementation responsibilities, the ISA has prepared and approved regulations for prospecting and exploration for polymetallic nodules, which include a set of guidelines for the assessment of possible environmental impacts arising from the exploration for polymetallic nodules.[206] The guidelines, which are based on the current state of scientific knowledge and will be reviewed periodically, are intended to assist contractors in preparing a "plan of work" for environmental monitoring.[207] The ISA also began preparation of regulations for prospecting and exploration for polymetallic sulfides in 2000.[208]

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197. LOSC, *supra* note 136, art. 1(1); *see also* Wesley S. Scholz, *The Law of the Sea Convention and the Business Community: The Seabed Mining Regime and Beyond*, 7 GEO. INT'L ENVTL. L. REV. 675 (1995).

198. LOSC, *supra* note 136, art. 136.

199. *Cf. id.* art. 133(a). Part XI does, however, authorize measures for the prevention of damage to the flora and fauna of the marine environment. *Id.* art. 145(b).

200. *Id.* art. 137(1), (3).

201. *Id.* art. 1(3).

202. The "Authority" is the International Seabed Authority. *Id.* art. 1(2).

203. *Id.* art. 140.

204. *Id.* art. 141. The principle was established by U.N. General Assembly Resolution 2750 on December 17, 1970. G.A. Res. 2750 (XXV), U.N. GAOR, 25th Sess., Supp. No. 28, U.N. Doc. A/8028 (1970).

205. *See generally id.* Annex III; 1994 Part XI Implementation Agreement, *supra* note 137, Annex, § 1, ¶¶ 5(f), 5(g) & 15; Michael J. Cruickshank, *Law of the Sea and Minerals Development*, 13 OCEAN Y.B. 80 (1998).

206. *See supra* note 115 and accompanying text.

207. 1994 Part XI Implementation Agreement, *supra* note 137, Annex, § 1, ¶ 7. The guidelines describe the procedures to be followed by contractors in acquisition of baseline data, monitoring exploration activities and in reporting on those activities to the ISA.

208. *See 1999 U.N. S-G Report on Oceans & Law of the Sea*, *supra* note 53, ¶ 341.

3. Regime for Living Marine Resources

The LOSC generally adopts a zonal approach to questions of access to, and conservation and management of, living marine resources (LMRs), under which the nature of the regime varies by the location of the activity.[209] It will be seen, however, that the Convention's treatment of LMRs principally addresses only those resources that have been traditionally harvested, such as finfish, shellfish, and certain "sedentary species," and does not directly address microbes, such as vent bacteria or archaea.

a. LMRs Within Areas of National Jurisdiction

At least as early as 1958, international law recognized certain coastal State rights over living resources within and beyond the territorial sea. In that year, two of the four Geneva Conventions on the Law of the Sea provided for coastal State sovereignty over the territorial sea and its resources,[210] and sovereign rights over sedentary species on the adjacent continental shelf.[211] "Sedentary species" were defined in the 1958 Convention on the Continental Shelf as "organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil."[212]

The 1982 LOSC articles governing LMRs within areas subject to national jurisdiction carry forward the distinction between sedentary species, which are governed by the convention's continental shelf regime, and all other LMRs, which are governed by the high seas or EEZ articles, as applicable. Article 77(1) of the 1982 Convention establishes the coastal State's sovereign rights over the continental shelf for the purpose of exploring it and exploiting its natural resources, including living sedentary species of the shelf.[213] Similarly, article 56 provides that coastal States have sovereign rights over the living and non-living

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209. For a discussion of zonal and functional approaches, see CHURCHILL & LOWE, *supra* note 147, at 1.

210. Convention on the Territorial Sea and Contiguous Zone, *done* at Geneva, Apr. 29, 1958, 15 U.S.T. 1606, 516 U.N.T.S. 205. Article 1 of the Convention recognizes the sovereignty of the coastal State over its territorial sea, subject to a right of innocent passage. Article 14(5) makes clear that fishing is not an incident of innocent passage.

211. Convention on the Continental Shelf, *supra* note 179, art. 2 (recognizing coastal State sovereign rights in sedentary species of the adjacent continental shelf).

212. *Id.* art. 2(4); *see also* 4 WHITEMAN, DIGEST OF INTERNATIONAL LAW, *supra* note 150, at 856-64 (discussing controversy over the definition). Positions varied from that of Iceland, which advocated that all continental fishery resources be included within the continental shelf regime, to Japan, which sought to exclude all living resources. *See* JUDA, *supra* note 143, at 149. Intermediate States, such as Mexico, Yugoslavia and Burma, advocated that all bottom fish be included. *Id.* at 149-50. The U.S. Outer Continental Shelf Lands Act, written in 1953, defines "natural resources" as "oil, gas, and all other minerals, and fish, shrimp, oysters, clams, crabs, lobsters, sponges, kelp, and other marine animal and plant life but does not include water power, or the use of water for the production of power." 43 U.S.C. § 1301(e) (1994).

213. LOSC, *supra* note 136, art. 77(4).

natural resources within their EEZ, including the seabed, subsoil and superjacent waters.[214] Because they fall within the continental shelf regime, sedentary species are expressly excluded from the EEZ regime.[215] In exercising its sovereign rights over natural resources within the EEZ or on the continental shelf, the coastal State has a corresponding duty to protect and preserve the marine environment.[216]

The LOSC makes two key distinctions between LMRs under the EEZ and continental shelf regimes. Under the EEZ regime, coastal States have a qualified duty to manage and conserve their LMRs, and to grant other States access to harvest any surplus.[217] By contrast, the Convention imposes no affirmative conservation and management obligations on the coastal States in the exercise of their sovereign rights over LMRs falling within the continental shelf regime, nor does the Convention require such States to grant access to any unharvested surplus.[218] Finally, under those circumstances in which a coastal State's continental shelf claim legitimately extends beyond 200 NM, the provisions that require the coastal State to share a portion of the proceeds from the exploitation of non-living natural resources beyond the 200 NM limit do not apply to LMRs.[219] It is important to note, however, that any coastal State claim to LMRs of the hydrothermal vent communities on the juridical continental shelf beyond 200 NM will be legitimate only to the extent that such resources fall within the convention's definition of sedentary species. Application of the sedentary species test to vent resources is analyzed in Part V.

b. LMRs on the High Seas and Deep Seabed

The conferees to the First U.N. Conference on the Law of the Sea (UNCLOS I) in Geneva in 1958 addressed LMRs of the high seas in two separate conventions.[220] The Convention on the High Seas preserved the traditional freedom of fishing on the high seas,[221] while the Convention on

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214. *Id.* art. 56.

215. *See id.* art. 68 (providing that Part V "does not apply to sedentary species as defined in article 77, paragraph 4").

216. *See id.* art. 193.

217. *See id.* arts. 61, 62.

218. *See id.* art. 77(2) (providing that the coastal States rights "are exclusive in the sense that if the coastal State does not explore the continental shelf or exploit its natural resources, no one may undertake these activities without the express consent of the coastal State"); RESTATEMENT, *supra* note 140, § 515, cmt. b.

219. *See* LOSC, *supra* note 136, art. 82 (requiring coastal State to make payments or contributions to the Authority in respect of the exploitation of non-living resources of the shelf beyond 200 NM of the baseline).

220. Convention on the High Seas, Apr. 29, 1958, 13 U.S.T. 2312, T.I.A.S. No. 5200, 450 U.N.T.S. 82 (entered into force on Sept. 30, 1962) [hereinafter 1958 Convention on the High Seas]; Convention on Fishing and Conservation of the Living Resources of the High Seas, *done* at Geneva, Apr. 28, 1958, 17 U.S.T. 138, T.I.A.S. No. 5969, 559 U.N.T.S. 285 [hereinafter 1958 Convention on High Seas Fishing].

221. 1958 Convention on the High Seas, *supra* note 220, art. 2(2).

High Seas Fishing required high seas fishing States to "cooperate" in conservation and management of fishery stocks.[222] At the same time, the Convention on High Seas Fishing recognized that coastal States have a "special interest" in LMRs of the high seas adjacent to their territorial sea.[223] The effect of the Convention on High Seas Fishing was, however, limited by the fact that few fishing nations ratified it.

The 1982 LOSC's provisions for LMRs of the high seas effected a number of improvements over the regime codified in the 1958 Geneva Conventions on the Law of the Sea; however, even the 1982 Convention falls short of a comprehensive scheme for conserving and managing living marine resources beyond national jurisdiction. "Fishing" has long been considered one of the traditional high seas freedoms.[224] However, neither the 1958 nor the 1982 conventions defines "fish" or "fishing" in describing the freedom. Interestingly, the 1982 Convention prescribes duties with respect to a broader category of resources in Articles 117 to 119. Each of those articles imposes obligations with respect to "living marine resources," presumably, a class that includes more than just fish. The application of those provisions to research or exploitation of vent LMRs on the seabed or superjacent waters is analyzed in Part V.

The LOSC approach to LMRs of the high seas rests on very different philosophical underpinnings than does the regime for NLMRs (mineral resources) of the deep seabed. Living marine resources have long been considered subject to appropriation and ownership under the rule of capture, in accordance with the limitations in the Convention, including the obligation to conduct the activities with due regard to the rights of other nations.[225] By contrast, the mineral resources of the deep seabed (and the seabed itself) are now deemed to be the common heritage of humankind and may not be appropriated, except in accordance with Part XI of the Convention.[226] Some have argued that the common heritage concept presently includes, or should be expanded to include, sedentary species and genetic resources of the deep seabed.[227] The legal merits of the argument are taken up in Part V.

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222. *Id.* art. 4.

223. 1958 Convention on High Seas Fishing, *supra* note 220, art. 6(1).

224. HUGO GROTIUS, MARE LIBERUM (1609), *translated in* RALPH VAN DEMAN MAGOFFIN, THE FREEDOM OF THE SEAS: A DISSERTATION BY HUGO GROTIUS (1916); 1958 Convention on the High Seas, *supra* note 220, art. 2(2); LOSC, *supra* note 136, arts. 87, 116-120.

225. Professors McDougal and Burke differentiate such inclusive regimes by degree, and concluded that the freedom to fish on the high seas is the most consequential inclusive claim. MCDOUGAL & BURKE, *supra* note 51, at 924.

226. LOSC, *supra* note 136, art. 137.

227. *See* BORGESE, THE OCEANIC CIRCLE, *supra* note 6, 188, 198 (proposing a revision to Article 133 of the LOSC).

4. Regime for Protection of the Marine Environment

The LOSC imposes an obligation on all States to protect and preserve the marine environment.[228] It expressly requires all States to cooperate on a regional and global basis, directly or through competent international organizations, to formulate international rules and standards to prevent, reduce, and control pollution.[229] The coastal State's jurisdiction over pollution prevention and control in its adjacent waters varies both spatially and by the nature of the source of the pollutant. Within its EEZ, a coastal State has jurisdiction to prescribe and enforce measures to protect and preserve the marine environment.[230] The parties are obligated to take measures necessary to preserve and protect rare or fragile ecosystems and the habitat of depleted, threatened, or endangered species or other forms of marine life.[231] The Convention permits the coastal State to prescribe stricter standards for particularly sensitive sea areas (PSSAs), that is, for a particular, clearly defined area within the EEZ where the adoption of special mandatory measures for the prevention of pollution from vessels is required by oceanographic and ecological conditions.[232] Vessel restrictions pursuant to the PSSA regime may complement a broader marine protected area (MPA) designation, which contemplates all relevant resource activities and pollution sources.[233] It should be noted, however, there is presently no legal authority to establish MPAs on the high seas beyond the limits of national jurisdiction.

Article 145 of the LOSC addresses particular requirements to protect the marine environment from harm by "activities" in the Area. It requires the ISA to adopt appropriate rules, regulations, and procedures to prevent pollution and other hazards to the marine environment,[234] protect and conserve natural resources of the Area, and prevent damage to the flora and fauna of the marine environment. Any "plan of work" submitted to the Authority by a seabed miner must be accompanied by an assessment of the potential environmental impacts of the proposed activities and a description of a program for oceanographic and baseline environmental studies in accordance with the rules adopted by the

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228. LOSC, *supra* note 136, art. 192 ("States have the obligation to protect and preserve the marine environment"); RESTATEMENT, *supra* note 140, §§ 601, 603.

229. *See, e.g.*, LOSC, *supra* note 136, arts. 208(5) (duty to cooperate in establishing rules and standards governing pollution from seabed activities subject to national jurisdiction), 211(1) (duty to cooperate in establishing rules and standards governing pollution by ocean dumping).

230. LOSC, *supra* note 136, art. 56(1)(b)(iii) & pt. XII.

231. *Id.* art. 194(5); RESTATEMENT, *supra* note 140, § 603, cmt. d & n. 6.

232. LOSC, *supra* note 136, art. 211(6). The coastal State must first consult with the International Maritime Organization and any other concerned States. *Id.*

233. *See generally* THE OCEAN, OUR FUTURE, *supra* note 5, at 199-201 (describing generally the approximately 1300 MPAs in the world).

234. The Convention requires "particular attention" to the need for protection from the harmful effects of activities in the Area such as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines, and other devices related to activities. LOSC, *supra* note 136, art. 145(a).

Authority.[235] Under the Convention, the ISA has the authority to disapprove areas for exploitation in cases where substantial evidence indicates a risk of serious harm to the marine environment and to issue emergency orders, which may include orders for the suspension or adjustment of operations, to prevent serious harm to the marine environment arising out of activities in the Area.[236] In combination, Articles 145, 162 and 194(5) could be read to require the ISA to place active vent sites "off limits" to mining exploration or exploitation activities where there is substantial evidence that the activities would endanger the vent biotic community.[237]

As marine biotechnology applications become more common, the LOSC regime for protection of the marine environment resulting from the use of technologies under the parties' jurisdiction or control, or the intentional or accidental introduction of "new or alien" species that may cause significant and harmful changes to the environment, may be tested. [238]

B. UNCED AND THE OCEANS

The 1992 United Nation's Conference on Environment and Development (UNCED) in Rio de Janeiro was perhaps the most ambitious international environmental conference of the twentieth century.[239] The so-called "Earth Summit" produced a body of international law and soft law instruments that represent a widely held commitment to sustainability and the conservation of biological diversity. The UNCED instruments that will guide marine law and policy makers in designing and implementing conservation and management measures for seabed vent resources include the Declaration of Principles, Chapter 17 of Agenda 21, and the Convention on Biological Diversity.

1. Rio Declaration of Principles

The Rio Declaration on Environment and Development enumerates a number of shared principles, which are intended to serve as a blueprint for conserving and managing global resources and the environment.[240] The Principles are considered

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235. 1994 Part XI Implementation Agreement, *supra* note 136, § 1, ¶ 7.

236. LOSC, *supra* note 136, art. 162(2)(w) & (x).

237. Article 162(x) permits the ISA Council to disapprove areas for exploitation only "in cases where substantial evidence indicates the risk of serious harm," seemingly rejecting a precautionary approach. Nevertheless, the ISA Mining Code for Nodules expressly incorporates a precautionary approach. *See ISA Mining Code for Nodules*, *supra* note 115, reg. 31. Moreover, even the high "substantial evidence" of "risk of serious harm" standard should be easily met in cases involving active vent sites that support "rare" and "fragile" ecosystems.

238. *See* LOSC, *supra* note 136, art. 196(1). Article 196 would appear to include the release of potentially harmful GMOs in the marine environment.

239. For a series of articles discussing the importance of UNCED to marine issues see *UNCED's Marine Agenda: The Challenges of Implementation*, 17 MARINE POL'Y 6 (1993).

240. *See Report of the United Nations Conference on Environment and Development (*Rio de Janeiro, June

soft law, which "carry a strong moral obligation"[241] and inform international and national decision-making; however, the Principles are not themselves binding. They include a commitment to sustainability, to ensure intergenerational equity,[242] and a recognition that environmental protection and impact analysis must constitute an integral part of the development process.[243] The Principles acknowledge the sovereign right of States to exploit their natural resources, as limited by international law, and the duty to ensure that such activities within their jurisdiction do not cause damage to the environment of other States or areas beyond national jurisdiction.[244] All nations are called upon by the Principles to cooperate in order to "conserve, protect, and restore the health and integrity of the Earth's ecosystem."[245] Like Part XIV of the LOSC, the Principles require all States to cooperate in strengthening capacity-building for sustainable development through exchanges of scientific and technological knowledge and by enhancing the development and transfer of technology.[246] Finally, the Principles advocate wide application of the precautionary approach so that lack of scientific certainty will not be used as a reason for postponing measures to prevent environmental degradation where there exists a threat of serious or irreversible damage.[247]

2. Agenda 21

To implement the Principles set out by the Rio Declaration, the UNCED conferees also produced Agenda 21,[248] a program of action for sustainable development and environmental protection for the twenty-first century. Although Agenda 21 is, like the Declaration of Principles, soft law, the principles it sets out are increasingly being incorporated into new international agreements and judicial decisions.[249] Moreover, Agenda 21 now provides many of the organizing

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3-14, 1992), U.N. Doc. A/CONF.151/27 (1992), *reprinted in* 31 I.L.M. 874 (1992) *and in* EARTH SUMMIT AGENDA 21: PROGRAMME OF ACTION FOR SUSTAINABLE DEVELOPMENT, U.N. Sales No. E.93.I.11 (1993) [hereinafter Declaration of Principles].

241. *See id.*, Introd., at 3; *see also* Pierre M. Dupuy, *Soft Law and the International Law of the Environment*, 12 MICH. J. INT'L L. 420 (1991).

242. Declaration of Principles, *supra* note 240, princs. 3, 8.

243. *Id.* princs. 4, 17.

244. *Id.* princ. 2.

245. *Id.* princ. 7.

246. *Id.* princ. 9.

247. *Id.* princ. 15.

248. *Agenda 21: Programme of Action for Sustainable Development*, *in* Annex II to the Report of the United Nations Conference on Environmental and Development (Rio de Janeiro, 3-14 June 1992), U.N. Doc. A/CONF.151/26 (Vol. I-III) (1992) [hereinafter Agenda 21].

249. *See, e.g.*, Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, art. 5 (adopting principles of sustainable development and the precautionary approach), *opened for signature* Dec. 4, 1995, U.N. Doc. A/CONF.164/37 (1995) *reprinted in* 34 I.L.M. 1542 (1995) (not in force) [hereinafter 1995 Straddling Stocks Agreement].

principles that will guide future legal developments in the areas of ocean and coastal resources and the marine environment. At the request of the UNCED conferees, the U.N. General Assembly established the U.N. Commission on Sustainable Development to monitor global implementation of Agenda 21.[250]

Chapter 17 of Agenda 21 forms the blueprint for protection of the oceans and coastal areas and their resources. Some have characterized it as the "link-pin" between UNCLOS and the UNCED process.[251] Chapter 17 expressly recognizes that the LOSC sets forth the rights and obligations of States and provides the international basis upon which to pursue sustainable development of the marine and coastal environment and its resources.[252] It does not directly address seabed vent resources; however, it may serve as a basis for construing and implementing the LOSC articles relevant to those resources. Agenda 21 seeks to complement the LOSC framework by calling for new approaches that are integrated in content and are precautionary and anticipatory in nature.[253] The Agenda repeatedly urges sustainable use of resources of the high seas and within areas of national jurisdiction and calls for strengthening international and regional cooperation and coordination.

Other chapters of Agenda 21 also address subjects relevant to seabed hydrothermal vent field activities. Chapter 8 of Agenda 21 calls for an integration of environmental and developmental considerations into decision-making, effective legal and regulatory frameworks, and effective use of market and other economic incentives. Chapter 16 encourages States to adopt environmentally safe biotechnology management practices, in order to increase the availability of food, improve human health, and enhance the protection of the environment.

3. The Convention on Biological Diversity

The Convention on Biological Diversity[254] is the first comprehensive agreement to address all aspects of biological diversity, including genetic resources, species, and ecosystems. Its objectives are to both conserve and promote the sustainable use of biological diversity, and to facilitate a fair and equitable

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250. *See* G.A. Res. 47/191, U.N. GAOR, 47th Sess., at 1, U.N. Doc. A/RES/47/191 (1993). Officially, the U.N. Economic and Social Council (ESC) established the CSD to ensure effective monitoring, coordination and supervision of the U.N. system in the follow-up to the Rio Conference. *See* U.N. Doc. E/CN.17/1994/L.11 (1994). Additionally, the Administrative Committee for Coordination of the ESC established a subcommittee on oceans and coastal areas in 1993 to meet the coordinating needs of Chapter 17 of Agenda 21. *Coordination Questions: Reports of Coordinating Bodies*, U.N. Economic and Social Council ¶ 21, U.N. Doc. E/1994/19 (1994).

251. ELISABETH MANN BORGESE, OCEAN GOVERNANCE AND THE UNITED NATIONS 23 & ch. 3 (2d ed. 1996).

252. *See* Agenda 21, *supra* note 248, ¶ 17.1.

253. *Id.*

254. Convention on Biological Diversity, art. 1, *done on* June 5, 1992, U.N. Doc. DPI/130/7 (1992), S. TREATY DOC. 20, 103d Cong. 1st Sess. (1993), *reprinted in* 31 I.L.M. 818 (1992) [hereinafter CBD] (entered into force Dec. 29, 1993, not in force for the United States).

sharing of the benefits that arise out of the utilization of the world's genetic resources.[255] The CBD recognizes that the conservation of biological diversity is "a common concern of humankind" and an integral part of the development process.[256] Parties to the CBD cooperate on implementation of the Convention through a periodic Conference of Parties (COP), the supreme body under the Convention.[257] The Convention also established a Secretariat[258] and a Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA).[259] Parties provide financial support for CBD implementation in developing nations through the Global Environmental Facility.[260] President Clinton signed the CBD on behalf of the United States on June 4, 1993, and presented it to the Senate for its advice and consent.[261] In 1994, the Senate Foreign Relations Committee recommended ratification, subject to seven "understandings";[262] however, the full Senate has yet to give its consent to ratification.

a. Conservation of Biological Diversity

The first pillar of the CBD regime is the obligation of all contracting parties to conserve the components of biological diversity. The Convention broadly defines biodiversity as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."[263] Conservation of biodiversity requires both an inventory and periodic monitoring of the components of biological diversity.[264] Where biodiversity is threatened, actions must be taken "as far as possible and appropriate" to conserve it through *in-situ* and *ex-situ* conservation means.[265]

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255. CBD, *supra* note 254, art. 1. "Genetic resources" are defined as "genetic material of actual or potential value." *Id.* art. 2. "Genetic material" includes "any material of plant, animal, microbial or other origin containing functional units of heredity." *Id.*

256. *Id.* pmbl., para. 3.

257. *Id.* art. 23.

258. *Id.* art. 24.

259. *Id.* art. 25.

260. *Id.* art. 21. For information on the GEF, see *Global Environmental Facility, available at* http://www.gefweb.org/ (last visited Feb.5, 2001).

261. *Message from the President of the United States Transmitting the Convention on Biological Diversity, with Annexes, done at Rio de Janeiro June 5, 1992, and signed by the United States in New York on June 4, 1993*, S. TREATY DOC. NO. 20, 103d Cong., 1st Sess. (1993) [hereinafter President's CBD Transmittal Message].

262. S. EXEC. REP. NO. 30, 103d Cong., 2d Sess. (1994) [hereinafter CBD Senate Report]. The seven understandings relate to articles 3, 16, 19, 21 and sovereign immunity for vessels. *Id.* at 6-16.

263. *Id.* art. 2.

264. *Id.* art. 7.

265. *Id.* arts. 8, 9. "In-situ conservation" is defined as "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings." *Id.* art. 2. "Ex-situ conservation" is defined as the "conservation of components of biological diversity outside their natural habitats." *Id.*

The Convention encourages parties to establish reserves or protected areas,[266] where necessary, to facilitate *in-situ* conservation of diversity within species, genetic resources, and ecosystems.[267] *Ex-situ* conservation strategies, which could include aquaria, "gene banks" and microbial culture collections, are intended to complement, not supplant, *in-situ* conservation.[268] The obligation of the parties to develop national strategies to conserve biodiversity,[269] as broadly defined by the CBD, is rendered even more expansive through application of the precautionary approach to decision-making under conditions of uncertainty.[270]

b. Sustainable Use of Biodiversity Components

The second pillar of the CBD regime is the promotion of "sustainable use"[271] of the components of biological diversity, to achieve intergenerational equity. The tale of the rare and priceless *Diazona* serves as a reminder of just how vulnerable marine biological diversity can be. In 1991, scientists from the Scripps Institution of Oceanography discovered a rare jelly-like animal related to the sea squirt in a thirty-meter deep cave in the ocean waters off the Philippines.[272] Sample tissues from the animal, named *Diazona chinesis*, produced Diazonomide A, one of the most powerful cancer-fighting compounds known. Unfortunately, scientists have been unable to locate another *Diazona* specimen since the initial find a decade ago, and researchers have so far been unable to duplicate the cancer-fighting compound despite having preserved a sample.

Careful examination of the CBD reveals that it is not a preservationist regime. The CBD plainly contemplates that those resources that are not threatened or endangered are subject to *use*. The CBD preamble, for example, recognizes the critical importance of sustainably using the planet's biological resource components to meet humanity's food, health, and other needs.[273]

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266. *Id.* art. 8(a). A "protected area" is "a geographically defined area which is designed or regulated and managed to achieve specific conservation objectives." *Id.* art. 2.

267. *Id.* art. 8(a).

268. *See id.* art. 9.

269. CBD, *supra* note 254, art. 6(1). Conservation measures must "avoid or minimize adverse impacts on biological diversity." *Id.* art. 10(b).

270. Although not expressly identified by that title, the precautionary approach is incorporated into the Preamble to the CBD, which provides that: "where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat." CBD, *supra* note 254, pmbl., para. 9.

271. Sustainable use is defined as using the "components of biological diversity in a way and at a rate that does not lead to the long term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of future generations." *Id.* art. 2.

272. Richard Cole, *Anti-cancer Compound Discovered, Then Lost*, SEATTLE TIMES, Feb. 10, 1997, *available at* http://www.seattletimes.com/extra/browse/html97/canc_021097.html (last visited May 15, 2000).

273. *Id.* pmbl., para. 20; *see also* Agenda 21, *supra* note 248, ¶ 16.2 (acknowledging value of biotechnology in increasing food production and distribution).

c. Fair and Equitable Access to the Components of Biological Diversity

A paramount principle recognized by the CBD is the sovereign right of all States to exploit their own resources, pursuant to their environmental policies.[274] A leading goal of the CBD was to reverse what some called a "new colonialism" by developed nations, based on biological resources "plundered" from developing nations.[275] The case for fairness and equity in the distribution of benefits from genetic resources is brought into sharp focus through the case of the wild rosy periwinkle of Madagascar and the Eli Lilly Corporation. Two wonder drugs, vinblastine and vincristine, were discovered accidentally by scientists studying the island's wild rosy periwinkle in the 1960s. Eli Lilly now markets the drugs for the treatment of Hodgkin's disease and pediatric leukemia. Though Eli Lilly reportedly earns roughly US $100 million/year from its sales of the two drugs, Madagascar receives no share of those profits.[276] Article 15 of the CBD now provides a mechanism for source States to obtain an equitable share of the benefits from genetic resources.[277]

To achieve fairness and equity, the CBD, in accordance with the spirit of the Rio Declaration on Environment and Development, promotes a renewed partnership among nations. Its provisions on scientific and technical cooperation, access to genetic resources, and the transfer of environmentally sound technologies form the foundations of this partnership.[278] The CBD articles on technology transfer and distribution of biotechnology benefits have generated considerable controversy, owing to their possible implications for intellectual property rights (IPRs).[279] In presenting the CBD to the Senate, President Clinton included recommended "understandings" that would preserve IPRs in the technology developed under the CBD regime.[280] Although the CBD, like the LOSC, does not

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274. CBD, *supra* note 254, art. 7.

275. VANDANA SHIVA, BIOPIRACY: THE PLUNDER OF NATURE AND KNOWLEDGE 1-5 (1997) (denouncing biotechnology applications of the current intellectual property regime as the "second coming of Columbus"). The term "biological resources" encompasses genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential value for humanity." CBD, *supra* note 254, art. 2.

276. Shayana Kadidal, Note: *Plants, Poverty, and Pharmaceutical Patents*, 103 YALE L. J. 223 (1993).

277. The benefits may include participation in the research, fair and equitable sharing of the commercial and other benefits later derived from the genetic resources, access to and transfer of technology making use of the resources, participation in the biotechnological research activities based on the resources, and priority access to results and benefits arising from biotechnological use of the resources. *See* LOSC, *supra* note 136, art. 249; CBD, *supra* note 254, arts. 15, 16.

278. This description is adapted from the CBD Secretariat web site, *available at* http://www.biodiv.org/ (last visited Jan. 26, 2001).

279. *See* CBD, *supra* note 254, arts. 16, 19; *see also* KERRY TEN KATE & SARAH A. LAIRD, THE COMMERCIAL USE OF BIODIVERSITY: ACCESS TO GENETIC RESOURCES AND BENEFIT SHARING (1999).

280. President's CBD Transmittal Message, *supra* note 261, at xii - xiv (Dep't of State Letter of Submittal). The need to clarify the relationship between provisions of the CBD and intellectual property laws is real. One commentator, for example, asserts that in the event of a conflict between the CBD requirements to promote sustainable development and established intellectual property rights, the CBD provisions prevail, by operation

permit reservations, it does not expressly preclude a contracting party from making its ratification subject to understandings.[281]

d. Applicability of the CBD to Marine Resources

As with all treaties, the CBD imposes obligations only on States that become a contracting party to the convention.[282] Non-parties are not bound by the Convention, though States (like the United States), which have signed but not yet ratified it, are under an obligation not to defeat its object or purpose.[283] Importantly, the CBD does not, in itself, impose any obligations on individuals. Private entities are bound only by the laws and regulations enacted to implement the CBD, or by contracts into which they voluntarily enter.[284]

The Convention's biological diversity provisions respecting the components of biological diversity apply throughout the "limits of national jurisdiction" for each contracting party.[285] It therefore extends—within the functional and geographic limits of jurisdiction prescribed in the LOSC—to the EEZ (if one is claimed) and continental shelf of any party.[286] In addition, processes and activities carried out "under the jurisdiction or control" of any party fall within the CBD's ambit, whether conducted within or beyond national jurisdiction, regardless of where their effects occur.[287] This latter provision raises potential issues with respect to a contracting party's obligations under the CBD as a funding source for MSR activities and as the flag State for vessels operating outside national waters.[288] CBD jurisdictional questions will be examined in Part VI.

The need to protect biological diversity in the oceans is no less urgent than the need for such protection on land.[289] In November 1995, the Second CBD

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of Article 16.5 of the CBD. *See* BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 108 n.59 (quoting Harlan Cleveland 1996 speech).

281. CBD, *supra* note 254, art. 37. The distinction between "understandings" and "reservations" is not always clear. The Vienna Convention on the Law of Treaties defines a "reservation" as "a unilateral statement, however phrased or named, made by a State, when signing, ratifying, accepting, approving or acceding to a treaty, whereby it purports to exclude or to modify the legal effect of certain provisions of the treaty in their application to the State." Vienna Convention, *supra* note 144, art. 2(d).

282. Vienna Convention, *supra* note 144, art. 34. Treaties may also codify existing customary law or become incorporated into customary law.

283. *Id.* art. 18.

284. For a discussion of contracts as a supplementary source of international law, see Daniel M. Bodansky, *International Law and the Protection of Biological Diversity*, 28 VAND. J. TRANSNAT'L L. 623, 630-31 (1995) (observing that such contracts are most commonly made between governments and private enterprises).

285. CBD, *supra* note 254, art. 4(a). Although not defined in the CBD, the "components" of biological diversity are generally understood to mean the biological resources, which "include[] genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity." *Id.* art. 2.

286. *See generally* A. CHARLOTTE DE FONTAUBERT ET AL., BIODIVERSITY IN THE SEAS: IMPLEMENTING THE CONVENTION ON BIOLOGICAL DIVERSITY IN MARINE AND COASTAL HABITATS 3 (1996).

287. CBD, *supra* note 254, art. 4(b).

288. *See* LOSC, *supra* note 136, art. 92(1).

289. *See generally* IMO/FAO/UNESCO-IOC/WHO/IAEA/UN/UNEP Joint Group of Experts on the

Conference of Parties (COP) adopted the broad-ranging "Jakarta Mandate on Marine and Coastal Biological Diversity."[290] The Jakarta Mandate established five thematic areas for CBD implementation in marine and coastal areas: (1) integrated marine and coastal area management; (2) marine and coastal protected areas; (3) sustainable use of marine and coastal living resources; (4) mariculture; and (5) alien species.[291] To facilitate implementation, the CBD Executive Secretary has developed a roster of experts on marine and coastal biological diversity who are nominated by, and provide technical assistance to, parties to the Convention.[292] The CBD Secretariat has also entered into a Memorandum of Cooperation with the Intergovernmental Oceanographic Commission, allowing the CBD parties to draw on the IOC's expertise on subjects relevant to marine biodiversity.[293]

It is still too early to predict what impact the CBD will have on the conservation of biodiversity within and among seabed vent ecosystems. Even though the COP selected the coastal and ocean sector as its first priority for CBD implementation in 1994,[294] little actual progress has been made since. At least one commentator has concluded that the present CBD agenda is too ambitious, and that implementation success will come only when the CBD parties and secretariat concentrate on a more focused set of objectives.[295] Whether vent biodiversity will be on the list of near-term CBD implementation objectives is not clear.

C. RESOLVING CONFLICTS BETWEEN THE LOSC AND THE CBD

The LOSC and the CBD established a complementary, though admittedly still incomplete, regime to govern access to and conservation and management of the

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Scientific Aspects of Marine Environmental Protection (GESAMP), *Marine Biodiversity: Patterns, Threats and Conservation Needs*, GESAMP Rep. Stud. No. 62 (1997), *available at* http://gesamp.imo.org/no62/f_page.htm (last visited Sep. 15, 2000); GLOBAL MARINE BIODIVERSITY: A STRATEGY FOR BUILDING CONSERVATION INTO DECISION-MAKING (Elliott Nourse ed., 1993); Donald K. Anton, *Law for the Seas' Biological Diversity*, 36 COLUM. J. TRANSNAT'L L. 341 (1997).

290. UNEP, CBD Conference of Parties, Decision II/10: *Conservation and Sustainable Use of Marine and Coastal Biological Diversity, in* Report of the second Meeting of the COP to the Convention on Biological Diversity, Annex II, Decision II/10, U.N. Doc. UNEP/CBD/COP/2/19 (1995) [hereinafter Jakarta Mandate].

291. The Fourth COP, held in May 1998, adopted a Programme of Work to achieve the goals set by the Jakarta Mandate. *See* COP Decision IV/5, *Conservation and Sustainable Use of Marine and Coastal Biological Diversity, Including a Programme of Work*, U.N. Doc. UNEP/CBD/COP/4/5 (1998), *available at* http://www.biodiv.org/FinalReports/index.html (last visited Aug. 19, 2000).

292. The database is available at http://www.biodiv.org/jm/3-1.html (last visited Aug. 20, 2000).

293. *See* UNESCO/Intergovernmental Oceanographic Commission, *Identification of Priority Actions in the Field of Marine and Coastal Biodiversity in the IOCINCWIO Region*, IOCINCWIO-IV/12, Apr. 7, 1997, *available at* http://ioc.unesco.org/iochtm/gwio04/doc12/12.htm (last visited Jan. 30, 2001).

294. CBD Conference of Parties, *Medium Term Programme of Work*, Decision I/9, U.N. Doc. UNEP/CBD/COP/1/17 (1994).

295. Chris Wold, *The Futility, Utility, and Future of the Biodiversity Convention*, 9 COLO. J. INT'L ENVTL. & POL'Y 1, 3 (1998).

resources of deep-sea vents. The action plan for implementing the conventions is laid out in Chapter 17 of Agenda 21.[296] Despite their complementary design, conflicts between the two conventions in the context of seabed vents are not difficult to imagine. Neither convention directly addresses access to genetic resources on the high seas or in the Area,[297] thus opening the door to potential disputes over application and interpretation of the two conventions and their priorities in cases of conflict. Both conventions require nations to cooperate in the conservation of living resources.[298] Both conventions preserve freedom of marine scientific research on living resources in areas beyond national jurisdiction and call for international information sharing.[299] However, the two conventions adopt different approaches to conservation and management and create parallel decision-making processes that may undermine integrated management. The CBD expressly seeks to conserve the diversity of genetic resources, while the LOSC addresses conservation only at the level of species or particular stocks.[300] The CBD adopts an "ecosystem" approach to conservation, and even seeks to define a "healthy" ecosystem,[301] while the LOSC does not mandate an ecosystem approach.[302] The CBD incorporates a precautionary principle, a feature notably absent from the present LOSC.[303] Where researchers propose to collect biological samples of "actual or potential value" from a coastal State's waters or continental shelf, the CBD requirements for "prior informed consent" and "mutually agreed terms" are likely to complicate what would otherwise be a more scientist-friendly MSR access regime under the LOSC.[304] The prospects for marine science under such terms are discouraging.

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296. *See* Agenda 21, *supra* note 248, ch. 17.

297. *See generally* Patricia Kraniotis & Roger B. Griffis, *International Law: Implications for Exploitation of Deep-Sea Benthic Biodiversity*, 9 OCEANOGRAPHY 100, 101 (1996).

298. *See generally The Convention on Biological Diversity (CBD) and the UN Convention on the Law of the Sea (UNCLOS): Selected Provisions on Conservation, Sustainable Use and Research*, *in* BIODIVERSITY IN THE SEAS, *supra* note 286, app. 2.

299. *See* LOSC, *supra* note 136, arts. 87(f), 143 & pt. XII; CBD, *supra* note 254, arts. 5, 17-18, 22.

300. *See, e.g.*, LOSC, *supra* note 136, art. 119(1)(b) (consideration of associated or dependent "species") & 119(2) (addressing conservation of fish "stocks").

301. CBD, *supra* note 254, pmbl., para. 10; *see also 1997 SBSTTA Report*, *supra* note 9, ¶ 46. The UNCED conferees ultimately eliminated an ecosystem approach in the final version of Agenda 21, Chapter 17. *See* William T. Burke, *UNCED and the Oceans*, 17 MARINE POL'Y 519, 522 (1993).

302. It is true that Article 119 requires that measures for conservation of LMRs of the high seas take into account "the interdependence of stocks" and "the effects on species associated with or dependent upon harvested species"; however, that requirement does not require a true ecosystem approach.

303. Articles 5 and 6 of the Straddling Fish Stocks and Highly Migratory Fish Stocks Implementation Agreement and Regulation 31 of the ISA Mining Code for Nodules do, however, expressly incorporate a precautionary approach. *See supra* note 249; *ISA Mining Code for Nodules*, *supra* note 115, reg. 31. Some commentators have concluded that the precautionary approach is emerging as a discrete principle of general international environmental law and is thus incorporated into the general environmental law obligations imposed by the LOSC. *See* David Freestone, *The Conservation of Marine Ecosystems Under International Law*, *in* INTERNATIONAL LAW AND THE CONSERVATION OF BIODIVERSITY, *supra* note 149, at 91, 105.

304. CBD, *supra* note 254, art. 15.

Article 22 of the CBD provides that the CBD is to be implemented "consistently" with the rights and obligations of States under the law of the sea.[305] Should a conflict over the rights or obligations of parties to the two conventions arise, the rules of construction codified in the Vienna Convention on the Law of Treaties provide guidance for their resolution. Under the *pacta sunt servanda* norm, any State party to both conventions must perform their obligations under both in good faith.[306] In cases of ambiguity, the terms of the conventions must be interpreted in good faith, in accordance with the ordinary meaning to be given to the terms in their context and in the light of their object and purpose.[307] When a treaty specifies that it is "not to be considered as incompatible with" an earlier treaty, the earlier treaty prevails in cases of conflict.[308] Commentators who have examined the CBD and LOSC and their application to living resources of the high seas and deep seabed concluded that, in the event of a conflict, the LOSC take precedence over the CBD.[309] The conclusion is supported by Article 22 of the CBD and by Article 311(2) of the LOSC, which saves the application of other compatible treaties (such as the CBD), so long as they do not alter the rights and obligations of parties to the LOSC.

Actions taken by the CBD community so far suggest that the COP does not necessarily view the CBD as subordinate to the LOSC with respect to vent resources. In a 1996 working paper addressed to the U.N. Division for Ocean Affairs and the Law of the Sea (UNDOALOS), the CBD Secretariat declared that "it is unclear whether, or how, UNCLOS, or the common heritage principle, applies to the genetic resources of the deep sea-bed," and it requested an "in

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305. *Id.* art. 22(2). Article 22(2) of the CBD closely parallels Article 4 of the 1995 Straddling Stocks Agreement. *See* 1995 Straddling Stocks Agreement, supra note 249, art. 4. The CBD does not explicitly mention the 1982 LOSC, which did not enter into effect until 1994. It seems beyond dispute that the "law of the sea" language in Article 22(2) now includes, at a minimum, the LOSC as well as the customary law rules it incorporates. Arguably it also includes the various LOSC implementation agreements and the decisions by tribunals constituted under Part XV of the LOSC and applying customary law of the sea principles or the LOSC, though the latter are binding only on parties to the dispute.

306. Vienna Convention, *supra* note 144, art. 26.

307. *Id.* art. 31(1); RESTATEMENT, *supra* note 140, § 325.

308. Vienna Convention, *supra* note 144, art. 30(1); RESTATEMENT, *supra* note 140, § 323.

309. LYLE GLOWKA ET AL., A GUIDE TO THE CONVENTION ON BIOLOGICAL DIVERSITY 109 (1994) [hereinafter GLOWKA, GUIDE TO THE CBD]; Anton, *supra* note 289, at 357. The conclusion is apparently premised in part upon the assumption that by operation of Article 22(2) of the CBD, the CBD's provisions are "limited by the rights and obligations of states under the law of the sea." *Id.* & n.85. Article 22(2) actually provides that the CBD is to be implemented with respect to the marine environment (both within and beyond national jurisdiction) "consistently" with the rights and obligations of States under the law of the Sea." When discussing Article 22, the Senate Report states that:

> It establishes the relationship between the Convention and existing international agreements, including the United Nations Convention on the Law of the Sea. The article provides that the Convention shall not affect the rights and obligations of Parties established in existing international agreements, to the extent that the exercise of those rights and obligations do not cause serious damage or threat to biological diversity.

S. EXEC. REP. 30, *supra* note 262, at 13.

depth study on how to best address the use of these resources."[310] The CBD paper strongly advocates control over access to genetic resources in the Area, despite an absence of authority for such control in the LOSC or in the CBD.[311] Informal discussions between the CBD Secretariat and UNDOALOS reportedly began in March 1999, and included questions of bioprospecting for deep-sea resources.[312] At the time of this writing, however, the UNDOALOS has yet to respond to the CBD's request.

Future conflicts between the LOS and CBD conventions, and their implementation, will likely be addressed by the U.N. Secretary-General, the General Assembly, and the Commission on Sustainable Development (CSD).[313] In 1999, the U.N. General Assembly resolved to set up a new procedure for cooperation on law of the sea issues. Under the resolution, all members now meet annually to review the Secretary-General's annual report on oceans and the law of the sea and establish action priorities for international and intergovernmental organizations concerned with the oceans.[314] The new procedures were initiated two years after the General Assembly resolved that there should be a periodic intergovernmental review by the CSD of all aspects of the marine environment and its related issues as described in Agenda 21, and for which overall legal framework is provided by the United Nations Convention on the Law of the Sea.[315] The CSD review and the Secretary-General's annual report on oceans and the law of the sea are now

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310. *See SBSTTA, Bioprospecting Report, supra* note 52, ¶ 2. *See also* ¶ 12 of the CBD Conference of Parties II/10, Conservation and sustainable use of marine and coastal biological diversity, in which the COP:

> *12. Requests* the Executive Secretary, in consultation with the United Nations Office for Ocean Affairs and the Law of the Sea, to undertake a study of the relationship between the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea with regard to the conservation and sustainable use of genetic resources on the deep seabed, with a view to enabling the Subsidiary Body on Scientific, Technical and Technological Advice to address at future meetings, as appropriate, the scientific, technical, and technological issues relating to bio-prospecting of genetic resources on the deep seabed . . . .

See Jakarta Mandate, *supra* note 290, ¶ 12; *see also* Lyle Glowka, *Genetic Resources, Marine Scientific Research and the International Seabed Area*, 8 RECIEL 56, 58-64 (1999) (tracing the history of the CBD Secretariat efforts to evaluate the regime for access to seabed genetic resources).

311. *SBSTTA, Bioprospecting Report, supra* note 52, ¶ 16.

312. *Report by the Executive-Secretary, Progress Report on the Implementation of Programmes of Work on Thematic Areas: Inland Water, Marine and Coastal, Agricultural, and Forest Biological Diversity*, U.N. Environment Programme ¶ 29, UNEP/CBD/SBSTTA/4/3 (1999).

313. G.A. RES. 49/28, U.N. GAOR, 49th Sess., Supp. No. 49, at 34, U.N. Doc. A/RES/49/28 (1994) (calling on Secretary-General to prepare special topic reports relevant to law of the sea issues upon request by intergovernmental organizations such as the CBD Conference of Parties); *see generally* Moritaka Hayashi, *The Role of the Secretary-General under the LOS Convention and the Part XI Agreement*, 10 INT'L J. MAR. & COASTAL L. 157, 158-59 (1995).

314. *Results of the Review by the Commission on Sustainable Development of the Sectoral Theme of "Oceans and Seas": International Coordination and Cooperation*, G.A. Res. 54/33, U.N. GAOR, 54th Sess., U.N. Doc. A/RES/54/33 (2000); *see also 1999 U.N. S-G Report on Oceans and Law of the Sea, supra* note 53, ¶ 5.

315. G.A. Res. S-19/2, 19th Special Sess., at 36, U.N. Doc. A/RES/S-19/2 (1997).

considered by the U.N. General Assembly under a consolidated agenda.[316] Although, in the assessment of one expert, the arrangement is working for the moment, there is some concern that the expanding agenda could become a burden to the United Nations.[317]

V. CLASSIFICATION AND COVERAGE OF DEEP-SEA VENT RESOURCES AND ACTIVITIES UNDER THE LOSC

The LOSC serves two important roles in defining the legal regime for seabed vent fields and their resources. First, it generally defines the rights and obligations of the parties with respect to vent access, conservation, and management. Second, State rights and obligations under the CBD are in part derivative; that is, they depend to some extent on extrinsic legal authorities to establish the underlying sovereign rights and jurisdiction of the contracting parties to prescribe and enforce implementing laws. For ocean space, a State's sovereign rights in resources and its jurisdiction to prescribe and enforce laws are determined principally by the LOSC, as a matter of conventional law with respect to the parties to the Convention, and (for most of its provisions) as a matter of customary law for non-parties. This section therefore begins with an examination of the seabed vent issues under relevant provisions of the LOSC.

A. LEGAL CLASSIFICATION OF THE SEABED AND SUBSOIL UNDER THE LOSC

In determining how vent fields and vent living and non-living resources should be classified under the LOSC, this analysis is mindful of the distinctions drawn by the Convention between the status of the seabed and subsoil, the surrounding and superjacent waters, and the resources on the seabed, in the subsoil, or within the water column. The inquiry begins with the status of the seabed and subsoil.

1. Seabeds Within Areas of National Jurisdiction

Part IV of this article provided an overview of the EEZ and continental shelf regimes established by the LOSC. Two issues may arise concerning the legal classification of seabed areas that are within national jurisdiction, or that are subject to a claim of national jurisdiction, though neither issue is unique to seabed areas where vent fields are found. The first potential issue concerns the determination of the boundaries between the outer limits of coastal State continental shelves and the inner limits of the Area, and the related issue concerning access to and management of vent fields that "straddle" both

316. *See 1999 U.N. S-G Report on Oceans and Law of the Sea*, *supra* note 53, ¶¶ 5-6 & pt. XIII.

317. Louis B. Sohn, *Managing the Law of the Sea: Ambassador Pardo's Forgotten Second Idea*, 36 COLUM. J. TRANSNAT'L L. 285, 302 (1997).

areas.[318] Disputes over continental shelf/Area boundary determinations could arise, for example, when a coastal State adopts a non-normal (straight) baseline[319] from which the EEZ and 200 NM continental shelf are measured, effectively pushing its boundary seaward, or if the State asserts a claim to a continental margin beyond the presumptive 200 NM limit.[320] Claims to a vent field on a ridge beyond 200 NM, but arguably on the coastal State's continental margin, might also test the meaning and application of Article 76(3) of the Convention, which precludes claims to "the deep ocean floor with its oceanic ridges or the subsoil thereof."[321] A question closely related to the continental shelf/Area boundary delimitation issue is the issue of the relationship between high seas freedoms (such as the freedom to fish or to engage in MSR) and coastal State jurisdiction and control over that ten percent of the oceans where the geological continental shelf extends more that 200 NM.[322] Boundary delimitations between the EEZs and/or continental shelves of adjacent States, like the United States and Canada in the vicinity of the Juan de Fuca Plate in the North Pacific, and access to and management of any "shared" vent fields present a second area of potential dispute.[323] Although these questions may figure prominently in the analysis of seabed vent fields situated near or astride national and international jurisdictional boundaries, both questions have been ably analyzed by others.[324] Accordingly, out of concern for time and space constraints, neither question will be analyzed further in this article.

2. Seabed Areas Beyond National Jurisdiction

Roughly sixty percent of the seabed lies within the Area, beyond national jurisdiction.[325] The majority of the vent fields of current research interest are

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318. The LOSC addresses the "straddling" resource issue in several articles. *See, e.g.*, LOSC, *supra* note 136, arts. 142, 145, 147, 209, 215, 256-257, 300.

319. The methods for determining baselines are described in Articles 5 and 7 of the LOSC. *Id.* arts. 5, 7.

320. A possible area of future dispute concerns the potential for "late" claims to continental shelves beyond 200 NM. A number of States have complained to the United Nations that the ten-year deadline prescribed by the LOSC may not be adequate for them to perfect their claims. *See U.N. Convention on the Law of the Sea: Report of the 10th Meeting of States Parties* (New York, May 22-26, 2000), para. VI.C, U.N. Doc. SPLOS/60 (2000), *available at* http://www.un.org/Depts/los/Docs/SPLOS/SPLOS_60.htm (last visited Feb. 7, 2001).

321. LOSC, *supra* note 136, art. 76(3).

322. *See id.* arts. 78, 257 (preserving freedom to conduct MSR in water column beyond EEZ); *see also* CHURCHILL & LOWE, *supra* note 147, at 207 (estimating that ten percent of the high seas overlie "extended" continental shelves beyond 200 NM).

323. Regarding accommodations in cases of shared vent fields, see LOSC, *supra* note 136, arts. 78(2), 208, 214, 256-257, 300.

324. For coverage of these issues, see U.N. DIVISION FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, THE LAW OF THE SEA: DEFINITION OF THE CONTINENTAL SHELF: AN EXAMINATION OF THE RELEVANT PROVISIONS OF THE UN CONVENTION ON THE LAW OF THE SEA, U.N. Sales No. E.93V.16 (1993); U.N. OFFICE FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, THE LAW OF THE SEA: BASELINES: AN EXAMINATION OF THE RELEVANT PROVISIONS OF THE UN CONVENTION ON THE LAW OF THE SEA, U.N. Sales No. E.88.V.5 (1989); and McDorman, *The 1982 LOSC and the Article 76 Outer Continental Shelf Regime*, *supra* note 188.

325. CHURCHILL & LOWE, *supra* note 147, at 239.

located in the Area.[326] Thus, the status of the seabed and subsoil within the Area takes on particular importance to vent access, conservation, and management decisions. Early approaches to the rights of States in the seabed and its resources tended to analogize to either the *res nullius* or the *res communis* property concepts, which were developed principally for determining a given nation's sovereignty in, or title to, terrestrial lands.[327] Under the *res nullius* view, popular in the late 1940s and early 1950s when it was used to justify coastal State claims to adjacent continental shelves, the seabed was likened to unclaimed land, which could be reduced to exclusive access or use by occupation.[328] Under the *res communis* view, the seabed was—like the high seas—not subject to exclusive claims by any State or entity.

The LOSC now declares that the "Common Heritage of Mankind" (CHM) articles in Part XI extend not only to the *resources* in the Area (as defined by the Convention), but also to the *Area* itself, including the sea-bed and ocean floor and subsoil thereof.[329] Some commentators urge that the CHM concept should be extended to other common spaces and resources, including Antarctica, outer space, the atmosphere and even energy and food supplies.[330] Some of those same commentators argue that the CHM concept has already ripened into a rule of customary international law, an argument analyzed in section C.3.

The Article 136 CHM concept has its roots in the 1970 U.N. General Assembly resolution on the Declaration of Principles Governing the Sea Bed and Ocean Floor.[331] Inspired by Ambassador Pardo's 1967 plea to the First Committee of the U.N. General Assembly,[332] the Declaration of Principles asserted, in selected part, that:

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326. This conclusion is based on an inspection of tbl. 2.A in VAN DOVER, ECOLOGY OF VENTS, *supra* note 14. Certain frequently visited vent fields on the Juan de Fuca Plate, which lie within the Canadian EEZ, are a prominent exception.

327. See Steven J. Burton, *Freedom of the Seas: International Law Applicable to Deep Seabed Mining Claims*, 29 STAN. L. REV. 1135, 1151-69 (1977).

328. A favored example of how such a claim could be perfected was the extraterritorial claims to sedentary species asserted by several states. *See* Jon Van Dyke & Christopher Yuen, *"Common Heritage" vs. "Freedom of the High Seas": Which Governs the Seabed?* 19 SAN DIEGO L. REV. 493, 514-18, 521-24, 529-30 (1982) (citing claims over sedentary species by Ceylon, Australia, Mexico, Colombia and Italy).

329. LOSC, *supra* note 136, arts. 136, 1(1).

330. Jan van Ettinger et al., *Ocean Governance and the Global Picture*, *in* OCEAN GOVERNANCE: SUSTAINABLE DEVELOPMENT OF THE SEA, *supra* note 174, at 247, 252-75.

331. *See Declaration of the Principles Governing the Sea-Bed and the Ocean Floor, and the Subsoil Thereof, Beyond the Limits of National Jurisdiction*, G.A. Res. 2749(XXV), U.N. GAOR, 25th Sess., Supp. No. 28, U.N. Doc. A/8028 (1970), *reprinted in* 10 I.L.M. 220 (1971) [hereinafter *Declaration of Principles*].

332. At the time of his historic 1967 speech to the U.N. General Assembly, Ambassador Pardo declined to define precisely the legal content of his CHM concept, later confessing "a certain vagueness was considered necessary by us in order to obtain serious consideration of our initiative." *The Common Heritage of Mankind: Interview with Arvid Pardo*, 2 DEVELOPMENT: J. SOC'Y FOR INT'L DEV., (1983), at 6, 6-7. The 1970 U.S. Assembly Declaration of Principles resolution also recognized that the international legal regime did not, at that time, provide any substantive rules for regulating the exploration or exploitation of the deep seabed or its resources. *See Declaration of Principles*, *supra* note 331, para. 3.

1. The sea-bed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction (hereinafter referred to as the Area), as well as the resources of the Area, are the common heritage of mankind.
2. The area shall not be subject to appropriation by any means by States or persons, natural or juridical, and no State shall claim or exercise sovereignty or sovereign rights over any part thereof.
3. No State or person, natural or juridical, shall claim, exercise or acquire rights with respect to the area or its resources incompatible with the international regime to be established and the principles of this Declaration.
4. All activities regarding the exploration and exploitation of the resources of the area and other related activities shall be governed by the international regime to be established.[333]

Application of the CHM regime to the Area does not preclude non-conflicting uses of the seabed or traditional high seas freedoms in the superjacent waters. Indeed, the CHM articles applicable to the Area are similar in many respects to the inclusive use articles governing the high seas.[334] Several familiar non-consumptive uses of the seabed incorporated in the traditional freedom of the high seas regime were expressly preserved in the 1982 LOSC. For example, the freedom to lay submarine cables and pipelines (which may be imbedded in the seabed) and to construct artificial islands and other installations is a recognized high seas freedom in Article 87. Similarly, the freedom to engage in marine scientific research on the seabed beyond national jurisdiction is preserved in Articles 87 and 143 of the 1982 LOSC, subject to the requirements that it be conducted for peaceful purposes and for the common benefit of humankind.[335]

In some ways the virtue of the present CHM regime is also its principal shortcoming as a conservation and management framework for deep-sea vent resources and activities. Under the CHM regime, no State has jurisdiction to establish integrated conservation and management measures or pollution prevention and control regulations for vent fields in the Area.[336] At the same time, the ISA authority over the Area is limited to mining activities and the environmental effects of those mining activities.[337] There is, therefore, presently no State or international organization with the needed authority to protect the vent resources

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333. *Declaration of Principles*, *supra* note 331, paras. 1-4; *see also* U.N. DIVISION FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, THE LAW OF THE SEA: CONCEPT OF THE COMMON HERITAGE OF MANKIND: LEGISLATIVE HISTORY OF ARTICLES 133 TO 150 AND 311(6) OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA 161-91 (1996), U.N. Sales No. E.96.V3 [hereinafter CONCEPT OF COMMON HERITAGE] (documenting alternative proposals for declaration).

334. For example, Article 89 of the LOSC provides that "No State may validly purport to subject any part of the high seas to its sovereignty." LOSC, *supra* note 136, art. 89. The high seas are also reserved for "peaceful purposes." *Id.* arts. 88, 301.

335. Installations in the Area used for carrying out "activities" in the Area are governed by Article 147. *Id.* art. 147.

336. *See id.* art. 137.

337. ISA jurisdiction and authority are discussed in Part IV.A.2.b.

against the tragedy of the commons by, for example, establishing marine protected areas for those fields threatened by unsustainable or otherwise incompatible uses. Nor does any State or international organization have area-based jurisdiction to control marine pollution or seabed waste disposal at or near vent fields within the Area. The inclusiveness of the present CHM regime for the seabed and subsoil within the Area thus stands as the first of the legal impediments to effective conservation of deep-sea vent resources.[338]

B. LEGAL CLASSIFICATION OF VENT NON-LIVING MARINE RESOURCES UNDER THE LOSC

Having established that the CHM regime created by Part XI of the LOSC extends to vent fields located on the seabed within the Area itself, it must then be asked which vent resources fall within the Part XI CHM regime.[339] In analyzing the CHM regime's coverage in the particular context of vent resources it is necessary to distinguish non-living resources from living resources, and then to ask whether genetic resources are juridically distinct from living resources generally. This section examines the classification of vent non-living resources. Living and genetic resources of the vent communities are addressed in section C.

Although few would dispute that the massive polymetallic sulfide deposits found at hydrothermal vent sites fall within the definition of "resources" of the Area, their classification is not entirely free from doubt. The 1958 Convention on the High Seas, which preceded the current LOSC, did not directly address rights to explore or exploit the seabed and subsoil beneath the high seas. Most scholars analyzing the International Law Commission preparatory work and the record of the 1958 UNCLOS I in Geneva have concluded that—to the extent the question was considered at all—it was generally accepted at the time of the 1958 Conference that exploration and exploitation of the seabed beneath the high seas, beyond national jurisdiction, fell within the general principles of freedom of the high seas.[340] Within a decade, however, that widespread agreement gave way to uncertainty.[341] The uncertainty in turn opened the way for emergence of the CHM concept incorporated in the 1982 LOSC.

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338. In another context, Professor Parker comes to the conclusion that "consensus-based 'management' approaches are not always sufficient to preserve global commons resources . . . ." Richard W. Parker, *The Use and Abuse of Trade Leverage to Protect the Global Commons: What We Can Learn from the Tuna-Dolphin Conflict*, 12 GEO. INT'L ENVTL. L. REV. 3, 9, 99-100 (1999).

339. The 1970 Declaration of Principles did not define or delimit the "resources" that were to fall within the CHM concept, other than by reference to their location within the Area. Twelve years later, however, the final text of the 1982 LOSC limited the term to mineral resources. *See* LOSC, *supra* note 136, art. 133(a).

340. CHURCHILL & LOWE, *supra* note 147, at 225. Coming to a contrary conclusion is Van Dyke & Yuen, *supra* note 328, at 501-08.

341. *See, e.g.*, Louis Henkin, *Changing Law for the Changing Seas*, *in* USES OF THE SEAS 69 (Edmund A. Gullion ed., 1967), who argued that:

> As to the law governing the extraction of minerals from the deep-sea bed, the only certainty is that the law is uncertain. It is not clear whether any nation can acquire and claim sovereignty in the sea-bed,

The 1970 Declaration of Principles discussed above made no attempt to define what "resources" were to be embraced by the emerging CHM regime.[342] It is apparent from the text of Ambassador Pardo's speech that, at the very least, the CHM proponents contemplated that the CHM concept would extend to mineral resources other than just the manganese nodules.[343] There is every reason to believe that in choosing the unqualified term "resources," proponents of the CHM concept had in mind all natural resources of the deep seabed. By the end of the UNCLOS III negotiations, however, the conferees had settled on a definition of "resources" that was limited to mineral resources.[344] Those mineral resources within the Area fall within the CHM regime in Part XI of the Convention, and are subject to appropriation only in accordance with the Convention.[345]

As defined by Article 133(a), the "resources" of the Area are more limited than the "natural resources" of the continental shelf defined in Part VI of the LOSC. Article 77 of the Convention recognizes the coastal State's sovereign rights over the continental shelf for the purpose of exploring it and exploiting its natural resources. Article 77 explains that "[t]he natural resources referred to in this Part consist of the *mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to sedentary species. . . .*"[346] Two distinctions are apparent in the respective definitions. First, the continental shelf "natural resources" definition in Part VI of the LOSC includes "mineral and other non-living resources," while the "resources" of the Area definition in Part XI omits any mention of non-living resources other than minerals. Second, the "natural resources" of the continental shelf include a limited class of living resources, namely, living organisms belonging to sedentary species.[347] Neither "sedentary species" nor any other class of living resources is included in the Part XI CHM regime.

For some, the limited definition of Area "resources" raises questions as to whether mineral resources other than manganese nodules fall within the Part XI regime. One commentator, for example, advocates a revision to Article 133, to remove any doubt that polymetallic sulfide deposits, hydrates, hydrocarbons, and cobalt crusts are included within the definition of resources of the Area.[348] Those

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and if so, by what measures. It is not clear whether, without any claims of sovereignty, any state (or private entrepreneurs) can lawfully proceed to dig and keep what it extracts.

Id. at 81; *see also* LOUIS HENKIN, LAW FOR THE SEAS' MINERAL RESOURCES 24 (1968) (concluding that "[t]o put it bluntly, no one knows what the law is").

342. *See Declaration of Principles*, *supra* note 331.

343. Pardo cited, for example, gold- and silver-rich muds and brines in the Red Sea. *See* William Wertenbaker, *Reporter at Large: The Law of the Sea I*, NEW YORKER, Aug. 1, 1983, at 38, 48.

344. LOSC, *supra* note 136, art. 133(a).

345. *Id.* art. 137.

346. *Id.* art. 77(4) (emphasis added).

347. This second distinction is analyzed in section C.2.

348. BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 188 & 199.

doubts seem unwarranted and the proposed amendment unnecessary. While it is true that the deep seabed mineral resources of immediate interest to the UNCLOS III delegates were the polymetallic (manganese) nodules,[349] and that polymetallic nodules are the only mineral resources expressly mentioned in the definition,[350] there seems little doubt that the legal regime established by the 1982 LOSC applies equally to all other solid, liquid, or gaseous mineral resources located on or under the seabed in the Area.[351] Indeed, the ISA has already taken steps, under authority of the LOSC,[352] and without any apparent objection,[353] to develop regulations for mining minerals other than polymetallic nodules.[354] The proposed Article 133 amendment is therefore unnecessary because the present definition of "resources" is already sufficiently broad to include all of the non-living resources contemplated by the amendment. The apparent absence of any State objection to the ISA initiative to develop regulations for sulfide deposits and cobalt crusts confirms the general acceptance of this interpretation. The proposed amendment also seems unwise because the substitute definition, which relies in part on an enumeration of covered resources, invites controversy if and when new non-living resources that were not contemplated when the proposed list was composed are discovered.

C. LEGAL CLASSIFICATION OF VENT LIVING MARINE RESOURCES UNDER THE LOSC

The challenges posed in determining where vent fields and their non-living resources "fit" within the LOSC are relatively minor. The same cannot be said of the task facing marine policy analysts attempting to classify vent living and genetic resources, whether on a nation's continental shelf or within the Area. Determining where vent living marine resources (LMRs) fit within the LOSC regime entails both a factual and legal analysis. The factual analysis may require study of the relevant physical characteristics of thousands of vent organisms over their entire life cycle. Armed with the necessary biological information, the classifier then turns to the text of the LOSC, the context in which it developed,

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349. Marine scientists have been aware of sulfide deposits at hydrothermal vent sites since the mid-1960s, following British, United States and Russian expeditions to the brine pools of the Red Sea. GEORGE A. DOUMANI, OCEAN WEALTH: POLICY AND POTENTIAL 25-26 (1973). Anticipating the biotechnology potential, Doumani noted "the extraction of medicinal and pharmaceutical products is often little known and unpublicized." *Id.* at 33.

350. LOSC, *supra* note 136, art. 133(a).

351. Neither the 1998 Report by the U.N. Secretary-General, nor any State practice described therein, intimated any doubt that the Part XI regime extended to polymetallic sulfide deposits and cobalt crusts. *See Oceans and the Law of the Sea: Report of the Secretary-General*, U.N. GAOR, 53d Sess., Agenda Item 38(a), at ¶ 301, U.N. Doc. A/53/456 (1998).

352. *See* LOSC, *supra* note 136, art. 162(o)(ii) (authorizing the ISA to adopt and apply provisionally rules and regulations for resources "other than polymetallic nodules").

353. Neither the relevant documents distributed by the ISA, nor the U.N. Secretary-General, reports any protest to the ISA action.

354. *See supra*, Part IV.A.2.b.

and any available evidence of State practice to determine the relevant access, conservation, and management regime applicable to those biological resources. In embarking on the task of classifying remote and exotic organisms under a legal regime, the drafters of which were likely unaware of the vents' existence and most certainly ignorant of their potential importance,[355] the following analysis honors the wise counsel given by pioneers in the quest to bring public order to the oceans. Those pioneers caution that interpretations of the LOSC should be constitutive, that is, "broad not narrow, flexible not rigid, and adaptive in orientation, not fixed on the past."[356]

1. The Likely Claims over Vent LMRs

If, as many predict, the genetic material extracted from vent organisms offers a multi-billion dollar biotechnology potential, disputes over access to those resources and the distribution of any benefits derived from them appear inevitable. The principal international law issue with respect to living resources found within a vent field located on a nation's continental shelf is likely to be whether access to those resources will be governed by the continental shelf regime, if the resources fall within the class of "sedentary species," or the EEZ regime, which applies to the other "living marine resources" within the 200 NM EEZ. Although the respective regimes differ in several respects,[357] under either regime the coastal State possesses sovereign rights to explore and exploit those resources and to regulate LMR-related MSR activities. A potentially more controversial issue is whether a coastal State has sovereign rights to explore and exploit vent living and genetic resources (and to regulate related MSR activities) on its continental shelf beyond 200 NM, where the geologic continental margin extends that far. The answer will turn in part on whether those vent resources fall within the class of "sedentary species."

Access to vent living resources on or under the seabed within the Area is likely to present at least two conflicting claims regarding their classification. Some developing nations might well argue that the living and genetic resources of seabed vents beyond national jurisdiction are, or should be treated as, the common heritage of humankind, and that any benefits derived from their

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355. Despite the discovery of hydrothermal vent sulfide deposits in the 1960s, see *supra* note 349, and the associated biological communities in 1977—five years before UNCLOS III concluded its work—my research found no evidence the exotic creatures and microbes which comprise the biotic communities of the seabed vents were considered by the UNCLOS III conferees.

356. Burke, *State Practice, supra* note 1, at 222. Professor Burke notes that a constitutive approach in settling disputes under the treaty is particularly important owing to the "absence of an effective legislative institution at the international level, which would allow timely creation of new law to meet changing conditions." *Id. See also* HAROLD D. LASSWELL & MYRES S. MCDOUGAL, JURISPRUDENCE FOR A FREE SOCIETY pt. IV, ch. 1 (1992) (describing the principles of the constitutive process).

357. See the discussion regarding coastal State conservation and management obligations and provisions for access to surpluses under the respective regimes in Part IV.A.3.a.

exploration and exploitation should accrue to the entire international community. Developed nations, access-minded marine scientists, and biotechnology interests, on the other hand, are likely to respond that access to the vent living and genetic resources falls within the high seas freedoms in Part VII of the LOSC, or the freedom to conduct MSR in the Area under Part XI, and that the resources are therefore subject to collection, examination, or capture by any private or government entity, subject only to the obligation to exercise those freedoms with "due regard" for the interests of other States,[358] and any applicable resource conservation and marine environmental protection provisions in Parts VII and XII.[359] A third possibility, already suggested by a few commentators, is that some or all of the access, conservation, and management issues applicable to vent living and genetic resources fall outside of the existing conventional and customary law regime, and that any rules governing their collection and use must be developed through the customary law process or a new international agreement.[360]

2. Do Vent Living Resources Meet the Definition of "Sedentary Species" Under Part VI of the LOSC?

Determining the relevant regime for access to, and conservation and management of, LMRs on a nation's continental shelf turns on whether the resources meet the LOSC's definition of "sedentary species." For vent LMRs within 200 NM, the answer determines whether access to those resources will be governed by the continental shelf regime or the EEZ regime. The distinction between sedentary species and other LMRs is also critical in determining the respective rights of States in resources lying on a coastal State's continental margin beyond 200 NM, because access to sedentary species will be governed by the continental shelf regime, while access to all other LMRs fall under the high seas articles. Given the commercial potential for vent resource biotechnology applications, it is not difficult to imagine circumstances under which a coastal State might assert a claim to an extended continental shelf in order to gain sovereign rights in a vent field lying beyond the presumptive 200 NM limit. The temptation would be particularly great if the resources were otherwise likely to be collected and/or exploited by foreign researchers or prospectors possessing a technological advantage over the coastal State.[361]

An understanding of the reach of the phrase "sedentary species" and its development is important beyond its application in determining which living

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358. *See* LOSC, *supra* note 136, art. 87(2).

359. *See id.* arts. 116-119.

360. One commentator has concluded that the hydrothermal vents beyond national jurisdiction and their related biological resources "fall into an international legal crack; neither UNCLOS nor the CBD specifically reference them and their application can only be inferred." Glowka, *Testing the Waters*, *supra* note 10, at 45.

361. Burke, *State Practice*, *supra* note 1, at 232.

resources are subject to the continental shelf regime. The historical and philosophical underpinnings of the sedentary species classification might reasonably be used to inform international judgment in interpreting other convention language and in determining how it might be applied to vent LMRs in the Area. For example, does the same logic that links the coastal States' claims to an adjacent continental shelf to the LMRs classified as "sedentary species" compel a similar connection between the seabed within the Area and the analogous living resources that inhabit it? Finally, to meaningfully evaluate current proposals to amend Part XI of the LOSC, to include sedentary species in the definition of "resources" of the Area,[362] it is critical to determine which of the vent living resources would fall within the newly added class of sedentary species. If it is not clear that vent living resources, including vent microbes and their genetic material, fall within the sedentary species definition, any such proposal is likely to fail in its objective.

a. The Legal Test for Sedentary Species

Article 77 of the 1982 LOSC defines the "natural resources" within the continental shelf regime as "[t]he mineral and other non-living resources of the sea-bed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the sea-bed or are unable to move except in constant physical contact with the sea-bed or subsoil."[363] The definition of natural resources in Article 77 of the 1982 Convention is identical in all relevant respects to the definition in Article 2 of the 1958 Convention on the Continental Shelf.[364] Accordingly, the *travaux préparatoires* and publicist commentary for the 1958 Convention provide a useful starting point for ascertaining the meaning of any related terms in the 1982 Convention found to be ambiguous or obscure.[365]

In developing what would become the 1958 Convention on the Continental Shelf, the International Law Commission considered several possible rationales for extending coastal State rights to living resources found on the continental shelf beyond the territorial sea.[366] A leading theory considered by the Commission, but later rejected, justified the coastal State's exclusive claim by its "occupation" of the shelf and its resources. A closely related theory posited that

362. *See, e.g.*, BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 188, 199 (proposing to re-define "resources" of the Area to include, among other things, sedentary species).

363. *See* LOSC, *supra* note 136, art. 77(4).

364. Convention on the Continental Shelf, *supra* note 179, art. 2.

365. *See* Vienna Convention, *supra* note 144, arts. 31, 32 (describing the accepted rules for treaty interpretation); *see also* RESTATEMENT, *supra* note 140, § 325 cmt. e & n. 1 (contrasting a general reluctance by certain other nations and the International Court of Justice to give weight to the *travaux préparatoires*, with a willingness by U.S. courts to rely on such extrinsic sources).

366. *See generally* 4 WHITEMAN, DIGEST OF INTERNATIONAL LAW, *supra* note 150, ch. XI.

long-standing State practice ripened by prescription into a right to exclusive access. Another commonly offered rationale for exclusive coastal State access to sedentary species on the shelf reasoned that those resources represented the "fructus of the seabed,"[367] and should therefore be subject to exclusive claims by the attending State. The final article incorporated into the 1958 convention, and a later decision by the International Court of Justice, grounded the coastal States' continental shelf claim on both usage and physical contiguity.[368] It is noteworthy that the reason for limiting the definition of resources to "sedentary species" appears to be grounded in what some might call a precursor to an integrated "system," if not an ecosystem, approach to resource management.

The International Law Commission (ILC) initially envisioned that the 1958 Continental Shelf Convention would include a separate article addressed solely to sedentary species.[369] Resources other than sedentary species that were to be governed by the Continental Shelf Convention would be addressed elsewhere in the convention. In 1953, however, the ILC decided to eliminate the separate article, in favor of a single article defining the "natural resources" that were to be governed by the Convention.[370] At the same time, the ILC sought to distinguish, in its report, the phrase "natural resources" from the more limited term "mineral resources."[371] The ILC explained that it came to the conclusion that:

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367. Richard Young, *Sedentary Fisheries and the Convention on the Continental Shelf*, 55 AM. J. INT'L. L. 359, 361 (1961) (arguing that there was a "similarity" between sedentary species and crops on land, "and the oysters or other species were often spoken of as a fructus of the seabed, to be harvested rather than hunted like swimming fish").

368. Convention on the Continental Shelf, *supra* note 179, art. 2(4); North Sea Continental Shelf (F.R.G. v. Den./F.R.G. v. Neth.), 1969 I.C.J. 3, 19 (Feb. 20) (relying, in part, on the "natural prolongation" rationale in upholding a coastal State's claim over the adjacent continental shelf); *see also* Burton, *supra* note 327 at 1156 (reasoning that "[t]he sedentary species cases thus represent a special example of limited coastal rights based on historic usage and physical contiguity"). The advent of the minimum 200 NM wide juridical continental shelf under the 1982 LOSC represents an abandonment of the "natural prolongation" rationale as the sole basis for extended coastal State jurisdiction over the shelf.

369. For early discussions of the separate article on sedentary fisheries and initial definitions, see *Summary Records of the 120th Meeting*, [1951] 1 Y.B. INT'L L. COMM'N 319, U.N. Doc. A/CN4/Ser.A/1951; *see also* 4 WHITEMAN, DIGEST OF INTERNATIONAL LAW, *supra* note 150, at 856-64 (describing respective State positions).

370. The Commission explained that:

> [The Commission] did not think it necessary to retain, among the articles devoted to the resources of the sea, an article on sedentary fisheries. The Commission envisaged the possibility that shallow areas rendering possible the exploitation of sedentary fisheries may exist outside the continental shelf. However that possibility was considered to be at present too theoretical to necessitate separate treatment.

Report of the International Law Commission to the General Assembly, 8 U.N. GAOR Supp. (No. 9) at 14, U.N. Doc. A/2456 (1953), *reprinted in* [1953] 2 Y.B. INT'L L. COMM'N 214, para. 71, U.N. Doc. A/CN.4/Ser.A/1953/Add.1 (1953) [hereinafter *1953 Report of the ILC*]. L.F.E. Goldie criticized the decision to eliminate the separate article on sedentary species and include such species instead in a single article on continental shelf natural resources. L.F.E. Goldie, *Sedentary Fisheries and Article 2(4) of the Convention on the Continental Shelf – A Plea for a Separate Regime*, 63 AM. J. INT'L L. 86, 90-91 (1969).

371. *1953 Report of the ILC*, *supra* note 370, para. 70.

> [T]he products of sedentary fisheries, in particular to the extent that they were natural resources permanently attached to the bed of the sea, should not be outside the scope of the regime adopted and . . . this aim could be achieved by using the term 'natural resources'. It is clearly understood, however, that the rights in question do not cover so-called bottom-fish and other fish which, although living in the sea, occasionally have their habitat at the bottom of the sea or are bred there.[372]

The single-article approach to defining continental shelf resources may be explained in part by the perceived logic of addressing all seabed resources together. Professor Bailey, leader of the Australian delegation, seized upon the logical necessity of a joint approach to sedentary species and the mineral resources with which they are associated, concluding that the "permanent association of some living resources with mineral resources of the seabed and subsoil was such that it was best that both those types of resources should be exploited jointly."[373] He further argued that it would be "senseless to give coastal States exclusive rights over mineral resources such as the sands of the seabed but not over the coral, sponges and living organisms which never moved more than a few inches or a few feet on the floor of the sea." He went on to explain, however, that the logic of a joint approach did not extend beyond certain limited sedentary species, which lacked that "permanent intimate association" with the seabed.[374] The remaining text of the draft ILC article defining the continental shelf's "natural resources" was incorporated into Article 2(4) of the 1958 Convention on the Continental Shelf and carried forward virtually unchanged into Article 77(4) of the 1982 LOSC.

To fall within the LOSC's sedentary species classification, and therefore come within the continental shelf regime, an organism must meet one of two conditions when at the harvestable stage: it must either be immobile on the seabed or subsoil, or, if mobile, it must be capable of movement only in constant physical contact with the seabed or subsoil. Marine biologists will quickly recognize that the sedentary species classification crafted by the 1958 convention drafters, and carried forward into the 1982 LOSC, has little or no relationship to biological taxonomy.[375] Moreover, by omitting any consideration of the relationship between the individual organism and its greater ecosystem, the sedentary species

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372. *Id.*

373. Marjorie M. Whiteman, *Conference on the Law of the Sea: Convention on the Continental Shelf*, 52 AM. J. INT'L. L. 629, 639 (1958) (quoting Professor Bailey, U.N. Doc. A/CONF.13/C.4/SR.21, at 7-8).

374. *Id.*

375. The vague "sedentary species" classification (and the equally unworkable "highly migratory species" classification used in Article 64) may be contrasted with other, more easily understood and applied, terms used within the LOSC, such as those for anadromous and catadromous species and marine mammals. *See* LOSC, *supra* note 136, arts. 65-67. The vagueness of the "highly migratory species" classification is ameliorated by enumerating the species covered by the relevant articles. *See id.* Annex I (listing seventeen classes of highly migratory species).

definition suffers the very kind of dysfunctional limitation Professor Bailey argued against, thus opening the way for fragmented, uncoordinated conservation and management practices.

In approaching the classification of seabed hydrothermal vent LMRs, several characteristics of the vent organisms and their collection methods should be recalled.[376] First, the organisms found at active vent sites are believed to be transient migrants: they arrive at the vent field by routes and means that are not yet fully understood, and are not likely to be understood for some time.[377] Some vent microbes are believed to originate in a vast subseabed biosphere. There is growing evidence that some vent organisms travel across the sea-floor, while others may be carried from one vent to another in spinning whirlpools.[378] Most of the vent organisms exist at a particular field only so long as the nutrient-rich hydrothermal geyser continues, and then they either die off or migrate to another field. Many of the vent organisms therefore must be seen as oceanic voyagers of a sort, a factor that must be considered in determining which, if any, are sedentary species. Second, it is important to recall that the vent food web inverts the trophic model that predominates the rest of the biosphere. The vent food web is fueled by chemical energy driven up from the seafloor, not solar energy radiated down from above. Many—perhaps all—of the microbes that serve as primary producers are believed to originate from the subseabed and draw their sustenance from it. Vent fauna thus better meet Professor O'Connell's "functional dependency" test[379] and Professor Bailey's "permanent intimate association" with the seabed test for sedentary species than do many other species commonly included within the definition. Finally, there is no point in pretending the emperor is clothed in regal raiment. The fact is, in attempting to apply a "sedentary species" test to vent organisms, lawyers must acknowledge to scientists that it makes no sense to attempt to identify a "harvestable stage" for the organisms commonly found at, and collected from, vent fields, or to assess the "mobility" of organisms equipped with nothing more than a primitive flagella. Vent organisms are not harvested in

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376. *See supra* Part II.B.

377. *See generally* ELLIS, DEEP ATLANTIC, *supra* note 26, at 49, 122-23; VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, ch. 11.

378. Jon Copley, *Going for a Spin*, NEW SCI., 12 Dec. 1998, *available at* http://www.newscientist.com/ns/981212/plume.html (last visited Aug. 21, 1999). Moreover, a number of vent organisms have a free-living larval stage, which allows wide dispersal. R.C. Vrijenhoek, *Gene Flow and Genetic Diversity in Naturally Fragmented Metapopulations of Deep-sea Hydrothermal Vent Animals*, 88 J. HERED. 285 (1997). The "whirlpools" may therefore carry both animal larvae and microorganisms of hydrothermal vents.

379. The "functional dependency" test refers to the various relationships and dependencies described by Professor O'Connell. *See* 1 D.P. O'CONNELL, THE INTERNATIONAL LAW OF THE SEA 502-03 (I.A. Shearer ed., 1982) (describing, in the sedentary species classification context, four categories of relationships between LMRs of the seabed and the seabed itself, including: dependence on the seabed for location and movement; dependence on the seabed for physiological functioning—including physical and chemical conditions necessary for the organism's metabolism; dependence on the seabed for nutritional purposes; and dependence on the seabed for reproduction).

the same sense as other commercially important LMRs. Since 1978, they have been *collected*—sometimes inadvertently—in water and mineral samples taken from vent sites or as "hitchhikers" on larger biological specimens. Most oceanographers would justifiably take exception with those who would label their biological sample collection efforts as "harvesting" rather than research. While it is true that a distinct legal regime governs MSR activities, and that the vent sample collection activities reported so far are governed by that regime and not by the LMR harvesting provisions of the LOSC, the analysis in section V.D will demonstrate that future collection activities by "bioprospectors" probably will not fall exclusively within the MSR regime, and must therefore be addressed under the LMR harvest articles. That said, the unsuitability of the present sedentary species test for determining which legal regime governs a particular LMR is best demonstrated by application of the test to vent macrofauna and microfauna.

b. Determining an Organism's "Harvestable Stage"

The first step in determining whether a particular organism is a sedentary species is to determine its "harvestable stage." The 1982 LOSC does not define the term.[380] Thus, a strictly textual approach to understanding the definition and applying it to vent organisms would be unproductive. An examination of the historical development of the definition and contemporaneous interpretations by conference delegates is only slightly more helpful. In the context of the 1958 conventions, for example, Richard Young reports with uncharacteristic circularity that the term "harvestable stage" in the Convention provided a "common sense rule" that "refer[red] to the harvestable stage in the creature's life cycle."[381] Professor Bailey sought to clarify the meaning, arguing that it refers to "that stage of life during which the resources *are harvestable*," not the particular moment at which they are captured.[382] Even if Bailey's gloss to the definition is accepted, it fails to provide helpful guidance in approaching vent organisms, which are not, and likely will not be, "harvested" commercially in the same sense as oysters or clams.

For those organisms that, during their life cycle, undergo one or more morphological changes that affect their mobility, the "harvestable stage" analysis could be simplified in one of two ways. First, Professor Bailey's suggested approach could be rejected in favor of an approach that looks only at the organism's capability for movement at the time it is collected. This approach,

380. Chances are good that the definition was not as controversial during UNCLOS III as it was in 1958, in light of the advent of the 200 NM EEZs, which provide the coastal State with broadly similar sovereign rights over LMRs on or in the seabed out to 200 NM.

381. *See* Young, *supra* note 367, at 368.

382. *See* Whiteman, *Conference on the Law of the Sea: Convention on the Continental Shelf*, *supra* note 373, at 640 (quoting Bailey).

which appears more consistent with the position taken by the United States,[383] has the appeal of linking the access regime for a resource to its location and mobility at the time of the activity being regulated. Alternatively, the classifier could assume for purposes of the analysis that an organism is "harvestable" at any point in its life cycle at which it can be collected for later study or exploitation. It can be argued that this latter approach is appropriate in those cases where the ultimate target of the collection effort is the organism's genetic material, and the genetic material can be extracted at any point during the organism's life cycle.

c. Evaluating an Organism's "Mobility"

Once the organism's harvestable stage is determined, the analysis turns to an examination of the organism's capability for movement at that stage in its life cycle. For macrofaunal organisms with distinct developmental stages that affect their mobility, this classification step may require extended study of the organism's entire life cycle, particularly if a broad view of "harvestable stage" is adopted. As with the search for the meaning of "harvestable stage," the text of the LOSC provides no further definition to guide the analysis of an organism's "mobility." The text does not make clear, for example, whether the only "mobility" relevant to legal classification is movement generated by the organism itself, or if it includes motion caused by outside forces, such as water current or even transport by a host carrier. Nothing in the text or context of the LOSC supports the latter view, however, and in fact, the *travaux préparatoires* suggest that only self-locomotion is relevant.[384]

For benthic organisms that are capable of movement at the harvestable stage, commentators have sought to clarify the standard for evaluating whether the movement is made only in "constant physical contact" with the seabed,[385] a question that arose in the recent dispute between the United States and Canada over the classification of sea scallops.[386] Although in that dispute the United States initially argued that sea scallops were not sedentary species because they were capable of movement through the water in their adult stage without being in

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383. *See infra* note 388 (quoting a colloquy in the course of the Senate ratification hearings during which the Administration spokesperson focused on "the part in their life history when they are of value commercially").

384. *See* Young, *supra* note 367, at 368 (reporting that the conference understood that the sedentary species definition "covers satisfactorily both attached and unattached species that are not self-propelled").

385. Arthur H. Dean, *The Geneva Conference on the Law of the Sea: What was Accomplished*, 52 AM. J. INT'L. L. 607, 621 (1958) (reasoning that the qualifier "in constant physical contact with the sea bed or the subsoil" was added and that the definition excludes such crustaceans as shrimp, but it does give coastal States the right to control oyster beds and pearl fisheries).

386. See, for example, the discussion of the 1994 dispute between the United States and Canada over whether scallops fall within the definition and were therefore subject to Canadian continental shelf claims beyond 200 NM. Jon M. Van Dyke, *Modifying the 1982 Law of the Sea Convention: New Initiatives on Governance of High Seas Fisheries Resources: The Straddling Stocks Negotiations*, 10 INT'L J. MARINE & COASTAL L. 219, 221-22 (1995).

constant contact with the seabed, in other cases the United States has taken a broader view of the sedentary species classification than other nations. The United States' view is evidenced by its assertion of sovereign rights over a long list of "continental shelf fishery resources" in the Magnuson-Stevens Fishery Conservation and Management Act (MSA).[387] The MSA definition, which includes over a dozen commercially important species of crab and lobster, is at odds with the 1958 and 1982 conventions' definition of sedentary species.[388] It can be seen, therefore, that State practice reveals continuing disagreement over the sedentary species classification, even for species like scallops, whose life cycle is well known and which have been commercially harvested for centuries.

d. Classification of Vent Macrofauna

Classifying most of the known vent macrofauna, including the various species of coelenterates and tubeworms, the infaunal mollusks, such as the bivalves and gastropods, along with the crustaceans, fish and octopus, should present no problems different in kind from those encountered in classifying similar species found outside the vent fields. That is not to say, however, that their classification will in all cases be free from dispute, as the recent exchange between the United States and Canada over the classification of sea scallops and an earlier dispute between the United States and Japan over the classification of Alaska king crab reveal.[389]

To the extent that a "harvestable stage" for vent macrofauna can be ascertained or agreed to, a number of familiar macrofauna will—like their shallow-water cousins—almost certainly fail to meet the test of "immobility" or "mobility only in constant physical contact with the seabed." For example, the fish and octopus

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387. The Magnuson-Steven Fishery Conservation and Management Act (MSA), 16 U.S.C. § 1802(7) (1994), extends to "continental shelf fishery resources" (CSFR). In contrast to "sedentary species," which are defined by their characteristics, the MSA defines CSFR by enumerating those species falling within the definition. *Id.* The Act also permits the Secretary of Commerce to add species to the list if the Secretary concludes that they meet the definition of "sedentary species." *Id.*

388. The following colloquy took place between Senate members (asking questions) and the Administration (answering the questions) in a hearing before the Committee on Foreign Relations during its review of the 1958 Convention on the Continental Shelf:

> Q: "Would you give examples of natural resources falling within and falling outside of this definition?"
>
> A: "The definition of such 'natural resources' in the Continental Shelf Convention includes such species as shellfish which burrow into the sea bottom or are constantly in contact with the sea bottom during the part of their life history when they are of value commercially. Hence, clams, oysters, abalone, etc. are included in this definition, whereas shrimp, lobsters, and finny fish are not."

Conventions on the Law of the Sea, Hearing Before the Senate Comm. on Foreign Relations, 86th Cong. 2d. Sess., at 88 (1960).

389. *See supra* note 385 and accompanying text. The king crab dispute between the United States and Japan over the State of Alaska's regulation of the fishery is described in Charles E. Curtis, Comment, *Alaska's Regulation of King Crab on the Outer Continental Shelf*, 6 UCLA–ALASKA L. REV. 375 (1977).

species found at vent sites are plainly capable of movement through the water without being in constant physical contact with the seabed. Such organisms are not sedentary species within the meaning of the LOSC. At the other extreme are the sessile anemones, tubeworms, and polychaetes. These organisms, which attach themselves to the seabed and other substrate, along with the infaunal mollusks (bivalves and gastropods), which rest on or burrow into the seabed, will fall within the sedentary species definition if deemed harvestable only in their adult stage, as are the more traditionally harvested sessile organisms and mollusks found in near shore habitats.[390]

e. Classification of Vent Microfauna

Marine scientists have learned much about vent microbes over the past two decades; far more is yet to be learned. Without a clear understanding of the microbes' origin and life cycle, any conclusions regarding their legal classification as sedentary species are at best preliminary. Nevertheless, some generalizations may help guide future classification efforts, as vent microfauna of interest are better understood. First, it can be said with a conviction rare in this classification analysis that even the most sedulous examination of the LOSC will uncover no consideration of marine microbes as a potentially important "resource." Certainly, there is no evidence that the half-century old definition of "sedentary species" was ever intended to address the seas' microscopic organisms. While it seems beyond cavil that marine microbes logically fall within the larger class of "living marine resources" addressed in Parts V and VII of the LOSC, there is no evidence that the unique legal issues posed by the collection, study, and exploitation of marine microbes were ever considered by the UNCLOS III conferees. Finally, my research found no evidence that the international community has yet attempted to formally classify marine microbes under the Law of the Sea, whether those microbes are found on the seabed or in the vast superjacent waters.[391] None of the recent summaries of State practice in the U.N. Secretary-General's oceans and law of the sea reports reveals an existing claim by any State that vent microbes are "sedentary species" under Part VI of the LOSC. To the extent that questions about legal coverage of vent microbes and their genetic resources have surfaced at all, those questions have been raised primarily by ocean law and policy commentators.[392] Accordingly, the questions remain ripe for development by State practice.

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390. Bivalves are free swimming during larval stages of their life cycle, a characteristic that ensures their dispersal. *See generally* VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, ch. 9.

391. Preliminary discussions are reportedly underway within the United Nations and CBD secretariats, but at best they reveal uncertainty and, perhaps, some eagerness to amend the law. *See supra* Part IV.C. (discussing communications between the CBD Conference of Parties and UNDOALOS).

392. *See, e.g.*, Glowka, *The Deepest of Ironies, supra* note 1, at 168; BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 174.

Despite the absence of any direct reference to marine microbes in the LOSC, some tentative conclusions regarding microfaunal classifications are appropriate. For the present analysis, the multifarious vent microfauna can be grouped into four generic categories by habitat.[393] The first habitat includes the free-living microbial populations associated with the discharged vent fluids. These microbes presumably grow and reproduce within the subseabed system. The second habitat consists of microbes suspended within the hydrothermal vent water plumes. Those microbes may be free-living or attached to suspended particles. The third are the free-living microbial "mats" that grow on rock, chimney, sediment, or biotic surfaces that are exposed to vent water. The fourth habitat includes the symbiotic microbes associated with vent macrofauna, such as the tubeworms, clams, and polychaetes. It should be emphasized that these four classes represent habitats from which the microbes might be collected, not taxonomic classifications. The same microbe might well be found in all four habitats.

Any meaningful assessment of a microbe's "mobility" is problematic. Some marine microbes have evolved minute flagella, and may therefore be said to be capable of self-locomotion through the water or over other media on the seafloor. It is difficult to believe, however, that the UNCLOS I or UNCLOS III conferees had such primitive mobility in mind when they formulated the definition of sedentary species. Other microbes have no means of self-locomotion. Members of the latter class are by their very nature "immobile," and remain so throughout their life cycle, at least in terms of self-locomotion. The only question relevant to their classification as sedentary species, then, is whether they are immobile "on or under the seabed" when at the harvestable stage. Even those microbes possessing a primitive means of self-locomotion, when harvested from microbial mats on the seabed or other substrate, would meet the alternative test of being "unable to move except in constant physical contact with the sea-bed." Accordingly, they are best classified as sedentary species under the LOSC. Similar microorganisms collected from microbial mats growing on living surfaces would also be considered sedentary if the organism on whose surface they are growing meet the definition of sedentary species. The microorganismal symbionts of vent host organisms, such as the tubeworms and polychaetes, should also be classified as sedentary species if they are harvested from the tissues of vent fauna that are themselves sedentary. Presumably, the law of the sea would accord similar treatment to zooxanthellae symbionts resident in coral polyps or microbes of commercial interest found in or on other harvested or collected marine resources.

Microbes suspended in the water column in or near a vent present the strongest case for classification as non-sedentary species under the existing classification regime. Even the "immobile" microbes, if collected from the water column,

393. Adapted from David M. Karl, *Ecology of Free-Living Hydrothermal Vent Microbial Communities*, *in* THE MICROBIOLOGY OF DEEP-SEA HYDROTHERMAL VENTS *supra* note 14, at 60; VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, § 5.2.1 & fig. 5.2.

would fail to satisfy the test for immobility "on or under the sea-bed." Accordingly, access to those microbes would be governed by the EEZ or high seas provisions for living marine resources and/or marine scientific research, depending on their location, rather than on the continental shelf articles.

It is apparent from even this preliminary examination that the sedentary species classification approach is poorly suited to the vent biotic communities. It seems certain that some vent macrofauna and microfauna will meet the legal test for sedentary species and, like seabed mineral resources, will be governed by the continental shelf regime within areas of national jurisdiction. Other, "mobile" organisms found at those same vent fields, and very much a functioning element of the same ecosystem, will likely fall outside the sedentary species definition, and would therefore be subject to the EEZ regime for living marine resources within 200 NM. In moving beyond areas within national jurisdiction, the following section will show that it is not entirely clear which regime governs vent microfauna in the Area or on the high seas. The present regime could therefore lead to a fractured regulatory approach to conservation and management of vent field resources, which marine ecologists are certain to characterize as the components of a single complex ecosystem. Therein lies the second identifiable impediment to effective conservation and management of seabed vent fields.

3. Are Vent Living Resources Beyond National Jurisdiction "Resources" of the Area Under Part XI, "Living Marine Resources" Under Part VII, or Neither?

For those classes of organisms located in vent fields in the Area, and for those that, although located on a State's continental shelf and beyond the EEZ, do not fall within the class of "sedentary species," the next question is whether those organisms fall within the living marine resource regime of the high seas in Part VII of the Convention, the deep seabed regime in Part XI, or neither regime. Organisms falling within the first class are subject to the high seas "universal use principle" and the associated freedoms, while those in the second class fall within the CHM regime established by Part XI. Organisms not falling within either regime would arguably be governed by principles of general international law.

a. The Textual Basis for Legal Classification

The classification process necessarily begins with the text of the Convention. The text must be interpreted in good faith, in accordance with the ordinary meaning to be given to the terms in their context and in the light of their object and purpose.[394] The text of the relevant high seas articles, while broad, is not entirely clear in its coverage. The Article 87 chapeau provides that the high seas

394. Vienna Convention, *supra* note 144, art. 31(1); RESTATEMENT, *supra* note 140, § 325.

are "open" to all States, whether coastal or landlocked.[395] This provision, a central tenet of the Grotian tradition,[396] establishes what has been called the "universal use principle."[397] The freedoms of the high seas include, *inter alia*, the freedom to engage in navigation, fishing, and scientific research and to lay submarine pipelines and cables.[398] The 1982 LOS Convention fails, however, to define "fishing" or "marine scientific research."

Historically, the term "fishing" has been commonly applied to activities involving the harvest of a broad range of vertebrates and invertebrates, including not only the familiar finfish species, but also sponges, sea urchins, corals, sea cucumbers, squid, and sea snails.[399] After acknowledging a right of "fishing" on the high seas, the 1958 Convention on Fishing and Conservation of the Living Resources of the High Seas extends the verb "fishing" to the harvest of fish and "other living marine resources."[400] Within the United States, the MSA definition of "fish" extends to all forms of marine animal and plant life other than marine mammals and birds.[401] The Act's continental shelf "fishery" resources list includes six varieties of coral and four species of sponge.[402] Even the tiny Antarctic krill has been "fished."[403] These broad interpretations of the terms "fish" and "fishing" arguably provide a good faith basis for concluding that the freedom of "fishing" on the high seas is broad enough to include vent microbe

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395. The chapeau clauses of Article 86, which establish both "universal use" and "conditions on use" principles, control the enumeration of "high seas freedoms" listed in the article. LOSC, *supra* note 136, art. 86. The chapeau may thus be understood to provide a method for evaluating whether a use not included in the article's non-exhaustive list of freedoms nevertheless qualifies as a high seas freedom.

396. GROTIUS, MARE LIBERUM, *supra* note 224, at 29 (distinguishing those things that are exempt from private ownership on account of their "susceptibility to universal use"). Grotius justified high seas fishing freedoms in part on the inexhaustibility of those fish stocks. *Id.* at 57. For an argument that the twentieth century law of the sea has moved beyond the Grotian concept of high seas freedoms, see THOMAS A. FRANCK, FAIRNESS IN INTERNATIONAL LAW AND INSTITUTIONS 357-58 (1995).

397. Bernard H. Oxman, *The High Seas and the International Seabed Area*, 10 MICH. J. INT'L L. 526, 536 (1989).

398. LOSC, *supra* note 136, art. 86.

399. *See generally* U.S. Dep't of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Our Living Oceans: Report on the Status of U.S. Marine Living Resources: 1999*, at 109-15, 143-47, 183-87, 209-27 (1999) (assessing status of broad variety of marine invertebrates harvested by fishing industry).

400. The right of high seas fishing is recognized in Article 1. 1958 Convention on High Seas Fishing, *supra* note 220, art. 1. Articles 3, 4, 5, and 7 then go on to apply the terms of each article to "fishing" for "any stock or stocks of fish *or other living marine resources*." *Id.* arts. 3-5, 7 (emphasis added).

401. 16 U.S.C. § 1802(12) (1994). The Act further defines "fishing" as: (A) the catching, taking, or harvesting of fish; (B) the attempted catching, taking, or harvesting of fish; (C) any other activity which can reasonably be expected to result in the catching, taking, or harvesting of fish; or (D) any operation at sea in support. 16 U.S.C. § 1802(15) (1994).

402. 16 U.S.C. § 1802(7) (Supp. IV 1998).

403. *See* U.N. Food and Agriculture Organization, *Review of the State of the World's Fisheries: Marine Fisheries: "Southern Ocean,"* FAO Fisheries Circ. No. 920 FIRM/C920(En), *available at* http://www.fao.org/fi/publ/circular/c920/areax8tf.asp#AREAX8 (last visited Sept. 27, 2000).

collection activities.[404] That is not to suggest, however, that any nation had marine microbes in mind when it ratified the LOSC and its principle of the "freedom to fish" on the high seas. It should be enough, however, that the parties did intend that Article 87 would be made flexible and adaptable, through its "universal use principle" and the critical "*inter alia*" qualifier, and that *Alvin's* sample grabbing slurp gun could well be likened to a fishing trap without giving rise to a charge of bad faith in interpreting the convention.

Although Article 136 provides that the Area and its resources fall within the Part XI CHM regime, Article 133(a) limits the definition of the "resources" of the Area to mineral resources. In contrast to the definition of "sedentary species" in Article 77(4), the "resources" definition in Article 133 is refreshingly clear—no LMRs are included. Because Article 133 lacks the *inter alia* "extender" found in Article 87,[405] the familiar *expressio unius est exclusio alterius*[406] canon of construction supports the conclusion that Article 133 excludes resources other than mineral resources. A textual approach thus leads to the conclusion that no LMRs fall within the CHM regime established by Part XI. Despite the unambiguous textual evidence that LMRs are not presently included in the Part XI CHM regime, some might argue that the rules of interpretation recognized by the Vienna Convention on the Law of Treaties require the analysis to go beyond the text, to include an examination of the treaty's context and its object and purpose.[407] Such an examination in this case offers some support to both expansive and restrictive constructions of the CHM regime.

b. Contextual and Structural Evidence

In interpreting a treaty, the "context" includes the treaty's preamble.[408] The preamble to the LOSC lends some support for an expansive interpretation of the Part XI CHM regime. It acknowledges, for example, the desirability of an "equitable" utilization of the seas' resources[409] and recognizes that the Convention "will contribute to the realization of a just and equitable international

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404. Alternatively, collection activities may fall within the freedom to engage in marine scientific research on the high seas and in the Area. Under U.S. law, for example, activities that would normally constitute "fishing" are exempted from the MSA when conducted by a "scientific research vessel" engaged in scientific research. *See* 50 C.F.R. § 600.10 (1999). The question is discussed in Part V.D.

405. *See infra* note 440 and accompanying text.

406. A maxim of construction meaning that the expression of one thing implies the exclusion of anything not listed. *See* BLACK'S LAW DICTIONARY 602 (7th ed. 1999); *cf.* 2B NORMAN J. SINGER, STATUTES AND STATUTORY CONSTRUCTION § 47.23 (6th ed. 2000) (describing analogous canon in statutory construction).

407. Vienna Convention, *supra* note 144, art. 31. The argument is flawed to the extent that it seeks to rely on supplementary means (i.e., sources other than the treaty's text and context, in light of its object and purpose) to construe the convention's textual provisions except to (1) confirm an interpretation resulting from application of Article 31, or (2) to determine a meaning where Article 31 analysis leaves the meaning ambiguous or obscure or leads to a result which is manifestly absurd or unreasonable. *Id.* art. 32.

408. *Id.* art. 31(2).

409. LOSC, *supra* note 136, pmbl., para. 4.

economic order which takes into account the interests and needs of mankind as a whole and, in particular, the special interests and needs of developing countries."[410] By including the mineral resources of the Area within the CHM regime, the LOSC certainly did that. The preamble also cites the 1970 Declaration of Principles resolution by the U.N. General Assembly, which neither defined nor limited the "resources" to which it applied.[411] The effect of an express citation to the Declaration of Principles is subject to two possible interpretations. First, it could be argued that by citing the Declaration of Principles in the preamble, the parties sought to incorporate *all* of the principles the Declaration embodied into the LOSC. On the other hand, it might be inferred from the fact that the preamble cited the Declaration of Principles, while the body of the Convention limited the CHM regime to mineral resources, that the Convention, as drafted, represents the conferees' consensus on the full extent to which the CHM principle is to be applied to ocean resources.

The structure of the Convention, and its placement of the limited CHM regime in Part XI, which contains no direct provisions for conservation and management of LMRs,[412] argues against an interpretation that goes beyond the text, to include living resources in the CHM regime. In contrast to Part XI, the high seas regime found in Part VII of the Convention (particularly, Articles 116-119) provides a framework—admittedly inadequate, but nevertheless a legal framework—for access, conservation, and management of LMRs beyond national jurisdiction.[413] Under those articles, all States have a duty to take, or to cooperate with other States in taking, such measure for their respective nationals as may be necessary "for the conservation of the living resources of the high seas,"[414] and to cooperate with each other in "the conservation and management of living resources in the areas of the high seas."[415] To stretch the present definition of "resources" in Part XI to include sedentary species or any other LMRs would place those resources under a regime that presently includes no provision for their conservation or management. Arguably, this would frustrate the preambular goal of efficient utilization and conservation of marine living resources.[416]

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410. *Id.* pmbl., para. 5; THE OCEAN, OUR FUTURE, *supra* note 5, at 63-64.

411. LOSC, *supra* note 136, pmbl., para. 6; *see also Declaration of Principles*, *supra* note 240, paras. 1, 7 & 11(b).

412. It is true that Article 145 requires the ISA to prescribe rules for the protection of the marine environment and the protection and conservation of natural resources in the Area, the article addresses only the effects of mineral resource exploration and exploitation, not the direct harvest or collection of living marine resources. LOSC, *supra* note 136, art. 145.

413. The LOSC high seas fishing regime will presumably be supplemented by the 1995 Straddling Stocks Agreement, *supra* note 249, and the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, *done* at Rome, Nov. 24, 1993, S. TREATY DOC. 103-24 (1994) (not in force), *reprinted in* 33 I.L.M. 968 (1993).

414. LOSC, *supra* note 136, art. 117.

415. *Id.* art. 118.

416. *Id.* pmbl., para. 4.

Two additional structural points should be made with regard to the scope of the phrase "living marine resources" in the high seas articles of the LOSC. First, the same phrase is used in the EEZ articles in defining the ambit of a coastal State's sovereign rights over EEZ resources.[417] It follows from the "ordinary meaning" canon of construction in Article 31 of the Vienna Convention that identical phrases in the same instrument should be given the same construction, unless the context calls for a different meaning. Any construction of the phrase "living marine resources" in the EEZ articles that would deny a coastal State sovereign rights in microbes in the waters or on the seabed within its EEZ would almost certainly be rejected by all coastal States. Second, it is significant that the high seas "fishing" articles extend, with some qualifications, to marine mammals, thus making it clear that even within the high seas regime, the phrase "living marine resources" includes more than just fish species.[418]

c. Arguments for a Narrow Construction of High Seas Freedoms and an Expansive Construction of the CHM Concept

A contextual argument can be made that any judgment regarding classification of vent LMRs within the Area should be informed by the CHM concept.[419] Indeed, one writer unequivocally asserts that the bacteria of the vents already fall within the CHM regime.[420] In support of the argument, the 1970 U.N. Declaration of Principles resolution might be considered relevant "context" for interpreting Articles 133 and 136 of the LOSC. The desirability of grouping all closely related deep seabed resource exploration and exploitation activities under a single comprehensive regime, as Professor Bailey urged in support of the 1958 Convention on the Continental Shelf,[421] also provides a persuasive policy argument for an expansive interpretation of the CHM concept that includes all of the living and non-living resources in the Area.

The most logical legal rationale for what appears to be primarily a normative argument[422] for expanding the CHM concept to include some LMRs is that the 1970 U.N. Declaration of Principles resolution extends the CHM concept to a broader class of "resources" than do Articles 133 and 136 of the LOSC. It will be recalled, however, that the Declaration left open which "resources" its supporters contemplated.[423] Even Ambassador Pardo declined to elaborate on which

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417. *Id.* arts. 61, 62.

418. *Id.* art. 120 (providing that Article 65 of the Convention "also" applies to marine mammals on the high seas).

419. *See id.* pmbl., para. 6 (articulating the desire to "develop the principles embodied in" the Declaration of Principles).

420. *See* BORGESE, OCEAN GOVERNANCE AND THE UNITED NATIONS, *supra* note 251, at 48.

421. *See supra* note 388 and accompanying text.

422. THE OCEAN, OUR FUTURE, *supra* note 342, at 60 (arguing that "there is still a place for morality in [ocean] politics").

423. *See supra* note 342 and accompanying text.

"resources" fell within the CHM principle he espoused.[424] Thus, we can only speculate on its meaning in that context, and the case for an existing norm in the law of the sea that extends the CHM principle beyond the mineral resources of the Area has not been made.[425] Moreover, even if one could reasonably conclude that those nations that voted for the Declaration in 1970 intended that it would apply to living resources on the deep seabed, the Declaration lacks the force of law. The U.N. General Assembly has no legislative authority.[426] Although some have argued that Assembly resolutions may serve as evidence of emerging customary law,[427] the better view holds that they have that status only if the nation voting in favor of the resolution did so with the intent to be bound, thus meeting the *opinio juris* requirement.[428] Persuasive evidence that any given State did not intend to be bound by the Declaration of Principles might be found in contemporaneous statements by Assembly delegates clarifying their understanding of the Declaration,[429] and in the fact that a particular State voted against the earlier Moratorium resolution[430] and was persistent in its objection to it.[431]

An alternative rationale offered in favor of the expansive interpretation of the Part XI CHM regime is that the CHM concept is now *jus cogens*—a peremptory norm under international law.[432] A peremptory norm is a norm of international

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424. *See supra* note 343 and accompanying text. CHM proponents most likely did not intend to limit the term "resources."

425. That is not to say, however, that such a case could not be made, at least with respect to those States that also voted for the 1969 Moratorium Resolution.

426. *See* Voting Procedure on Questions Relating to Reports and Petitions Concerning the Territory of South-west Africa, 1955 I.C.J. 67, at 115 (June 7) (separate opinion of J. Lauterpacht); RESTATEMENT, *supra* note 140, § 103 cmt. c & n. 2 (concluding that "[e]ven a unanimous resolution may be questioned when the record shows that those voting for it considered it merely a recommendation or a political expression").

427. For an argument that U.N. General Assembly resolutions have "significance for the formation of international law," see Van Dyke & Yuen, *supra* note 328, at 524-26, 529; *cf.* IAN BROWNLIE, PRINCIPLES OF PUBLIC INTERNATIONAL LAW 14-15 (4th ed. 1990) (concluding that General Assembly resolutions adopted by a majority vote may "provide a basis for the progressive development of the law and the speedy consolidation of customary rules.").

428. CHURCHILL & LOWE, *supra* note 147, at 9-10; BROWN, *infra* note 441, at 541.

429. Express limiting comments were made by representatives of the U.K., Australia, Canada, Norway, and Peru. BROWN, *infra* note 441, at 543-44. Hamilton Shirley Amerasinghe, later president of UNCLOS III, commented the "[t]he Declaration cannot claim the binding force of a treaty internationally negotiated and accepted, but it is a definite step in that direction." Remarks by H. S. Amerasinghe before General Assembly, 25 U.N. GAOR (1933d mtg.), at 21, ¶ 245, U.N. Doc. A/PV.1933 (1970). Suggesting a natural law component, he also noted that the Declaration had an "element of moral authority that is more binding than treaties." *Id.* Certainly, none would question that moral considerations influence the content of law over time. *See* H.L.A. HART, THE CONCEPT OF LAW 199-200 (1961).

430. The 1969 Moratorium, under which States were "bound to refrain" from seabed mining until an international regime could be established to regulate such activities, passed by a vote of 62 to 28, with 28 States abstaining. *See* G.A. Res. 2574D(XXV), U.N. GAOR 24th Sess., Supp. No. 30, U.N. Doc. A/2834 (1969), *reprinted in* 9 I.L.M. 419 (1970).

431. RESTATEMENT, *supra* note 140, § 102 note 2 (singling out the U.N. Moratorium resolution as one to which the United States was not bound because it voted against the resolution); *see also* CHURCHILL & LOWE, *supra* note 147, at 227, 235.

432. BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 117. *But see* Christopher C. Joyner, *Legal Implications*

law not subject to derogation by treaty.[433] Those who argue the CHM principle is a peremptory norm point to Article 311(6), in which the parties to the LOSC agree "that there shall be no amendments to the basic principles relating to the common heritage of mankind set forth in article 136. . . ." An examination of the *travaux préparatoires* for Article 311 actually reveals, however, that the UNCLOS III conferees adopted the current version of the article after rejecting a proposal by Chile to label the CHM principle a peremptory norm.[434] Moreover, it is not even clear how Article 311(6) advances the argument for a construction of Article 136 that expands the textual definition of "resources" of the Area beyond "mineral" resources. The strength of the peremptory norm argument is also undermined by the substantial amendments effected by the 1994 Part XI Implementation Agreement.[435] The 1994 amendments plainly scaled back the original Part XI regime.[436] The widespread support for, and ratification of, the 1994 Agreement provides evidence that the majority of States likely do not believe the CHM regime is a peremptory norm.[437]

d. Arguments for a Broad Construction of High Seas Freedoms and Narrow Construction of the CHM Concept

Although both the geographic and functional extent of the high seas freedoms was curtailed by the 1982 LOSC, particularly by Parts V and XI, the freedoms are still broad, as are the State obligations that accompany those freedoms. Professors Churchill and Lowe highlight the flexible and adaptable nature of the high seas articles in Part VII, pointing out that "because new ocean technology is constantly developing, the freedoms of the high seas cannot be exhaustively listed."[438] They reason that, in analyzing an ocean use not specifically listed in Article 87 as a potential high seas freedom, disputes should be resolved by asking

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of the Concept of the Common Heritage of Mankind, 35 INT'L & COMP. L.Q. 190, 199 (1986) (concluding that the "most" that can be said about the CHM concept is that it "may" indicate an emergent principle of international law).

433. Vienna Convention, *supra* note 144, art. 53; *see also* RESTATEMENT, *supra* note 140, § 102 cmt. k.

434. Chile proposed to label the CHM expressly as "a peremptory norm of general international law from which no derogation is permitted." Informal Proposal by Chile at Eighth Session of UNCLOS III, *reprinted in* CONCEPT OF COMMON HERITAGE, *supra* note 333, at 376.

435. THE OCEAN, OUR FUTURE, *supra* note 5, at 60 (observing that the 1994 agreement reduced the application of the CHM regime).

436. One critic of these amendments to the LOSC labeled the Part XI Implementation Agreement a "flagrant violation of international law." BORGESE, OCEAN GOVERNANCE AND THE UNITED NATIONS, *supra* note 251, at 6, 44-45.

437. *See* Vienna Convention, *supra* note 144, art. 31(3)(a) (providing that subsequent agreements by the parties constitute relevant context for interpreting the treaty).

438. CHURCHILL & LOWE, *supra* note 147, at 205; *see also* MCDOUGAL & BURKE, *supra* note 51, at 927 (describing four policy issues that must be addressed in any governance regime for the appropriation of living marine resources beyond national jurisdiction).

whether the use is "compatible with the status of the high seas."[439] They conclude that if the use involves no claim to appropriation of the high seas, involves no unreasonable interference with the rights of others on the high seas and is not expressly excluded by the convention, the use should be admitted as a high seas freedom.[440] It can be asserted in good faith that the collection of LMRs by marine scientists from vents lying within the Area or in the surrounding waters of the high seas, or even LMR harvesting by bioprospectors in those areas, falls within the freedom to fish, to engage in marine scientific research or, perhaps, an unspecified hybrid of those two high seas freedoms.[441] Those high seas freedoms, when exercised with due regard to the interests of other States under the Convention and in accordance with measures implementing Part XII of the Convention, embrace the freedom to capture, study, and use the living resources beyond any nation's jurisdiction. Over two decades of State practice confirms the soundness of this interpretation. Marine scientists have been collecting biological samples from the vent chimneys and the surrounding waters and seabed within the Area since at least 1979,[442] without any apparent objection.[443] Even after those specimens were put to commercial use in biotechnology application, there is no evidence that any State or international organization protested the activity as a violation of international law.[444] Nor has my research uncovered evidence that any nation has enacted legislation restricting the right of its vessels or nationals to gather biological samples from vent sites on the high seas or within the Area on grounds that the resources were governed by the CHM regime.

On the other hand, several factors militate against an expansive construction of the CHM concept. First, the UNCLOS III *travaux préparatoires* demonstrate that the conferees rejected a broader definition of "resources" of the Area that would have included living resources.[445] Even Ambassador Pardo, author of the CHM

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439. CHURCHILL & LOWE, *supra* note 147, at 206.

440. *Id.*

441. The list of high seas freedoms in Article 87(1) are preceded by the *inter alia* qualifier, indicating the list is not exhaustive. LOSC, *supra* note 136, art. 87(1); CHURCHILL & LOWE, *supra* note 147, at 205; 1 E.D. BROWN, THE INTERNATIONAL LAW OF THE SEA 281 (1994); *see also SBSTTA Bioprospecting Report*, *supra* note 52, at ¶ 11 (concluding that this is the "most plausible" interpretation of the LOSC).

442. VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, at xvii.

443. None of the U.N. Secretary-General reports on oceans and the law of the sea for the last five years indicate any State objections to the collection of vent organisms from sites in the Area, despite the fact that bioprospecting activities have been acknowledged in those same reports. *See, e.g.*, *1999 U.N. S-G Report on Oceans and the Law of the Sea*, *supra* note 53, ¶ 509.

444. This conclusion is also based on a review of the relevant annual reports by U.N. Secretary-General and the related reports the International Seabed Authority and Intergovernmental Oceanographic Commission.

445. As late as 1975, the UNCLOS III Informal Single Negotiating Text included a definition of "resources" of the Area that was not limited to mineral resources. *See* United Nations, Informal Single Negotiating Text, U.N. Doc. A/CONF.62/WP.8, arts. 1(iii), 3 (May 7, 1975) (defining the "resources" of the Area as "resources *in situ*"); Revised Single Negotiating Text, U.N. Doc. A/CONF.62/WP.8/Rev. 1 (May 6, 1976) (defining "resources" of the Area as "mineral resources *in situ*"); CONCEPT OF COMMON HERITAGE, *supra* note 333, at

concept, acknowledged that the final text of the LOSC "severely limited" the CHM regime.[446] Second, the "exhaustibility" argument offered in support of extending the CHM to the seabed's mineral resources before the LOSC entered into force is inapposite to vent LMRs.[447] The exhaustibility argument reasoned that because the mineral resources of the deep-sea are exhaustible, if they may be legally appropriated by any entity, the technologically advanced nations will exploit them to the exclusion of developing nations. Although deep seabed vents are neither common nor easily accessible, the living resources of the vents appear to be renewable. In fact, as one commentator concluded in looking at the probable collection and research cycle for vent microbes, "unlike the situation for fisheries (or even mineral mining), one person's access to the Area's microbial genetic resources and their subsequent use does not measurably diminish a fixed stock at the subsequent expense of another."[448] Third, in contrast to seabed mining claims, the rational development of which requires a regime that provides for preemptive claims to mining sites to effectively exclude all but the authorized miner, LMR collection efforts, as presently practiced, require no such exclusivity. Finally, any expansion of the CHM concept to resources other than seabed minerals is in derogation of a centuries-old tradition of broad high seas freedoms, and only an express or implied intent by States to diminish the scope of those freedoms, voluntarily assumed, carries the legitimacy necessary to serve as a binding norm.[449]

e. Arguments for Application of "Rules and Principles of General International Law" to Identifiable Lacunae

Notwithstanding the LOSC's encyclopedic 320 articles and nine annexes, many important law of the sea questions will continue to be resolved through State practice, both as an aid in interpreting the multitudinous terms in the Convention and as a potential source of new customary law.[450] Recognizing that "the problems of ocean space are closely related and need to be considered as a

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98-99, 211, 272, 274, 299, 304, 330 & 338 (chronicling the development of the definition of "resources" of the Area in UNCLOS III).

446. *See* Arvid Pardo, *An Opportunity Lost*, *in* THE LAW OF THE SEA: U.S. POLICY DILEMMA 13, 22 (Bernard H. Oxman ed., 1983).

447. *See, e.g.*, Van Dyke & Yuen, *supra* note 328, at 509-11 (articulating the "exhaustibility" rationale for extending the CHM principle to manganese nodules).

448. Glowka, *The Deepest of Ironies*, *supra* note 1, at 169.

449. This conclusion is based in part on the view that what is not prohibited by positive law is permitted. Nothing in Parts VII (high seas) or XI (the Area) presently precludes a freedom to collect, study and exploit seabed microbes, so long as the activities are conducted with due regard to the interests of other States and in accordance with other relevant provisions of the LOSC.

450. Burke, *State Practice*, *supra* note 1, at 222-23 (concluding that "[o]ver time the *practice* is what determines the purport of the treaty" (emphasis added); *see also* Vienna Convention, *supra* note 144, art. 31(3)(b) (recognizing, as an extrinsic interpretive aid, subsequent State practice in the application of the treaty).

whole,"[451] the drafters of the LOSC strove to produce a constitution for the seas that would address "all issues relating to the law of the sea."[452] At the same time, however, they recognized that the final document could not, and did not, address all known ocean-related legal issues, much less the unknown or the unforeseen. The Convention therefore makes two allowances for the application of "other law." First, the Preamble to the Convention provides that the rules and principles of general international law will continue to govern "matters" not regulated by the Convention.[453] Similarly, Article 87, which affirms the principle of freedom of the high seas, provides that the high seas freedoms are to be exercised under the conditions laid down by the Convention and by "other rules of international law."[454] Second, Article 311 of the Convention provides for the continued validity of other treaties "not incompatible with the LOSC."[455] The role of other conventions to supplement the LOSC is most recently demonstrated by negotiations on the proposed Convention on the Protection of Underwater Cultural Heritage,[456] addressing an issue described by one commentator (who is apparently unaware of the emerging deep seabed vent issues) as "the last major issue of a global nature which needs to be resolved in the law of the sea."[457] We thus encounter in the LOSC a treaty that, while ambitious in its scope, is not an exhaustive codification of the law for ocean space.

Under the prevailing, positivist view, international law is based on express or implied State consent.[458] There is broad agreement on a number of principles that govern the seabed and the superjacent high seas. Exclusive national claims over either domain are prohibited.[459] Both domains are reserved exclusively for peaceful uses.[460] Both are open to freedom of navigation[461] and marine scientific research.[462] The regime for each domain addresses certain classes of resources and activities. It must be acknowledged, however, that there is no reasonable basis for concluding that the international community has yet reached an express agreement in the LOSC on the issues relating to access to resources of the vents.

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451. LOSC, *supra* note 136, pmbl., para. 3

452. *Id.* pmbl., para. 1.

453. *Id.* pmbl., para. 8.

454. *Id.* art. 87(1).

455. *Id.* art. 311.

456. *See* UNESCO, *Draft Convention on the Protection of Underwater Cultural Heritage*, UNESCO Doc. CLT.98/CONF.202/CLD.5 (1999).

457. Alastair Cooper, *The Principal Issues in Underwater Cultural Heritage*, 20 MARINE POL'Y 283, 285 (1996).

458. *Cf.* The Lotus (Fr. v. Turkey), 1927 P.C.I.J. (ser. A) no. 10, at 18 (holding that international law is entirely generated by positive acts of States and emanating "from their own free will as expressed in conventions or by usages generally accepted as expressing principles of law"); *see also* OSCAR SCHACHTER, INTERNATIONAL LAW IN THEORY AND PRACTICE 9-10 (1995).

459. *See* LOSC, *supra* note 136, arts. 89, 137.

460. *See id.* arts. 88, 141.

461. *See id.* arts. 87(1)(a), 141.

462. LOSC, *supra* note 136, arts. 87(1)(f), 143(3).

It might therefore be argued that the absence of agreement on access to vent LMRs necessarily leaves a lacuna respecting those resources.

The preambular paragraph of the LOSC saving application of general international law in matters not governed by the Convention certainly opens the door for the development of new customary law norms through the familiar practice of claim and response. If, as a few argue, all of the resources of the Area fall within the CHM principle articulated in the 1970 Declaration of Principles,[463] the concept should be allowed to ripen into a customary rule of law, rather than attempt to achieve the desired result through a tortured interpretation of Part XI that is unlikely to attract widespread support. In the meantime, however, there is at the very least a good faith argument that access to vent LMRs in the Area falls within the inclusive high seas freedoms.

4. Is there a Distinctive Regime under the LOSC for the Genetic Resources of Vent Organisms?

The difficulty and expense of accessing vent sites to collect biological samples makes it unlikely that the biological resources of vent fields will ever be directly consumed or harvested for extraction of useful compounds. It is more likely that the organisms collected from vent sites will be examined for potentially useful traits that can be put to productive use through extraction and application of the organism's genetic code and the biochemical processes it regulates. Thus, it is the genetic resources of vent organisms that are most likely to be the objects of commercial interest.

The potential biotechnology applications of the vents' unique genetic resources may lead some to question whether the LOSC provides a distinct regime to govern access to and exploration and exploitation of the genetic resources. The answer must be 'no.'[464] Nowhere does the text of the Convention distinguish between living marine resources—sedentary or otherwise—and their genetic material. Moreover, there is no evidence that the LOSC has so far been interpreted as providing such a distinction in cases involving marine resources that have, for decades, been collected from the sea and used in biotechnology applications. Thus, no particular regime applies to the genetic resources of the high seas.[465] In fact, it will be seen in Part VI of this article that a principal purpose of the Convention on Biological Diversity, adopted ten years after the

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463. *See supra* note 419 and accompanying text.

464. Glowka, *The Deepest of Ironies*, *supra* note 1, at 168-69. It might be argued that the outline for a regime for marine genetic and biotechnology research is already provided by the Convention's framework articles for the conduct of marine scientific research and for technology transfer in Parts XIII and XIV of the Convention. Those issues are addressed in the following section.

465. *See SBSTTA Bioprospecting Report*, *supra* note 52, at ¶ 12 (concluding that the result occurred "by accident rather than design").

LOSC, was to address issues regarding access to genetic resources and the equitable sharing of the benefits obtained from them.

Recognizing the failure of the LOSC to directly confront the legal issues surrounding access to genetic resources of the deep seabed and the distribution of benefits obtained from those resources, long-time ocean policy advocate Elizabeth Mann Borgese, among others, has proposed a revision to Article 133 of the 1982 LOSC, which would add both sedentary species and genetic resources of the deep seabed to the definition of "resources" of the Area.[466] It is important to recognize, however, that the proposal must be seen as an effort to establish new law, not simply clarify existing law.

D. LEGAL CLASSIFICATION OF VENT RESEARCH ACTIVITIES

Part XIII of the Convention, together with MSR related provisions in the EEZ, continental shelf, high seas, and deep seabed Area articles, establishes the principles, rights, and obligations in respect of MSR activities. To determine the extent to which the LOSC articles on MSR rights and obligations apply to activities involving seabed vents, it is important to understand both the nature of the at-sea research activities and their likely applications, before turning to the text of the relevant Convention articles. As was the case in the previous section, which examined how the Convention's LMR provisions apply to vent resources, State practice, including the absence of State objection to known claims and activities, will also clarify both the scope of the Convention's MSR articles and their meaning.[467] As will be shown in Part VI of this article, in many cases the CBD supplements the LOSC regime governing access to living and genetic resources of the sea. Thus the two conventions must be read together when examining MSR questions arising within States that are party to both.

Within the United States, vent researchers are associated primarily with universities and government agencies. Their activities to date appear to fall squarely within the field of "marine scientific research," as that term is commonly understood.[468] It may be asked, however, how the MSR legal regime will apply if in the future the submersible diving on the Mid-Atlantic Ridge vent field is operated not by the Woods Hole Oceanographic Institution, but by a contractor under charter to a multinational biotechnology firm? Alternatively, what if a U.S. university sponsoring an oceanographic expedition to a vent site on the Canadian continental shelf encourages its researchers to seek out, and even to license, commercial applications of their research findings, perhaps in collaboration with private biotechnology companies? And if some of the mineral samples obtained

466. *See* BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 170-71, 199.

467. *See* Vienna Convention, *supra* note 144, art. 31(3)(b) (providing that subsequent practice by the parties constitutes relevant context for interpreting the treaty).

468. *See supra* Part III.A.

by university researchers during a dive to a vent field are later delivered to a marine mining firm, which uses its analysis of those samples to later apply for a mining permit from the ISA, will the university's at-sea activities be deemed "prospecting" or "exploring" rather than MSR? To answer these questions, a distinction must be drawn between marine scientific research and prospecting or exploring for mineral or biological samples, or exploiting those resources. In some cases, those distinctions can only be approximated from the text of the LOSC itself. As the following preliminary analysis will demonstrate, some of the regime will necessarily be developed through State practice or (less likely) by new international agreements addressed specifically to vent resources.

1. The Principles of Marine Scientific Research

Article 238 of the LOSC brings MSR activities within the "universal use principle."[469] More than that, all States and the relevant international organizations have a duty to promote and facilitate MSR and to create favorable conditions for such research.[470] The lofty status accorded to MSR activities by the LOSC is warranted by the "urgent need" for greater scientific knowledge of the marine environment[471] and the importance of MSR to the well-being of humankind.[472] Article 240 of the Convention prescribes a number of principles to guide MSR activities.[473] Such research shall be conducted exclusively for peaceful purposes. Researchers are required to use appropriate scientific methods and means that are compatible with the Convention. MSR activities must not unjustifiably interfere with other legitimate uses of the sea. Finally, Article 240 requires that MSR activities comply with all environmental protection regulations adopted in conformity with the LOSC.

2. Not All Research is "Marine Scientific Research"

The vent research activities described in Part III fall squarely within the commonly understood meaning of marine scientific research: activities intended for peaceful purposes and to increase scientific knowledge of the marine

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469. LOSC, *supra* note 136, art. 238 (providing that "[a]ll States irrespective of their geographical location, and competent international organizations have the right to conduct marine scientific research subject to the rights and duties of other States as provided for in this Convention").

470. *See id.*, arts. 239, 242-243.

471. *See* CBD, *supra* note 254, pmbl., para 7 (acknowledging urgent need to develop scientific basis for CBD implementation); Agenda 21, *supra* note 248, ¶ 16 (setting out a program of action for sound management of biotechnology to, inter alia, increase food supply, improve human health and protect the environment) & ¶ 17.46(g) (calling for promotion of MSR on high seas resources).

472. *See generally Marine Scientific Research: Report of the Secretary-General, Law of the Sea*, U.N. Doc. A/45/563 (1990) (describing some of the benefits of MSR activities) [hereinafter U.S. SECRETARY-GENERAL REPORT ON MARINE SCIENTIFIC RESEARCH].

473. LOSC, *supra* note 136, art. 240.

environment for the benefit of all humankind. Vent research findings are generously reported and have been made easily accessible through international organizations like the InterRidge network.[474] Vent research activities have the potential to dramatically increase our understanding of the planet, its geologic and volcanic processes, and even the origin of life and its evolution. In addition, the multitude of practical applications of those research findings hold out tremendous promise for improving the human condition. Finally, it is important to bear in mind that marine scientists—and significantly more research by those scientists—will be indispensable to the ongoing efforts to evaluate the environmental impact assessment and protection measures of the new ISA Mining Code, thereby providing the ISA with the information it will need to meet its obligations under Article 145, and in identifying "rare or fragile ecosystems" and habitats of depleted, threatened, or endangered species that must be accorded special protection measures under Article 194(5). Most would therefore agree that the law should encourage responsible MSR activities, not hobble researchers further with obscure definitions and Byzantine access regimes.[475] The "universal use principle," the duty to promote and facilitate MSR, and our urgent need to better understand ocean space require nothing less.

In the future, as vent research activities assume greater commercial importance, it may become necessary to determine how those activities should be classified under the existing legal regime. A given research activity might variously be classified as "marine scientific research," "prospecting" for resources under Part XI, or "exploring and/or exploiting" living or non-living resources. Indeed, a single cruise or expedition might involve activities falling within each of those categories. The consequences that follow from the activity's classification can be dramatic.[476] There is, for example, a freedom to engage in marine scientific research and to harvest marine living resources on the high seas and in the seabed of the Area.[477] By contrast, mineral resource prospecting, exploration, and exploitation in the Area are controlled by the ISA.[478] Some commentators advocate that in the future the ISA's regulatory authority be extended to seabed living and genetic resources.[479] States and international research organizations also have a duty to publish or disseminate their MSR

474. *See supra* note 52 and accompanying text. For information on InterRidge activities, see the organization's web site: http://triton.ori.u-tokyo.ac.jp/~intridge/ (last visited Aug. 19, 2000).

475. Although the present regime falls short of providing much needed MSR access to areas under national jurisdiction, it nevertheless preserves a right of access to the Area and the high seas beyond 200 NM.

476. Even the question of sovereign immunity for a State-owned vessel might turn on whether the vessel is engaged in MSR or a "commercial" purpose, such as resource exploration or exploitation. LOSC, *supra* note 136, art. 96 (extending immunity to State-owned vessels used "only on government non-commercial service"); RESTATEMENT, *supra* note 140, § 512 note 6 & § 513 cmt h.

477. LOSC, *supra* note 136, art. 256.

478. *Id.* Annex III, arts. 2-3.

479. BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 188, 199.

findings.[480] By contrast, information gained through prospecting, exploring, or exploiting efforts is generally considered proprietary and kept confidential.[481]

The 1982 LOSC fails to define marine scientific research and never uses the term "biological prospecting."[482] Those familiar with the negotiating history of the MSR regime from UNCLOS I through UNCLOS III understand why: States simply could not agree on a legal definition of scientific research.[483] The issue of MSR access into areas under coastal State jurisdiction was addressed only briefly in the 1958 Convention on the Continental Shelf. In describing the consent regime for such access, Article 5(8) of the Convention on the Continental Shelf provided that the coastal State could not normally withhold consent if the request came from a "qualified institution with a view to *purely scientific research* into the physical or biological characteristics of the continental shelf."[484] Disputes over what constituted "pure" scientific research were apparently common, and resulted in a number of U.S. researchers being denied access to research on the continental shelves of other nations.[485] The decade of UNCLOS III negotiations provides stark evidence that many nations were deeply suspicious that purportedly "pure" research was commonly used as a subterfuge by other nations to gain access to the coastal waters of less developed nations, purely for the researching nation's own economic or military aims.[486]

In the end, the 1982 LOSC did not define marine scientific research or distinguish between "pure" and "applied" research.[487] Nor does it provide a

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480. LOSC, *supra* note 136, art. 244.

481. Annex III, article 14 of the LOSC attempts to accommodate the prospective miner's interest in protecting its proprietary data from disclosure and the ISA's need for data necessary to effectively regulate seabed mining in the Area. *See also ISA Mining Code for Nodules*, *supra* note 115, reg. 6 & pt. VI (setting out the Mining Code confidentiality provisions).

482. Although not defined in the LOSC, "bioprospecting" has been defined within the CBD organization as "the process of gathering information from the biosphere on the molecular composition of genetic resources for the development of new commercial products." *SBSTTA Bioprospecting Report*, *supra* note 52, ¶ 31.

483. SOONS, *supra* note 146, at 110, 119-25; *see generally* U.N. DIVISION FOR OCEAN AFFAIRS AND THE LAW OF THE SEA, THE LAW OF THE SEA: MARINE SCIENTIFIC RESEARCH: LEGISLATIVE HISTORY OF ARTICLE 246 OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA, 1-3, 6-7, 11-15, U.N. Sales No. E.94.V.9 (1994) (documenting early attempts to define scientific research) [hereinafter MSR LEGISLATIVE HISTORY].

484. Convention on the Continental Shelf, *supra* note 179, art. 5(8) (emphasis added).

485. ARTHUR W. ROVINE, 1974 DIGEST OF UNITED STATES PRACTICE IN INTERNATIONAL LAW 370-74 (1975) (quoting testimony by John Norton Moore to House Committee on Judiciary, Subcommittee on Immigration, Citizenship and International Law, Mar. 14, 1974).

486. *See, e.g.*, MSR LEGISLATIVE HISTORY, *supra* note 483, at 82-83 (quoting remarks by Chinese delegate, arguing that "[i]t was a well-known fact that the Super-Powers, relying on their superiority in marine technology, were stealthily gathering marine intelligence on a large scale in order willfully to plunder marine resources under the screen of scientific research. To justify themselves, the Super-Powers had resorted to the fallacy of so-called 'pure science' ").

487. *See* Burke, *State Practice*, *supra* note 1, at 221 (observing that the MSR provisions were, like several other provisions, "vigorously contested in the [UNCLOS III] negotiations, with the result being built-in ambiguity and generality"). The U.N. MSR Implementation Guide concludes that problems in drawing a distinction between pure and applied research in Article 246 were a key reason "the drafters of the Convention included article 251, urging States to promote through competent international organizations the establishment

bright line test for distinguishing MSR from exploring or exploiting resources. It does, however, distinguish between research carried out "exclusively for peaceful purposes and in order to increase scientific knowledge of the marine environment for the benefit of all mankind" and "research having a direct significance for the exploration and exploitation of natural resources."[488] That sub-classification of MSR activities is relevant, however, only in the context of coastal State consent to research in the EEZ or on the continental shelf.

The evolution of the 1991 MSR Implementation Guide by the U.N. Office (now Division) for Ocean Affairs and the Law of the Sea reveals the on-going difficulties in defining marine scientific research. A 1989 draft of the Implementation Guide was circulated among a Group of Experts on Marine Scientific Research in September 1989.[489] The 1989 Draft concluded that "marine scientific research" did not include research having a "direct significance for the exploration and exploitation of natural resources."[490] Close study of the text of Article 246 and the overall structure of Part XIII reveals that the 1989 Draft conclusion was in error. While it is true that the final version of the MSR articles applicable to the EEZ and continental shelf regime distinguish research having a direct significance for the exploration and exploitation of natural resources from other research, the object of which is to increase scientific knowledge of the marine environment for the benefit of all humankind, both categories of research are subsumed under the broader category of "marine scientific research."[491] The final Implementation Guide issued two years later deleted the erroneous conclusion.[492] At the same time, the final Guide acknowledges that the Convention distinguishes between MSR and hydrographic surveys,[493] and prospecting and exploration activities.[494]

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of general criteria and guidelines for ascertaining the nature and implications of marine scientific research." *See* MSR IMPLEMENTATION GUIDE, *supra* note 146, at 12.

488. LOSC, *supra* note 136, art. 246.

489. U.N. Office for Ocean Affairs and the Law of the Sea, *Marine Scientific Research: A Guide to Implementation of the United Nations Convention on the Law of the Sea*, 2d rev. draft, Sep. 1, 1989 [hereinafter *Draft MSR Implementation Guide*] (copy on file with the author).

490. The Draft concluded that:

> The Convention does not contain a definition of marine scientific research. Considering this term in its context, it may be deemed to cover any scientific investigation conducted at sea having the marine environment as [its] object, with the exclusion of those that have direct significance for the exploration and exploitation of natural resources.

Id. at 3, para. 8.

491. If the chapeau of Article 246 is read to control each of the items on the list that follows, the "excludable" activities are not excluded from the definition of "marine scientific research"; they are simply MSR activities for which the coastal State may deny consent. Moreover, a persuasive structural argument can be made that any research that complies with the general principles established by Article 240 of the Convention constitutes "marine scientific research," and is, therefore, subject to the rights and obligations imposed by the Convention.

492. *See* MSR IMPLEMENTATION GUIDE, *supra* note 146, at 1, ¶ 2.

493. *See* LOSC, *supra* note 136, arts. 19(2)(j), 21(1)(g), 40.

494. *See* MSR IMPLEMENTATION GUIDE, *supra* note 146, at 1, ¶ 2 (concluding that because survey activities,

The final Guide confirms the conclusion that activities of "direct significance" to resource exploration/exploitation fall within the broader class of "marine scientific research" by listing the "direct significance" activities as one of the two categories of marine scientific research that are not subject to "normal" consent.[495] In the final analysis, however, the question will likely be academic. Coastal States that are disinclined to grant MSR access requests where the planned activities concern resources over which the coastal State has sovereign rights may simply avoid the MSR issue by deeming such activities an "exploration" for "resources." Support for such a position may be found in the opinion of a leading commentator on MSR issues under the LOSC, who points out that it makes no sense to talk about "research" relating to "exploration" for resources. "Exploration" is commonly understood to refer to activities undertaken with a view to possible future exploitation of those resources.[496] Alternatively, a coastal State might take the position that the meaning of "resources" under Article 246(5)(a) of the LOSC incorporates the broader definitions of "biological resources" and "genetic resources" under the CBD, which include such resources even if they have only a *potential* value.[497] The effect would be to vastly expand the discretion of coastal States to deny MSR access within their EEZ or on their continental shelf, or to require the researchers to obtain "prior informed consent" and reach "mutually agreed terms" with the coastal State before access is granted.[498]

It seems likely that some sample collecting activities at vent sites in the future will constitute "prospecting" or resource "exploration/exploitation" and, therefore, will not fall within the MSR regime. To the extent that a researcher collects samples of seabed mineral resources within the Area, the activity may constitute "prospecting."[499] Prospecting under the regime for the Area precedes the resource exploration and exploitation phases. Article 2 of Annex III to the Convention imposes upon the ISA a duty to encourage and regulate prospecting

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prospecting and exploration are governed elsewhere in the Convention, "this *could* indicate that these activities do not fall under the regime of Part XIII") (emphasis added). Professor Soons concludes that "exploration" refers to "data collecting activities concerning natural resources conducted specifically in view of the exploitation (i.e., economic utilization) of those resources." SOONS, *supra* note 146, at 170-71. He therefore infers that "marine scientific research" must refer to "those data collecting activities (irrespective of their object) which are *not* conducted specifically in view of the exploitation of natural resources." *Id.* at 171 (emphasis in original).

495. MSR IMPLEMENTATION GUIDE, *supra* note 146, at 11, ¶ 54.

496. SOONS, *supra* note 146, at 59.

497. CBD, *supra* note 254, art. 2.

498. *See id.* art. 15. This issue is more fully discussed in Part VI.A.3.

499. Within the deep seabed mineral regime, "prospecting" generally refers to activities that precede exploration and exploitation, both of which require consent by the ISA. *See* LOSC, *supra* note 136, Annex III, art. 2; *ISA Mining Code for Nodules*, *supra* note 115, reg. 1(e); CHURCHILL & LOWE, *supra* note 147, at 248. The LOSC uses the term "prospecting" only in the context of the mineral resources of the Area. No similar term has yet been applied to living marine resources under the LOSC.

in the Area,[500] a duty that might cause some to challenge those who advocate that the ISA's authority be expanded to include LMRs within the Area.[501] Before undertaking prospecting in the Area, a prospector must notify the ISA of the location of the proposed activity and submit a written undertaking to the ISA agreeing to comply with all relevant regulations.[502] Although prospectors do not gain any rights with respect to resources in the Area from their prospecting activities, they are permitted to recover a "reasonable quantity" of minerals to be used for later testing.[503] State practice and ISA acquiescence to date appear to recognize that marine scientific researchers may collect mineral samples from seabed vent fields within the Area without triggering of Part XI's "prospecting" provisions.[504] It is hoped that the issue will be addressed in the forthcoming ISA regulations on prospecting for polymetallic sulfides and other minerals, to lessen the likelihood of future conflicts between true marine scientific research expeditions to vent fields in the Area and mineral prospecting activities.[505]

Activities involving the sampling of living resources from seabed vent fields beyond national jurisdiction may soon draw attention to the distinction between MSR and the harvesting of living resources. Contemporary collection activities fall squarely within the express right to conduct MSR activities on the high seas or the Area. Ironically, however, MSR activities in the Area are subject to restrictions not applicable to entities that "harvest" LMRs from the Area. Those who harvest LMRs from the seabed within the Area are free to put those resources to any lawful, wholly private use, subject only to the ordinary limitations on high seas freedoms.[506] MSR in the Area must, however, be carried out exclusively for peaceful purposes and for the benefit of humankind as a whole.[507] Thus, at first glance, it would appear that marine scientists are more restricted in the uses to which they may apply samples obtained from the Area than are non-scientist "bioprospectors." Closer examination reveals, however, that the distinction may not be as significant as it first appears. The requirement that MSR be for peaceful purposes, merely repeats the first of the general

500. LOSC, *supra* note 136, Annex III, art. 2.

501. Indeed, some might view the ISA as the international equivalent of the U.S. Department of Interior Minerals Management Service, and question whether an agency that has a duty to promote mineral production and obtain lease revenues from mining interests is the best choice to also oversee the conservation and management of living resources that are likely to be impacted by those mining activities.

502. LOSC, *supra* note 136, Annex III, art. 2(1)(b).

503. *See ISA Mining Code for Nodules*, *supra* note 115, reg. 2(4).

504. The conclusion is based on the absence of any reported objection by a State or the ISA to mineral sample collection activities by researchers to date.

505. See U.N., International Seabed Authority, *Report of the Secretary-General of the International Seabed Authority under Article 166, paragraph 4 of the United Nations Convention on the Law of the Sea*, ¶¶ 52-54, ISA 6/A/9 (2000).

506. LOSC, *supra* note 136, art. 87(2). Living marine resource activities are also governed by Articles 116-119.

507. *Id.* art. 143(1).

principles for all MSR established by Article 240(a) and applies equally to other uses of the Area.[508] The purport of the second requirement, that the research benefit humankind as a whole, is likely to be the subject of continuing disagreement. Not surprisingly, the phrase is not defined in the Convention. One commentator has opined that the requirement can be satisfied through the publication or dissemination of research results, an action already required by Article 244.[509] Under such an interpretation, the requirement for universal benefit does not necessarily preclude a simultaneous, differential benefit to the researcher. Another commentator, however, has concluded that the universal benefit requirement raises the question whether the findings from MSR involving seabed resources within the Area can later be developed into applications for which intellectual property rights (IPRs) may be claimed.[510] The case against IPRs in MSR findings is, the proponents of the argument urge, strengthened by Article 241, a provision that originated in the 1970 Declaration of Principles,[511] and which provides that MSR activities shall not constitute the legal basis for any claim to any part of the marine environment or its resources. Though time and space constraints preclude an examination in this article of the arguments for and against IPRs in vent research findings, it appears the proponents of the case against IPRs have confused rights in the Area and its resources with rights in the intellectual property produced from later study of the Area and its resources. Moreover, the conclusion appears to be inconsistent with the commonly held interpretation of Article 241.[512]

When vent resource collection activities are conducted on a coastal State's continental shelf or in the superjacent waters with a view toward later commercial application, the activities may be classified either as MSR activities that are of "direct significance for the exploration and exploitation of natural resources"[513] or activities involving "exploration for or exploitation of" resources over which the coastal State has sovereign rights. The access regime for MSR activities differs in several respects from the access regime for resource exploration or exploitation; however, in both cases the coastal State is given broad discretion to grant or deny access. If the proposed activities are deemed to be MSR that is of "direct significance for the exploration and exploitation of natural

508. *Id.* art. 141.

509. *See* SOONS, *supra* note 146, at 229.

510. Gorina-Ysern, *supra* note 149, at 343-46.

511. *See Declaration of Principles*, *supra* note 331, para. 10. From the context of the Declaration, it is apparent that paragraph 10 was intended to foreclose the argument that seabed mining research activities could form the basis to a claim for exclusive access to an area of the seabed or its resources before the international regime that would govern such issues was in place.

512. *See, e.g.*, SOONS, *supra* note 146, at 137-39 (concluding that Article 241 adds nothing to the Convention not already established by other articles that preclude claims to the Area or its resources); *see also* CHURCHILL & LOWE, *supra* note 147, at 411 (concluding, somewhat optimistically, that Article 241 is unlikely to raise problems).

513. LOSC, *supra* note 136, art. 246(5)(a).

resources," the State may, at its discretion, withhold consent for research projects to be conducted within 200 NM.[514] It should be noted in this regard that the term "resources" under the CBD extends to ecosystems, organisms, and genetic material "with actual or potential value."[515]

If the at-sea "research" and collection activities are deemed to constitute exploring for or exploiting resources of the continental shelf, the coastal State's authority to deny access is virtually unreviewable, so long as the action does not amount to an abuse of rights.[516] The coastal State's discretion to deny access for the purpose of exploring for or exploiting resources of the EEZ is also broad, though narrower than the discretion embodied in the continental shelf articles.[517] It must be borne in mind, however, that, as the discussion in Part VI of this Article will show, the coastal State has broad authority under the CBD to set the terms of access to the living and genetic resources within its EEZ or on its continental shelf.

3. Prospects for Clarification of the MSR Classification Regime

The classification problems posed above, which are not unique to seabed vent research and sample collection activities, are likely to resurrect disputes over the distinction between pure and applied research and between research and resource exploration and exploitation. The distinction between pure and applied research has never been easy to apply in practice.[518] It is particularly difficult to apply in cases where a considerable period of time may elapse between the at-sea collection event and the ultimate commercial application. The U.N. Secretary-General observed that "[w]hile the full value of a research project may not be immediately apparent, it is inherent in the nature of scientific research that an offshoot may have greater significance that the intended goals of the project."[519]

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514. *Id.* art. 246(5). The coastal State may withhold its consent on other grounds as well. *See id.* art. 246(5)(b)–(d).

515. CBD, *supra* note 254, art. 2 (see definitions of "biological resources" and "genetic resources"). It must be recalled, however, that if MSR activities are to be carried out on the coastal State's juridical continental shelf more than 200 NM from the baseline, the coastal State's authority to withhold consent to MSR access is much more limited. *See id.* art. 246(6) (limiting discretion to areas designated by the coastal State "in which exploitation or detailed exploratory operations focused on those areas are occurring or will occur within a reasonable time").

516. *Id.* arts. 77, 300. In addition, the coastal State's authority under Part VI is limited to "natural resources" of the continental shelf and by other articles preserving the status of superjacent waters. *Id.* art. 78.

517. Under the Part VII EEZ regime, the coastal State has a duty to promote optimum utilization of the zone's resources. *See id.* art. 62.

518. *See* CHURCHILL & LOWE, *supra* note 147, at 402 (observing that "[w]hat might have begun and been intended as 'pure' research might, once the research had actually been undertaken and its results analyzed, have turned out to have significant practical implications."); *see also id.* at 406 (concluding that the distinction is clearer under the 1982 LOSC).

519. See U.N. Secretary-General, *Report on Marine Scientific Research*, *supra* note 472, at 5, ¶ 7.

In the particular setting of the LOSC, commentators have long recognized that the phrase "direct significance for the exploration and exploitation of natural resources" is imprecise and will undoubtedly give rise to differing interpretations.[520] The phrase has been interpreted by the United Nations to refer to projects "which can reasonably be expected to produce results enabling resources to be located, assessed and monitored with respect to their status and availability for commercial exploitation."[521] The MSR Implementation Guide prepared by the United Nations advises that the coastal State is to make its determination as to whether to grant an MSR access request based on the "objective facts submitted in the application."[522] Some have suggested the classification should turn on the researcher's intent;[523] however, such an approach is at odds with the preference in the law of the sea for approaches based on criteria capable of objective evaluation.[524] Others have emphasized that it is only research of a *direct* significance to exploration/exploitation that falls within the coastal State's exclusive discretion, implying "that the results of the research in question must have their own, intrinsic value from the point of view of exploitation or exploitation and that it is not enough that the research results are remotely significant (e.g., research results which can *become* useful from this point of view when they are combined with other data to be collected)."[525]

Regrettably, despite the plentiful grounds for dispute over classifying vent research activities, the prospects for orderly development of laws governing MSR access within coastal State EEZs or continental shelves through decisions by international tribunals are poor, owing to the exclusion of disputes over MSR access from the LOSC's compulsory dispute resolution provisions.[526] As a consequence, future legal developments in the regime for MSR within coastal

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520. SOONS, *supra* note 146, at 170-71.

521. MSR IMPLEMENTATION GUIDE, *supra* note 146, at 12, ¶ 58.

522. *Id.* at 12, ¶ 57 ("The coastal State cannot exercise its discretion to determine if a particular research project comes within the scope of [Article 246] paragraph 5(a)–(d); this determination must be based on the objective facts, viz., the information provided to the coastal State pursuant to article 248."); *see also* SOONS, *supra* note 146, at 169-70 (reaching same conclusion).

523. The U.S. Department of State observer concluded at the end of the MSR Implementation Guide Group of Experts meeting "[T]he fine line between research and resource exploration/exploitation appears to remain the 'intent' of the researcher." William Erb, U.S. Dep't of State, Bureau of Oceans & International Environmental and Scientific Affairs, Memorandum on Group of Experts Meeting on Marine Scientific Research – United Nations, New York, Sept. 5-8, 1989, at 4 (Oct. 3, 1989) (copy on file with the author).

524. The need to exercise coastal State authority in adjacent coastal waters on the basis of "objective criteria" is equally important in the assessment of whether passage is "innocent" under Articles 18 and 19 of the LOSC. *Cf.* Corfu Channel Case (U.K. – Albania) 1949 I.C.J. 1, 28 (Apr. 9) (reasoning that the determination whether a foreign vessel's passage is innocent turns on the manner of the passage, not the intent of the vessel's operator).

525. SOONS, *supra* note 146, at 171 (emphasis in original).

526. Article 297(2)(a) of the LOSC exempts disputes arising out of the exercise by a coastal State of its right or discretion to deny MSR access. Even in matters subject to compulsory conciliation, the conciliation commission may not question the coastal State's discretionary power to deny MSR access under Article 246(5).

State jurisdiction will be relegated to the uncertain and unpredictable domain of State practice or a new multilateral treaty.

VI. CLASSIFICATION AND COVERAGE OF VENT RESOURCES AND ACTIVITIES UNDER THE CONVENTION ON BIOLOGICAL DIVERSITY

The CBD was introduced in Part IV as a framework convention designed to complement existing treaties, including the LOSC.[527] The ongoing exchange between the CBD Secretariat and the U.N. Secretary-General's Division for Ocean Affairs and the Law of the Sea over application of the CBD to deep seabed living and genetic resources, also discussed in Part IV, highlights a certain measure of uncertainty over the role of the CBD in conserving and managing vent resources, as well as the respective roles of the two secretariats.

A. THEMATIC ISSUES RELATING TO VENT FIELD BIOLOGICAL DIVERSITY

Issues surrounding application of the CBD to vent resources and harmonization of the CBD with the LOSC are best analyzed through two overlapping approaches. The first approach, followed below, groups CBD application issues according to the three thematic purposes of the CBD. The second approach, taken up in Part VI.B, adopts a zonal perspective, dividing selected thematic issues between those arising within the territory of a party and those occurring beyond such territories.

1. Issues Relating to Conservation of Vent Biological Resources

The CBD seeks to conserve diversity within species, among different species, and of ecosystems.[528] Ecosystem diversity, a systemic measure, refers to the number of different ecosystems and the distribution and frequency of those ecosystems.[529] Because the vent biotic communities vary both temporally and spatially, each may be seen as a unique ecosystem. Species diversity, the most popularly understood measure, refers to the number of different species of organisms and their distribution and frequency. Scientists are just beginning to assess the diversity among species found at vent sites. Preliminary findings suggest, however, that up to ninety percent of those species are endemic to the

527. CBD, *supra* note 254, pmbl., para. 22 (articulating the parties' desire to "enhance and complement existing international arrangements for the conservation of biological diversity and the sustainable use of its components"); *see also* WILLIAM LESSER, SUSTAINABLE USE OF GENETIC RESOURCES UNDER THE CONVENTION ON BIOLOGICAL DIVERSITY 3 (1998); Anton, *supra* note 289, at 355-561.

528. *See* CBD, *supra* note 254, art. 2 (defining "biological diversity"). The measures of biodiversity are discussed in NOURSE, *supra* note 289, at 10-13, and THORNE-MILLER, THE LIVING OCEAN, *supra* note 35, ch. 3.

529. As used in the CBD, the term "ecosystem" means a "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit." CBD, *supra* note 254, art. 2. The term plainly appears to embrace any active vent field that supports a biotic community.

vents.[530] Until a fuller inventory of vent species is complete, the precautionary approach incorporated into the CBD,[531] the high endemism of vent organisms, and the lessons taken from the tale of the lost *Diazona*[532] provide compelling reasons to adopt a conservative approach to vent field resources.

Genetic diversity, perhaps the least apparent of the three measures of diversity, refers to the genetic variation within any given species. Marine scientists would be the first to admit that we know little about the genetic diversity within vent species identified so far, particularly within the microbial species. Because genetic diversity is, like species diversity, largely unknown, both *in situ* and *ex situ* conservation measures are appropriate. Most of the scientific community is to be commended for their biodiversity conservation initiatives.[533] The United Nations has observed, however, that even where data or genetic materials are collected for scientific purposes, they are too frequently incomplete or badly managed.[534] As the initiatives by InterRidge and similar organizations become better implemented, scientists throughout the world should have better access to vent biological specimen banks and cultured microorganisms.[535]

2. Issues Relating to Sustainable Use of Vent Biological Resources

As a "use" of biodiversity resources and their habitats, vent MSR and specimen collection activities must be conducted in a sustainable manner. Even at the present level of MSR activity at vent sites, coastal States in which vent fields are located and the research community must be mindful of the CBD's concern for conservation of biological diversity. The coastal State has broad authority to ensure that vent access, whether by researchers or bioprospectors, is sustainable. Both the EEZ and continental shelf regimes recognize the coastal State's sovereign rights in its natural resources and its jurisdiction over MSR activities and pollution prevention and enforcement.[536] Issues regarding sustainability of vent resources and activities are therefore likely to be mostly factual, not legal. To evaluate the sustainability of activities at vent fields within their EEZ or on their

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530. VAN DOVER, ECOLOGY OF VENTS, *supra* note 14, at 313.

531. Paragraphs 8 and 9 of the CBD Preamble form a precautionary approach. *See* GLOWKA, GUIDE TO THE CBD, *supra* note 309, at 11.

532. *See supra* note 62 and accompanying text. Until a complete biological inventory is complete, every organism retrieved from a seabed vent field must be seen as potentially the next *Diazona*. *See also* NOURSE, *supra* note 289, at 58 (advocating greater protection for highly endemic species).

533. The InterRidge group facilitates a variety of data and sample sharing programs. *See supra* note 52. Full implementation may, however, impose new work demands the MSR community is not funded to meet.

534. *See* Conservation of Biological Diversity Background and Issues: *Report of the Secretary General*, U.N. GAOR, 3rd Sess., U.N. Doc. A/CONF.151/PC/66.

535. *See* Lynda M. Warren, *The Role of Ex Situ Measures in the Conservation of Biodiversity*, *in* INTERNATIONAL LAW AND THE CONSERVATION OF BIODIVERSITY, *supra* note 149, at 129, 135 (highlighting the fact that the cultured and banked microorganisms are often the only source for research purposes and may be of considerable commercial importance).

536. *See supra* Part III.A, III.B.

continental shelves, States must first acquire and evaluate data on the nature of the vent fields and their resources. Understanding how new vent fields are colonized, and the possible role vent fields may play as oceanic seabed faunal "highways," will be essential to any efforts to manage vent field resources sustainably.[537] Next, States must obtain information on the consumptive and non-consumptive uses of vent fields and evaluate those uses to determine their impacts on vent resources and their diversity.[538] Unfortunately, technological and financial constraints are likely to limit information quantity and accuracy, particularly for less developed nations. Accordingly, parties must evaluate the effect of the precautionary approach incorporated in the CBD preamble. In doing so, parties need to determine whether a lack of scientific certainty about whether activities at vents may be jeopardizing the diversity of vent ecosystems, species, or gene pools is an appropriate justification for postponing measures to avoid or minimize possible threats to vent biodiversity.[539]

3. Issues of Fair and Equitable Access to Vent Biological Resources

Although no private bioprospecting at vent sites has yet been reported, it is becoming common for scientific research institutions to establish links with onshore commercial bioprospecting activities.[540] A 1991 survey found that over half of the academic institutions in the United States collaborated to some extent with private industry in their research efforts.[541] Up to eighty percent of marine biotechnology in Japan is funded by the private sector.[542] This public-private linkage between traditional MSR by academic institutions and private biotechnology interests, and the growing likelihood of commercial applications of MSR findings, implicates the fair and equitable access objective of the CBD.

It is often said that the CBD applies within a particular nation only to the extent of its implementation by legislation or through contract requirements imposed as a condition of access for MSR or natural resource exploration or exploitation.[543]

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537. *Cf.* THORNE-MILLER, THE LIVING OCEAN, *supra* note 35, at 113 (advocating that MPAs be defined by water circulation patterns where larvae are transported by the component currents).

538. *See* Agenda 21, *supra* note 248, ¶¶ 15.5(k), 17.5(d) (advocating environmental impact assessment).

539. *See* CBD, *supra* note 254, pmbl., paras. 8, 9; *see also* Agenda 21, *supra* note 248, ¶¶ 17.1, 17.5(d) (calling for responses that are precautionary and anticipatory).

540. FONTAUBERT, *supra* note 286, at 40 (concluding that "[i]n the United States, some companies have entered into agreement to pay universities or research institutions for samples of organisms collected from the sea"); Glowka, *Testing the Waters*, *supra* note 10, at 7; Meyers & Anderson, *supra* note 124, at 28.

541. *SBSTTA Bioprospecting Report*, *supra* note 52, ¶ 40 (citing R.A. Zilinskas et al., *The Global Challenge of Marine Biotechnology: A Status Report on the United States, Japan, Australia, and Norway* (1995)).

542. *Id.* ¶ 41.

543. *See* LESSER, *supra* note 527, at 45; *see also* Lyle Glowka, *Bioprospecting, Alien Invasive Species, and Hydrothermal Vents: Emerging Issues in the Conservation and Sustainable Use of Biodiversity*, 13 TUL. J. ENVTL. L. 329 (2000). Alternatively, Article 15 of the CBD can be read as establishing a presumption against consent "unless otherwise determined" by any given contracting party. *See* CBD, *supra* note 254, art. 15(5) ("Access to genetic resources shall be subject to prior informed consent of the

It is expected that in most cases coastal States will enact legislation requiring that their "prior informed consent" be obtained before their living or genetic resources may be exploited, and that the conditions of access will be subject to "mutually agreed terms," including any benefit sharing provisions.[544] The prior informed consent requirements contemplated by the CBD will almost certainly exceed the more accommodating consent regime for MSR activities under the LOSC.[545] The implied consent regime for "pure" research contemplated in Article 252 does not appear to meet the "informed consent" requirement established by the CBD. Accordingly, where MSR activities in a coastal State's EEZ or on its continental shelf will or may include the collection of biological samples, the standardized forms typically used for requesting and granting MSR access may require modification, to address relevant CBD concerns.[546]

B. APPLICATION OF THE CBD TO MARINE AREAS

The CBD recognizes a nation's sovereign rights to genetic resources within national jurisdiction.[547] State sovereignty over living and genetic resources within its jurisdiction carries with it the competence to establish limits on access to, and use of, those resources by domestic and foreign entities.[548] Selected provisions of the CBD also apply to processes and activities carried out "under the jurisdiction or control" of any party falling within the CBD's ambit, whether conducted within or beyond national jurisdiction, regardless of where their effects occur.[549]

Contracting Party providing such resources, *unless otherwise determined by that Party*") (emphasis added).

544. CBD, *supra* note 254, arts. 15(4), 15(5); *see generally* LYLE GLOWKA, A GUIDE TO DESIGNING LEGAL FRAMEWORKS TO DETERMINE ACCESS TO GENETIC RESOURCES (1998).

545. *See supra* Part III.A.1 (discussing the distinct consent regimes for pure and applied MSR activities).

546. MSR IMPLEMENTATION GUIDE, *supra* note 146, annex I (Draft Standard Form Application for Consent to Conduct Marine Scientific Research). Subparagraph 3.3 of the form requires the applicant to detail the types of samples and data to be obtained. Paragraph 9 describes the terms of coastal State access to data, samples and research results. Sample bioprospecting agreements are included and discussed in David Downes et al., *Biodiversity Prospecting Contract,* and Sarah A. Laird, *Contracts for Biodiversity Prospecting, in* WORLD RESOURCES INSTITUTE, BIODIVERSITY PROSPECTING annex 2 & ch. 4 (Walter L. Reid et al. eds., 1993).

547. CBD, *supra* note 254, art. 15(1).

548. U.S. biotechnology companies have already begun entering into agreements with other nations that set the terms of access to living resources and their genetic material that call for sizeable payments to the source nation. *See* Michael D. Coughlin Jr., *Using the Merck-INBios Agreement to Clarify the Convention on Biological Diversity*, 31 COLUM. J. TRANSNAT'L L. 337 (1993) (discussing a 1991 (i.e., pre-CBD) agreement between the Merck pharmaceutical company and the National Biodiversity Institute (INBios) created by the government of Cost Rica to provide Merck access to 10,000 animal, plant and soil samples).

549. CBD, *supra* note 254, art. 4(b); *see generally* RESTATEMENT, *supra* note 140, § 601 cmt. c (defining "activities within [a State's] jurisdiction").

1. CBD Application to Areas Within the Limits of a Party's National Jurisdiction

The CBD provisions applicable to (1) the components of biological diversity, and (2) the processes and activities which may affect biological diversity (regardless of where their effects occur) apply throughout the "limits of national jurisdiction" for each contracting party.[550] The "limits" of a coastal State's jurisdiction are in turn determined by its municipal law, as limited by the LOSC and any relevant customary law.[551] The LOSC authorizes coastal State claims to an EEZ up to 200 NM seaward from the territorial sea baseline; however, the provision is not self-executing, and must therefore be formally claimed by the coastal State.[552] States bordering the Mediterranean Sea, for example, have not generally made EEZ claims.[553] By contrast, coastal State sovereign rights in the continental shelf do not depend on proclamation.[554]

The distinction between "components" and "processes and activities" is not defined in the CBD.[555] The "components" of biological diversity include at the very least plant, animal, and microbial organisms, their genetic material and the ecosystems in which they are found.[556] The CBD articles on identification, monitoring, conservation and sustainable use of those "components" therefore apply within the "limits" of each party's jurisdiction.[557] Marine "activities" that fall within the CBD ambit, if they might adversely affect biological diversity,[558] presumably include vessel navigation and operations, marine scientific research, resource prospecting, exploration and exploitation, and the discharge or dumping of pollutants. The CBD articles applicable to "processes and activities" apply

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550. CBD, *supra* note 254, art. 4(a); *see also* Vienna Convention, *supra* note 144, art. 29 ("[U]nless a different intention appears from the treaty or is otherwise established, a treaty is binding upon each party in respect of its entire territory").

551. This was President Clinton's understanding in presenting the CBD to the Senate. With respect to Article 4, the President reported:

> Article 4 defines the jurisdictional reach of the Convention. With respect to components of biological diversity (e.g., species, ecosystems, genetic material), Article 4 generally restricts each Party's obligations to those components within the limits of its national jurisdiction in accordance with international law—its territory, exclusive economic zone, and if applicable, its continental shelf.

President's CBD Transmittal Message, *supra* note 261, at IX (comment on Art. 4).

552. LOSC, *supra* note 136, art. 57.

553. *See* CHURCHILL & LOWE, *supra* note 147, at 161.

554. LOSC, *supra* note 136, art. 77(3).

555. *See* Anton, *supra* note 289, at 356-57; *see also* Glowka, *Deepest of Ironies*, *supra* note 1, at 165 (observing that any distinction is "arbitrary, since the components of biological diversity are necessarily affected by human processes and activities").

556. *See* Catherine Tinker, *A "New Breed" of Treaty: The United Nations Convention on Biological Diversity*, 13 PACE ENVTL L. REV. 191, 203 (1995).

557. CBD, *supra* note 254, arts. 4(a), 7-10.

558. Glowka, *Deepest of Ironies*, *supra* note 1, at 171 (concluding that Article 7 of the CBD is limited to processes or activities that have or are likely to have significant adverse impacts on biodiversity).

both within the limits of each party's jurisdiction and beyond, where the contracting party has jurisdiction or control over the process or activity.[559] Article 3 of the CBD, for example, imposes on all contracting parties a duty to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.[560] Article 14 further requires contracting parties to require an environmental impact assessment of any proposed project that is "likely to have significant adverse effects on biological diversity."[561]

Bearing in mind that the CBD is to be implemented consistently with the law of the sea, it can be seen that coastal States have broad, but not unlimited, authority and responsibility over activities within the limits of their maritime jurisdiction. For example, coastal State measures applicable to foreign vessels in transit through the territorial sea are limited where the vessel is exercising a right of innocent passage or transit passage through an international strait.[562] Coastal States are even more limited in the measures they may apply to vessels and activities within their EEZ or on their continental shelves.[563] Importantly, the authority of a coastal State to establish marine protected areas (MPAs) within its EEZ and to enforce conservation and management measures against foreign vessels is subject to both substantive and procedural limits under the LOSC.[564] On the other hand, the Convention imposes fewer limitations on protected area measures a coastal State may prescribe and enforce in respect to activities other than vessel navigation, such as marine scientific research and resource prospecting, exploration and exploitation. In fact, parties must be mindful that the LOSC imposes an affirmative duty on all States to take measures necessary to protect and preserve rare or fragile ecosystems, as well as the habitats of depleted, threatened, or endangered species and other forms of marine life.[565] Many of the deep seabed hydrothermal vent fields will likely be deserving of such protection.

The CBD does not directly address scientific research or sampling. The regime governing access to coastal State waters for MSR or for natural resource collection activities is, of course, established by the LOSC. To the extent that MSR and resource collection activities implicate the CDB's concern for fair and equitable access to genetic resources, the LOSC regime must be read in conjunction with the relevant provisions of the CBD and any implementing coastal State legislation. The marine biotechnology industry should be particularly mindful of the CBD and the interplay between the CBD and the LOSC. Just

559. *Id.*
560. CBD, *supra* note 254, art. 3.
561. *Id.* art. 14. The LOSC imposes a similar requirement. *See* LOSC, *supra* note 136, art. 206.
562. *See, e.g.*, LOSC, *supra* note 136, arts. 21-25, 41-42.
563. *See, e.g., id.* arts. 56, 77, 208-211, 214-216, 220.
564. *See, e.g., id.* art. 211(6).
565. *Id.* art. 194(5).

as the marine mining industry had an interest in creating a stable regime for seabed mining of manganese nodules in the 1970s, to protect their investment, the biotechnology industry now has a similar interest in ensuring stability and predictability in the regime that will govern access to source biological resources and later distribution of any products derived from those resources. Violations of the CBD could jeopardize intellectual property rights (IPRs) or reduce their global value. Other nations might, for example, refuse to recognize a marine biotechnology company's IPR claim in a product on the ground that those "rights" were obtained without the prior informed consent of the nation holding sovereign rights in the resources.[566]

2. CBD Application to Processes and Activities Carried Out Under the Jurisdiction or Control of a Party

Article 4(b) of the CBD extends the obligations of the parties to the Convention to processes and activities carried out under their "jurisdiction or control," even if those processes or activities occur beyond national jurisdiction.[567] In addition, all contracting parties have a duty to cooperate in conservation and sustainable use of biological diversity in areas beyond national jurisdiction.[568] The obligations regarding "processes and activities" must be distinguished from the obligations imposed on parties within their jurisdiction respecting the "components" of biological diversity. Parties to the CBD incur no obligations under the Convention with respect to the "components" of biological diversity beyond the limits of their territorial jurisdiction.[569] To facilitate analysis, it will be useful to distinguish between what the LOSC labels "activities in the Area," which are subject to the concurrent prescriptive jurisdiction of the ISA and the respective flag or nationality States of the vessels and individuals or legal entities engaged in activities in the Area,[570] and all other activities in the Area or the

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566. Under Article 15(3) of the CBD, a party that did not acquire genetic resources in accordance with the CBD has no right to the benefits from those genetic resources. *See* GLOWKA, GUIDE TO THE CBD, *supra* note 309, at 77-78.

567. Other obligations for activities under a State's "jurisdiction or control" are prescribed in Articles 194(2) and 196(1) of the LOS Convention.

568. *Id.* art. 5. The cooperation may be facilitated by competent international organizations, such as the Intergovernmental Oceanographic Commission or, when seabed mining in the Area is contemplated, the ISA.

569. In presenting the CBD to the Senate for its advice and consent, President Clinton concluded:

> [T]he [CBD] imposes no direct management obligations on a Party acting individually with respect to components of biological diversity in an area where another Party exercises jurisdiction or on the high seas. The Parties' obligations with respect to high seas resources and other matters of mutual interest are limited to "cooperation" .... Each Party is responsible for processes and activities under its jurisdiction or control that are carried out within the area of its national jurisdiction or beyond the limits of any State's jurisdiction.

President's CBD Transmittal Message, *supra* note 261, at IX (comment on Art. 4).

570. The prescriptive jurisdiction of the ISA is established by Part XI of the LOSC, as modified by the Part

superjacent high seas beyond any nation's jurisdiction. It will be recalled that "activities in the Area" include only activities of exploration for, and exploitation of, the resources of the Area.[571] "Resources" of the Area are in turn limited to mineral resources.[572] Prescriptive and enforcement jurisdiction over all other activities, whether in the Area or the high seas, are governed by familiar principles of international law, many of which are reflected in the LOSC.[573]

Article 4(b) plainly raises potential issues with respect to a party's obligations under the CBD as the flag State for vessels operating outside of national waters, given the flag State's virtually exclusive jurisdiction over such vessels.[574] Expansive interpretations of Article 4(b) extending the CBD to "processes and activities" carried out under the "control" of a State-party might well look to the terms of the U.S. National Environmental Policy Act[575] as an analogue, and argue that all activities funded by a government agency, or which may be carried out only with a license or permit issued by the government, fall within the definition of "control." Moreover, States such as the United States, which have taken a very broad view of their jurisdiction over vessels on the high seas,[576] may find themselves facing similarly broad interpretations of the jurisdictional reach of the CBD in waters beyond national jurisdiction.

Nearly all would agree that international law does not, at present, adequately protect marine biological diversity outside of national jurisdiction.[577] This is particularly true in the case of seabed vent fields in the Area. The LOSC provides no authority for any nation or international organization to prescribe or enforce MPA measures on the high seas or in the Area.[578] Indeed, the LOSC expressly

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XI Implementation Agreement. The prescriptive jurisdiction of the respective flag States or States otherwise having jurisdiction over the vessels or entities is established by such provisions as Articles 92, 94, and 209 of the LOSC. Enforcement jurisdiction respecting marine pollution in the Area is established by Article 215, subject to the limits of Article 92.

571. LOSC, *supra* note 136, art. 1(3).

572. *Id.* art. 133(a).

573. *See* RESTATEMENT, *supra* note 140, § 402 (listing such bases as the activities, interests, status or relations of its nationals outside its territory); LOSC, *supra* note 136, arts. 92, 94.

574. *See* LOSC, *supra* note 136, art. 92(1).

575. *See* 42 U.S.C. § 4332 (1994); 40 C.F.R. § 1508.18 (1999) (CEQ regulations defining "major federal action" triggering NEPA requirements to include "projects and programs entirely or partly financed, assisted, conducted, regulated or approved by federal agencies; new or revised agency rules, regulations, plans, policies, or procedures; and legislative proposals").

576. *See, e.g.*, The High Seas Fishing Compliance Act, 16 U.S.C. § 5502(10) (1994 & Supp. IV 1998); MSA, 16 U.S.C. § 1802(44) (1994) (adopting the broad definition of "vessel subject to the jurisdiction of the United States" in the Maritime Drug Law Enforcement Act); 46 U.S.C. § 1903(c) (1994) [hereinafter MDLEA]. The MDLEA definition includes, for example, stateless vessels and vessels the flag State of which has consented to U.S. enforcement actions. *Id.*

577. *See* Anton, *supra* note 289, at 343.

578. Notwithstanding the absence of authority, in 1997 the SBSTTA recommended some vent sites in the Area be considered for MPA designation. *1997 SBSTTA Report*, *supra* note 9, at 11, ¶ 53. The report notes that:

> [The meeting h]ighlighted the unique significance of certain high seas and deep sea bed areas (such as identified spawning areas, deep ocean trenches and certain hydrothermal vents) outside the limits of

precludes any nation from asserting sovereignty or sovereign rights over the high seas or the Area.[579] Similarly, the CBD neither requires any party to establish MPAs beyond national jurisdiction, nor does it provide authority for such measures.[580] Lacking a basis for area-based jurisdiction, States must rely on extraterritorial bases, such as flag State jurisdiction, or funding or licensing restrictions to promote conservation and sustainable use of vent resources in the Area. Conservation goals might also be furthered through discretionary measures by the ISA to restrict mining operations at vent sites with living biological communities.[581] Indeed, it might be argued that Article 194(5) requires flag States, funding or permitting States, and the ISA to implement such protections for the "rare and fragile ecosystems" found at some vent sites.

Both the LOSC and the CBD impose a duty on all parties to cooperate with respect to treaty measures on the high seas.[582] In the context of seabed vent access and use, the scope of the duty and the kind of events or findings that potentially trigger the duty are not yet clear. The duty might require nothing more than attendance at conferences where conservation measures are to be discussed. On the other hand, a recent decision by the International Tribunal for the Law of the Sea,[583] which suggests that a failure to reach agreement violates the duty to cooperate, may impart a new, even revolutionary, meaning to the duty of cooperation under the Law of the Sea.

Turning lastly to questions over applicability of the CBD's articles on "fair and equitable" sharing of the benefits to be obtained from potential exploitation of the components of biodiversity, it is necessary to address the 1995 conclusion of the CBD Subsidiary Body for Scientific, Technical and Technological Advice in which the Body opined that "it is unclear whether, or how, UNCLOS, of the

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national jurisdiction, and called for consideration to be given to the development of means and modalities for the establishment of marine protected areas in such locations. The meeting suggested that the [CBD] Secretariat include this issue in its collaborative relations with the U.N. Department of Ocean Affairs and Law of the Sea.

579. *See supra* note 332 and accompanying text.

580. *See* Anton, *supra* note 289, at 358 (concluding that "the interplay between articles 4, 8(a), and 22(2) of the C.B.D., seemingly prohibits (and certainly does not require) any party or group of parties from unilaterally establishing a system of protected reserves in areas beyond national jurisdiction in order to ensure that special measures are taken to conserve biological diversity and the protection of ecosystems and natural habitats.").

581. Under the Convention, the ISA has the authority to disapprove areas for exploitation in cases where substantial evidence indicates a risk of serious harm to the marine environment, and to issue emergency orders, which may include orders for the suspension or adjustment of operations to prevent serious harm to the marine environmental arising out of activities in the Area. LOSC, *supra* note 136, art. 162(2)(x); *see also supra* Part III.A.4.

582. *See* LOSC, *supra* note 136, arts. 118, 63; CBD, *supra* note 254, art. 5.

583. Dispute Concerning Southern Bluefin Tuna (Austl. & N.Z. vs. Jap.), Order on Provisional Measures, ¶¶ 28(1)(d), 29(1)(D), 72, Int'l Tribunal for the Law of the Sea (Aug. 27, 1999), *reprinted in* 38 I.L.M. 1624 (1999) (apparently equating a refusal to *agree* on conservation measures with a failure to *cooperate* under Article 118 of the LOSC). The Tribunal's provisional relief was later vacated by an arbitration panel convened under the terms of the SBT treaty between the parties. 16 BULL. LEGAL DEVELOP. 188 (2000).

common heritage principle, applies to the genetic resources of the deep sea-bed" and that "there needs to be an in-depth study on how to best address the use of these resources."[584] The reasons for the SBSTTA's uncertainty are not clear. Part XI of the LOSC presently limits the CHM principle to the mineral resources of the Area. While it is true that some have proposed extending the CHM regime in Part XI of the LOSC to the genetic resources of the deep seabed,[585] access to those resources is presently governed by the high seas freedoms.[586] The CBD conferees rejected convention language that would have declared that genetic resources were the "common heritage" of humankind, agreeing instead to declare that biodiversity was a common "concern" of humankind.[587] The text and structure of Article 15 of the CBD strictly limit its "access to genetic resources" provisions to such resources within national jurisdiction. The United States has long taken the position that access to living and genetic resources beyond national jurisdiction, including the high seas and the Area, are beyond the scope of the CBD regime.[588] Because no State has sovereign rights in the living or genetic resources of the high seas or in the Area, there is presently no basis for compelling any State or private entity to "share" any benefits obtained from exploiting those resources.[589] One might reasonably conclude, therefore, that the SBSTTA's uncertainty may result not so much from true lacunae or ambiguities in the CBD or LOSC regimes, but rather from a larger plan to urge a revision to Part XI of the LOSC that would extend the CHM regime to the living and genetic resources of the deep seabed.

VII. PRELIMINARY CONCLUSIONS AND CONSEQUENCES FOR CONSERVATION AND MANAGEMENT OPTIONS

To effectively mediate among the conflicting uses of the ocean's exotic and ephemeral deep-sea vents, any conservation and management regime must be comprehensive and adaptive and incorporate criteria for prioritizing among expected uses. A few conclusions can be made for the benefit of marine policy makers charged with designing and implementing such a regime. It bears repeating, however, that the conclusions are, in many cases, preliminary, and should be updated as additional evidence of State practice becomes available.

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584. *SBSTTA Bioprospecting Report*, *supra* note 52, at 1 (citing Secretariat's Report to the Second Conference of Parties, UNEP/CBD/COP/2/13)).

585. BORGESE, THE OCEANIC CIRCLE, *supra* note 6, at 105, 188, 199.

586. One commentator argues that the "brazen intransigence" of the United States, "under pressure from its bio-industries" is keeping issues regarding access to marine genetic resources off the CBD agenda. *Id.* at 69.

587. CBD, *supra* note 254, pmbl., para. 3; GLOWKA, GUIDE TO THE CBD, *supra* note 309, at 3.

588. Glowka, *Genetic Resources, Marine Scientific Research and the International Seabed Area*, *supra* note 1, at 62 (citations omitted).

589. Glowka, *Bioprospecting*, *supra* note 543, at 359-60; Anton, *supra* note 289, at 360; Glowka, *Testing the Waters*, *supra* note 10, at 50.

Coastal States have broad authority to regulate natural resource exploration and exploitation and marine scientific research activities within their EEZs and on their continental shelves. Where appropriate, the coastal State has authority to establish MPAs at vent sites in its coastal waters, as Canada has already done. The CBD makes it clear the coastal States' natural resource rights extend to the genetic resources within the EEZ and continental shelf. In those States that choose to implement the CBD through appropriate legislation, specimen collection, and other research activities at seabed vents in the EEZ or on the continental shelf will require the coastal State's prior informed consent and will be subject to mutually agreed terms. Findings from vent specimen collection activities fall within the LOS Convention's MSR and technology transfer regimes. Additionally, those findings and the benefits they might generate are subject to the fair and equitable distribution provisions of the CBD, together with any contract terms imposed upon the researchers by the source nation. One issue that cannot be answered with confidence concerns the classification of living resources of the continental shelf where the juridical shelf extends more than 200 NM. Application of the sedentary species test to vent microfauna is at best problematic and at worst farcical. Moreover, allocating conservation and management authority on a species-by-species basis, according to which organisms meet the sedentary species test, will almost certainly preclude an ecosystem management approach to the vents.

Turning from coastal State waters to the global "commons," there may be good reason to doubt whether harvesting microbes and other vent organisms on the deep seabed or superjacent waters of the high seas constitutes "fishing" in the historical sense. There is little reason to doubt, however, that those microbes and other vent fauna fall within the class of "living marine resources" addressed by Articles 116-119 of the LOSC. The argument that customary law or a new agreement is needed to fill the gaps evident in the present regime has great normative appeal. However, the presence of apparent lacunae in the present regime does not justify the conclusion that collection activities are prohibited until the new regime is in place, particularly when those activities have been conducted without objection for decades. Collecting those living resources from vents located beyond any nation's continental shelf must be seen, for the present, as an incident of the high seas freedoms.[590] Such an interpretation of the Convention would certainly constitute no breach of "good faith." The reasonableness of this conclusion is confirmed by State practice. Two corollaries follow. First, as an incident of the high seas freedoms, access to the vents and collection of their resources must be exercised with due regard for the interests of other States in their exercise of the freedom of the high seas and with respect to

590. Others have reached the same conclusion. *See, e.g.*, Burke, *State Practice*, *supra* note 1, at 231; Glowka, *The Deepest of Ironies*, *supra* note 1, at 155, 168.

activities in the Area. Second, all States have a duty under Part VII of the LOSC to cooperate in the conservation and management of vent LMRs.

The ISA has broad authority to regulate mineral mining in the Area. However, research in the Area and biological specimen collection in the Area or from the surrounding waters of the high seas remain a freedom of the high seas. The CBD articles on sharing of benefits obtained from exploitation of genetic resources do not apply to specimen collection activities on the high seas or in the Area. Those resources fall outside the "resource" definition in Part XI of the LOSC and there is insufficient evidence that living and genetic resources in the Area fall within an enforceable CHM norm as a matter of customary law. The duty to cooperate and to exercise high seas freedoms with due regard for other users applies equally to MSR on the high seas and in the Area. Vessels engaged in those activities are generally subject to jurisdiction only by their flag State. Because both MSR activities and living resource access and exploitation fall outside of the LOSC Part XI regime, no State or international organization has authority to establish an enforceable MPA or any other area-based living resource conservation and management plan in the Area or on the high seas. The ISA certainly has the authority, and in some cases the duty, to limit mining activities as necessary for environmental protection and preservation, and could therefore determine that active vent sites should be placed off limits to mining activities.[591] Such a decision would eliminate the most destructive potential use of the vent fields and their resources and provide the marine science community the window they need to complete their pioneering work on these deep-sea treasures.

Deep-sea vent fields offer a realm of wondrous diversity. The pinnacles of rich seabed minerals at the vent fields attract our interest just as surely as do the fields' uniquely adapted living residents that draw their sustenance from planet's subsurface domain. The seabed vent fields are, for now, as pristine in their way as the legendary Garden of Eden from which one field takes its name. Although one can reasonably conclude that the near total inclusiveness of the present access regime for high seas and deep seabed LMRs, and the fragmented and incomplete allocation of responsibility for conservation and management of resources beyond national jurisdiction, might well undermine efforts to promote sustainable use of those resources, we nevertheless have a window of opportunity to take steps to craft a responsible approach to human activities at the fields.

591. This suggestion is consistent with the precautionary approach adopted by the ISA. *See ISA Mining Code for Nodules, supra* note 115, reg. 31(2).