

**FROM OUTER SPACE TO OCEAN DEPTHS: THE
'SPACECRAFT CEMETERY' AND THE PROTECTION OF THE
MARINE ENVIRONMENT IN AREAS BEYOND NATIONAL
JURISDICTION**

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INTRODUCTION

The so-called “spacecraft cemetery” lies in the southern part of the Pacific Ocean, approximately 3,000 miles off of New Zealand’s eastern coast and 2,000 miles north of Antarctica.¹ This large ocean area is centred on the farthest point from any land on Earth, which is called *Point Nemo*.² The “spacecraft cemetery” is technically known as the Oceanic Pole of Inaccessibility or South Pacific Ocean Uninhabited

1. See generally Kiona Smith-Strickland, *This Watery Graveyard Is the Resting Place for 161 Sunken Spaceships*, GIZMODO (May 14, 2015, 3:30 PM), <https://gizmodo.com/this-watery-graveyard-holds-161-sunken-spaceships-1703212211>; Denise Chow, *Will Space Station Plunge Into Ocean Grave in 2020?*, SPACE.COM (July 27, 2011), <http://www.space.com/12452-international-space-station-ocean-grave-russia-nasa.html>; Helen Thompson, *There’s a Spacecraft Cemetery in the Pacific*, SMITHSONIAN.COM (May 21, 2015), <http://www.smithsonianmag.com/smart-news/theres-spacecraft-cemetery-pacific-180955338/?no-ist>; Arthur D. Villasanta, *Spacecraft Cemetery in the Pacific is the Final Resting Place for Space Stations and Spacecrafts*, CHINA TOPIX (June 17, 2016, 11:25 PM) <http://www.chinatopix.com/articles/92532/20160617/spacecraft-cemetery-pacific-where-space-stations-junk-buried.htm>; Colton Kruse, *The World’s Underwater Space Graveyard*, RIPLEY’S BELIEVE IT OR NOT (July 20, 2016), <http://www.ripleys.com/weird-news/space-graveyard/>; Sarah Kaplan, *Dear Science: Where do old spacecraft go when they die?*, WASH. POST (Feb. 21, 2017), https://www.washingtonpost.com/news/speaking-of-science/wp/2017/02/21/dear-science-where-do-old-spacecraft-go-when-they-die/?utm_term=.1ac131aecdda.

2. Shannon Stirone, *This Is Where The International Space Station Will Go To Die*, POPULAR SCI. (June 13, 2016), <https://www.popsci.com/this-is-where-international-space-station-will-go-to-die>.

Area (“SPOUA”).³ Located beyond any state’s jurisdiction, this area is characterized as “freezing, dark and empty,”⁴ with very little human activity and entirely devoid of human life.⁵ Within this area, space-faring nations, such as Russia, the United States, Japan, and European states, have sunk over 263 pieces of space debris since 1971.⁶

The practice of controlled de-orbiting of space debris in the ocean has two aims. First, the aim is to ensure the sustainability of space activities by reducing the “space junk” that orbits around Earth, which threatens the future of space activities.⁷ The second aim is to address the risks that space debris may pose on people or property when falling down back to Earth and to avoid the corresponding liability.⁸ Both aims are legitimate and the spacecraft cemetery offers an appropriate way to achieve them. However, these practices pose several questions related to the marine environment. Regardless of whether *Point Nemo* is “truly in the middle of nowhere,”⁹ it is certainly inhabited by sponges, sea stars, squids, octopi, whales, viperfish, fishes, crustaceans, and other marine life.¹⁰ Moreover, the SPOUA area likely hosts a multiplicity of vulnerable ecosystems, especially on the ocean floor.¹¹

3. *Id.*

4. *Id.*

5. Kruse, *supra* note 1.

6. Luigi Bignami, *Qui c'è il 'Punto Nemo', il cimitero nascosto dei satelliti artificiali*, BUSINESS INSIDER ITALIA, (Oct. 20, 2017), <https://it.businessinsider.com/qui-ce-il-punto-nemo-il-cimitero-nascosto-dei-satelliti-artificiali/>.

7. Excessive space debris threaten the accessibility and safe navigation of outer space, especially when non-functional satellites are placed in low earth orbits (LEO and GEO). These areas have limited natural resources and are the most crowded regions of space.

8. The 1972 Liability Convention envisioned strict liability in cases where falling space objects cause damage on the surface of the Earth or to aircrafts in flight. *See* G.A. Res. 2777(XXVI), Convention on International Liability for Damage Caused by Space Objects, art. 2 (Nov. 29, 1971) [hereinafter The Liability Convention].

9. Stirone, *supra* note 2.

10. Smith-Strickland, *supra* note 1.

11. Maria C. Baker et al., *An Environmental Perspective*, in THE STATUS OF NATURAL RESOURCES ON THE HIGH SEAS 10 (2001).

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The actual or potential environmental consequences of spacecraft oceanic re-entries known as splashdowns¹² should be assessed individually. Most importantly, splashdowns should also be assessed cumulatively in accordance with the general principles and specific substantive and procedural rules that protect and preserve the marine environment in areas beyond national jurisdiction (“ABNJ”). These general principles and rules are set out in the United Nations Convention on the Law of the Sea (“LOSC”), in other relevant treaties, and customary international law.¹³ This article intends to probe how splashdowns should be assessed according to general principles and rules.

While splashdowns are legitimate, lawful, and necessary under space law,¹⁴ splashdowns use ocean commons with little consideration for their potentially harmful consequences that these practices may cause upon the marine environment. The ecological balance of the marine environment is an “essential interest” of the international community.¹⁵ In fact, while studies seek new technological and material solutions¹⁶ to address the space debris problem in certain circumstances, splashdowns remain the recommended solution by both domestic and international guidelines.¹⁷ This article’s aims are simply

12. G. Ortega Hernando et al., *World Catalogue For Launchers Trajectory and Splash-Down Safety Analysis*, in PROC. OF THE FIRST IASS CONF.: SPACE SAFETY, A NEW BEGINNING (H. Lacoste ed., 2005).

13. See United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397; see also Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, *opened for signature* Dec. 29, 1972, 1046 U.N.T.S. 120; The South China Sea Arbitration (Phil. v. China), Case No. 2013-19 (Perm. Ct. Arb. 2016), <https://pcacases.com/web/sendAttach/2086>.

14. These splashdowns are in fact in line with both national and international guidelines, which is discussed in Part I of this article.

15. See, e.g., Gabcikovo-Nagymaros Project (Hung. v. Slov.), Judgment, 1997 I.C.J. 7, ¶ 53 (Sep. 25) (addressing references to the global environment, of which the marine environment is a part).

16. Studies have explored using demisable materials that reduce the amount of mass from splashdowns.

17. Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on its Fifty-Fifth Session, *Compendium of Space Debris Mitigation Standards Adopted by States and International Organizations*, U.N. Doc. A/AC.105/C.2/2016/CRP.16 (2016) [hereinafter *2016 Compendium of Space Debris Mitigation Standards*]; *International Consensus on Debris Threat: Findings from the 7th European Conference on Space Debris*, EUR. SPACE AGENCY (Apr. 21, 2017),

exploratory, offering a preliminary discussion of relevant issues and questions rather than comprehensively assessing the applicable law. Moreover, the existence of critical scientific uncertainties warrants and necessitates a precautionary approach from both the perspectives of law of the sea and space law.

This article also timely considers the ongoing negotiations for a global treaty on marine biodiversity in areas beyond jurisdiction. While countries have emphasized the protection and preservation of the marine environment in areas beyond national jurisdiction,¹⁸ in relation to both pollution¹⁹ and biodiversity conservation,²⁰ the intersection of space activities with questions related to the protection and preservation of the marine environment finds little space in scholarly and policy literature.²¹ This article aims to fill this gap.

The article will begin with Part I discussing the question of the sustainability of space activities. This discussion will review the problems and the legal framework regarding available mitigation measures and the relevant procedural obligations. Part II will discuss one of the solutions that addresses the problems threatening the sustainability of space activities, namely oceanic splashdowns in the so-called "spacecraft cemetery." Also, Part II will discuss the splashdowns' potential negative impact on the marine environment. Part III shall revisit the practice of splashdowns from the perspective of

https://www.esa.int/Our_Activities/Operations/Space_Debris/International_consensus_on_debris_threat; Sergio Marchisio, *The Legal Dimension of the Sustainability of Outer Space Activities*, 55th IISL Colloquium on the Law of Outer Space, INT'L ASTRONAUTICAL CONG., 2 (Oct. 2012).

18. Splashdowns in the SPOUA may fall under the scope of the Treaty, especially in relation to environmental impact assessments, which is one of the four agenda items under negotiations. See G.A. Res. 72/249, International Legally Binding Instrument under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (Dec. 24, 2017).

19. See, e.g., Environment Assembly of the United Nations Environment Programme Res. 2/11, *Marine Plastic Litter and Microplastics*, U.N. Doc. UNEP/EA.2/Res.11 (Aug. 4, 2016).

20. See, e.g., G.A. Res. 72/249, *supra* note 18.

21. There are few notable exceptions. See, e.g., Michael Byers & Cameron Byers, *Toxic Splash: Russian Rocket Stages Dropped in Arctic Waters Raise Health, Environmental, and Legal Concerns*, 53 POLAR RECORD 580 (2017). (focusing narrowly on the droppings of upper stages subsequent to the launch, on land and sea areas within national jurisdiction).

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the law of the sea to explore the legal questions that are raised in connection with the practice of splashdowns. Such legal questions determine whether splashdowns can be considered a form of pollution or a form of dumping under LOSC. Further, Part III shall discuss whether splashdowns constitute a form of cross-media pollution under Article 195 of the LOSC, whether splashdowns trigger obligations of environmental impact assessment, and whether countries meet these obligations.

I. THE SUSTAINABILITY OF SPACE ACTIVITIES

A. *The Problem*

Outer space is far from an empty expanse. Thousands of satellites, probes, spacecrafts, and space stations orbit the Earth. There is a high density of space objects in the lower regions of the Earth's orbit ("LEO")²² and in the geostationary orbit ("GEO").²³ Additionally, these orbits are populated by large quantities of fragments from failed, derelict, or damaged satellites and launch vehicle orbital stages.²⁴ Thus, the international community has become concerned with space congestion as it threatens the sustainability of space activities.²⁵ The

22. In terms of the number of orbital objects and debris, the most populated space region is the one nearest to Earth, located between an altitude of 300 and 2000 kilometers. Roughly, 36% of the entire mass of objects in orbit is concentrated in this Low Earth Orbit (LEO) region. INT'L ACAD. OF ASTRONAUTICS, IAA SITUATION REPORT ON SPACE DEBRIS 14 (Christophe Bonnal & Darren McKnight eds., 2016), <http://www.iaaweb.org/iaa/Scientific%20Activity/sg514finalreport.pdf>.

23. The geostationary orbit is about 36,000 kilometers above the Earth. It is called geo-stationary because satellites in this area take twenty-four hours to orbit the Earth.

24. *International Consensus on Debris Threat: Findings from the 7th European Conference on Space Debris*, *supra* note 17; Karl Kruszelnicki, *Dr. Karl: How Much Space Junk Exists, and How Did It Get There?*, SCI. NEWS, <https://www.abc.net.au/news/science/2017-03-29/dr-karl-just-how-much-space-junk-is-out-there/8392742> (last updated Mar. 29, 2017, 5:54 PM).

25. Since space infrastructures are of utmost importance for a modern State, the lower regions of outer space are overpopulated by satellites and, consequently space debris. The UN Committee on the Peaceful Uses of Outer Space ("COPUOS") has set up a Working Group to consider the negative impact on the environmental conditions of outer space aiming to preserve the long-term sustainability of space activities. Other space institutions, such as ESA, have also developed studies and

increasing urgency of this issue has forced the international community to grapple with the task of limiting the exponential proliferation of fragments and disposing the increasing amount of space debris.²⁶ The National Aeronautics and Space Administration (“NASA”) estimates there are over 20,000 pieces of space debris that are larger than a softball; approximately 500,000 pieces are at least the size of a marble, and many millions are so small that they cannot be tracked—all orbiting Earth.²⁷ Moreover, the United States Space Surveillance Network currently tracks more than 16,000 orbiting space objects.²⁸ Among these objects, only about 5% are still functioning, and 87% are either fragmented debris or inactive space objects.²⁹ According to the European Space Agency (“ESA”), only 1,200 spacecrafts remain functional out of a total of at least 5,250 launches since 1957, and a population of more 23,000 tracked debris.³⁰

Collision is the key risk associated with space debris. Collisions with small objects may lead to perforations and other damages to a spacecraft, while collisions with large debris may lead to the destruction of spacecrafts or satellites.³¹ Importantly, every collision generates

policies to promote the sustainability of outer space activities. *UN COPOUS Working Group on Sustainability Concludes its Work with Agreement on 21 Guidelines*, SECURE WORLD FOUND. (Aug. 2, 2018), <https://swfound.org/news/all-news/2018/08/un-copuos-working-group-on-space-sustainability-concludes-its-work-with-agreement-on-21-guidelines>.

26. Inactive and broken space objects and fragments are currently filling the outer space. Kruszelnicki, *supra* note 24.

27. Mark Garcia, *Space Debris and Human Spacecraft*, NASA, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html (last updated Sept. 27, 2013).

28. *USSTRATCOM Space Control and Space Surveillance*, U.S. STRATEGIC COMMAND, <http://www.stratcom.mil/Media/Factsheets/Factsheet-View/Article/976414/usstratcom-space-control-and-space-surveillance/> (last visited Mar. 26, 2019).

29. The remaining 8% is comprised of rocket bodies. *Id.* However, after their utilization, such rocket bodies can be considered space debris as well.

30. *Call for a Sustainable Future in Space*, ESA (Apr. 21, 2017), http://www.esa.int/Our_Activities/Operations/Space_Debris/Call_for_a_sustainable_future_in_space.

31. Only a few collisions of this type have occurred to date, including the collision of the Russian satellite Cosmos 1934 with debris from the Russian satellite Cosmos 926, the collision of the French microsatellite Ceri with the debris of the European satellite Ariadne, and the collision of the American satellite Iridium 33 with

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more debris, which in turn increases the chances of further collisions, creating a spiralling vicious cycle.³² This cycle is known as the Kessler Effect, which is the exponential increase of debris.³³ Once space debris reaches a critical mass, a cascading effect ensues and the increase in debris and collisions occurs *ad infinitum*.³⁴

B. The Legal Framework Regulating Space Debris Mitigation

Space debris threatens accessibility to and safety of navigation in outer space, especially in LEOs. Importantly, the space debris threat impinges on fundamental principles of space law, such as freedom of exploration and use of outer space.³⁵ These fundamental principles were established in the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the “Outer Space Treaty”), which sets a general framework for states to conduct space activities.³⁶ Outer space is a global commons, which means its use is open to all states; however, states cannot lawfully appropriate it or conduct activities that may prejudice other states’ right to use it.³⁷

Article III of the Outer Space Treaty provides that space activities related to the exploration and use of outer space³⁸ must be carried out “in accordance with international law, including the Charter of the

the inactive satellite Cosmos 2251. Mika McKinnon, *A History of Garbage in Space*, GIZMODO (May 17, 2014, 7:00 PM), <https://gizmodo.com/a-history-of-garbage-in-space-1572783046>.

32. See Thomas Beer, *The Specific Risks Associated with Collisions in Outer Space and the Return to Earth of Space Objects-The Legal Perspective*, in 25:2 AIR & SPACE LAW 42, 44-50 (2000).

33. See Donald Kessler and Burton Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 83 J. OF GEOPHYSICAL RES. 2637, 2646 (1978). The Kessler effect is also known as the Kessler Syndrome.

34. *Id.*

35. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art I, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (entered into force Oct. 10, 1967) [hereinafter “Outer Space Treaty”].

36. *Id.*

37. *Id.* art. IX.

38. The exploration and use of outer space include the moon and other celestial bodies.

United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.”³⁹ Article III plays a major role in the environmental preservation of outer space in conjunction with Article IX, which outlines the fundamental and general obligations for the preservation of the space environment.⁴⁰ Moreover, such general obligations can incorporate existing and emerging principles, and international environmental law norms, such as those enshrined in the Stockholm Declaration and the Rio Declaration.⁴¹ Further, Article IX obligations can also incorporate the principles of sovereignty that allow states to carry out activities within their jurisdiction and control without causing environmental damage to other states or in areas beyond national jurisdiction, such as outer space.⁴²

The Outer Space Treaty provides that states, in conducting space activities, “shall be guided by the principle of cooperation,” and shall have “due regard” for the rights of other states.⁴³ This general obligation of “due regard” exists in other branches of international law, such as the law of the sea, and has important normative implications for states’ duties in removing the debris generated by their own space activities.

The complex legal issues pertaining to liability⁴⁴ is complicated by fundamental political and economic interests, making it impossible for states to reach a consensus on the adoption of relevant binding rules that address the problem of space debris.⁴⁵ The partial legal definition of

39. Outer Space Treaty, *supra* note 35, art. III.

40. See Pierfrancesco Breccia, *Art. III of Outer Space Treaty and its Relevance in the International Space Legal Framework*, Proceedings of the International Institute of Space Law 2016, INT. ASTRONAUTICAL CONG., 5 (2016).

41. Sergio Marchisio, *Article IX* in COLOGNE COMMENTARY ON SPACE LAW, VOL. 1, OUTER SPACE TREATY, 177 (Dr. Stephan Hobe, et al. eds., 2009).

42. *Id.*

43. Outer Space Treaty, *supra* note 35, art. IX.

44. See Jan Wouters et al., *The Removal of Inactive Satellites, and the Role of International Telecommunication Union in Space Debris Remediation 7* (Leuven Ctr. for Global Governance, Working Paper No. 104, 2013), https://ghum.kuleuven.be/ggs/publications/working_papers/2013/104deman.

45. Samantha Masunaga, *Space junk is a big problem, but no one wants to pay to fix it*, L.A. TIMES (Aug. 21, 2016, 6:10 PM), <https://www.abqjournal.com/830304/space-junk-is-a-big-problem-but-no-one-wants-to-pay-to-fix-it.html>; Stefano Antonetti, *Down to Earth: how to deorbit*

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space object is an important legal problem, because it is neither comprehensive nor detailed.⁴⁶ Further, states cannot reach a consensus on the legal definition of space debris,⁴⁷ despite repeated attempts.⁴⁸

However, states have reached a consensus on a technical notion. According to the Inter-Agency Space Debris Coordination Committee (“IADC”),⁴⁹ space debris are all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.⁵⁰ This definition is also endorsed by the Space Debris Mitigation Guidelines adopted by the United Nations Committee on the Peaceful Uses of Outer Space (“UNCOPUOS” or “COPUOS”).⁵¹ However, as observed by Chatterjee, the UNCOPUOS

satellites and save money, ROOM (Apr. 16, 2018), https://room.eu.com/article/Down_to_Earth_how_to_deorbit_satellites_and_save_money.

46. “The term “space object” includes component parts of a space objects as well as its launch vehicle and parts thereof. The Liability Convention, *supra* note 8, at 25; Convention on Registration of Objects Launched in Outer Space, art. I(b), Nov. 12, 1974 [hereinafter Registration Convention].

47. Indeed, the lack of consensus is not surprising, because space law is currently characterized by the elaboration of instruments of soft law “regulating some special categories of space activities for which the international community was not yet prepared to negotiate legally binding instruments.” Sergio Marchisio, *The Evolutionary Stages of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS)*, 31 J. SPACE L. 219, 231 (2005).

48. See, e.g., Buenos Aires Conference, *International Instrument on the Protection of the Environment from Damages Caused by Space Debris*, 309-312 (1994); Comm. On the Peaceful Uses of Outer Space, Legal Subcomm. Report adopted by the Scientific and Technical Subcomm., UN Doc. A/AC.105/720 (1999) [hereinafter Technical Report on Space Debris]; Comm. On the Peaceful Uses of Outer Space, Rep. of Subcomm. on its Fifty-Third Session, U.N. Doc. A/AC.105/1067 (2010) [hereinafter UNCOPUOS 2010]; see also Joveeta Chatterjee, *Legal Issues Relating to Unauthorized Space Debris Remediation*, INTERNATIONAL ASTRONAUTICAL FEDERATION, 1 (2014).

49. See Inter-Agency Space Debris Coordination Committee [IADC], *Terms of Reference for the Inter-Agency Space Debris Coordination Committee*, at 11, IADC-93-01 (rev.11.4) (Sept. 28, 2016). Membership in the IADC primarily includes national and international space agencies. See Nicholas Johnson, *Cleaning Up Space*, HARV. INT’L REV. 1 (Mar. 30, 2012), <http://hir.harvard.edu/a-new-empirecleaning-up-space/>.

50. Inter-Agency Space Debris Coordination Committee [IADC], *IADC Space Debris Mitigation Guidelines*, art. 3.1, IADC-02-01 Revision 1 (Sept. 2007).

51. See UNCOPUOS 2010, *supra* note 48, at 27. The Guidelines are non-binding, but they have been endorsed by the UN General Assembly, where the U.N.

definition is only included in the Space Debris Mitigation Guidelines' section titled "background,"⁵² depriving the definition of some of its normativity. Nonetheless, this definition is capable of explicating certain legal effects,⁵³ and functions as a reference for voluntary guidelines and technical standards adopted by the relevant agencies and institutions.

While space objects may remain inactive for a long time, they may later be re-activated; this is another issue regarding the status of non-functional objects.⁵⁴ Opposing views debate whether an object's functionality can or should be considered as an objective status or whether such functionality depends on the launching/registering state's specific choice, which is also known as subjective functionality.⁵⁵ Further, an object's functionality may also explain the differing opinions on the legal definition of space debris. However, this article focuses on the technical definition of space debris, and how this definition includes non-functional objects such as satellites, ejected instrument covers, orbital upper stages, fragments originated from space objects, leaking fuel and coolant droplets, and microparticulate matter released during space operations.⁵⁶ Moreover, the size of space debris is irrelevant because the technical definition includes non-functional objects of all sizes.⁵⁷

Based on the technical definition that space debris is non-functional space objects, the relevant rules pertaining to space objects *tout court*

General Assembly invited States to implement those voluntary guidelines through space debris mitigation practices. See G.A. Res. 62/217 ¶ 27 (Feb. 1, 2008).

52. See UNCOPUOS 2010, *supra* note 48, at 1.

53. See generally Francesco Francioni, *International 'Soft Law': A Contemporary Assessment*, in FIFTY YEARS OF THE INTERNATIONAL COURT OF JUSTICE, 167-178, (V. Lowe and M. Fitzmaurice eds., 1996); Gunther F. Handl et al., *Hard Look at Soft Law*, 82 Cambridge Univ. 371, 373-77 (1988); IRMGARD MARBOE, *SOFT LAW IN OUTER SPACE: THE FUNCTION OF NON-BINDING NORMS IN INTERNATIONAL SPACE LAW* (2012).

54. See Philip De Man, *The Removal of Inactive Satellites, and the Role of International Telecommunication Union in Space Debris Remediation 7* (Leuven Ctr. for Global Governance, Working Paper No. 104, 2013), https://ghum.kuleuven.be/ggs/publications/working_papers/2013/104deman.

55. See *id.* at 9.

56. *Id.* at 8.

57. INT'L ACAD. OF ASTRONAUTICS [IAA], *SPACE DEBRIS ENVIRONMENT REMEDIATION*, 61 (Heiner Klinkrad & Nicholas Johnson eds., 2013).

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must be applied to space debris *mutatis mutandis*.⁵⁸ This application can be inferred from Article VIII of the Outer Space Treaty.⁵⁹ Article VIII implies space objects—whether functional, operational, or neither—remain under the jurisdiction of the respective launching states, because the states retain ownership over space objects even after they cease to be functional.⁶⁰ Given the lack of legally significant distinctions between space objects and space debris, Article VIII applies to entire satellites, other spacecrafts, fragments, and other detached components.⁶¹

Unfortunately, Article VIII hinders effective space debris removal because interested third parties, whether public or private, must secure consent from the launching state before removing debris.⁶² However, with regard to fragments and other detached components, identifying the launching state could be difficult. Further, states do not always comply with their obligations under the Registration Convention, which requires launching states to provide information about their space objects and to inform the United Nations Secretary General about space objects that are no longer in orbit.⁶³

In recent years, the international community has tried to deal with the space debris problem by adopting several sets of non-binding mitigation guidelines and measures at the international⁶⁴ and regional

58. Furthermore, “[m]any authors consider debris a category of space objects for the purpose of liability, as there is no requirement that objects be functional in order to fall under article VIII OST.” De Man, *supra* note 54, at 6.

59. Outer Space Treaty, *supra* note 35, art. VIII; G.A. Res. 59/115, Application of the Concept of the “Launching State” (Jan. 25, 2005).

60. *Id.*

61. *Id.*

62. Martha Mejía-Kaiser, *Removal of Non-Functional Space Objects Without Prior Consent*, in PROCEEDINGS OF THE FIFTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE, 293 (2008).

63. Registration Convention, *supra* note 46, art. II.

64. International mitigation mechanisms include the IADC’s Space Debris Mitigation Guidelines, the UNCOPOUS’s Fifty-Third Session Report, the ITU’s Recommendation S.1003, the ESA’s Space Debris Mitigation for Agency Project, and the European Code of Conduct for Space Debris Mitigation. See Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on its Fifty-Fifth Session, Compendium of Space Debris Mitigation Standards Adopted by States and International Organizations, UN Doc. A/AC.105/C.2/2014/CRP.15 (2014) [hereinafter 2014 Compendium of Space Debris Mitigation Standards].

level.⁶⁵ The international community has also tried to adopt guidelines and measures through national space agencies, such as NASA and the National Centre for Space Studies (“CNES”),⁶⁶ and industry standards.⁶⁷ These guidelines deal with technical standards, like the UNCOPUOS’s guidelines,⁶⁸ and were subsequently endorsed by the United Nations General Assembly.⁶⁹ In 2010, UNCOPUOS also established a working group under the Scientific and Technical Committee (the “Committee”) to work on the long-term sustainability of space activities and promote the safe and sustainable use of outer

65. The European Code of Conduct for Space Debris Mitigation has been adopted by several European space agencies, such as the Italian Space Agency (“ASI”); The National Centre for Space Studies in France (“CNES”); German Aerospace Center (“DLR”); European Space Agency (“ESA”); and the United Kingdom Space Agency. *European Code of Conduct for Space Debris Mitigation*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (June 28, 2004), <http://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf>. The Space Situational Awareness Initiative and the Clean Space Initiative have also been noteworthy international attempts to deal with the space debris problem. See *SSA Programme Overview*, THE SPACE SITUATIONAL AWARENESS PROGRAMME, https://m.esa.int/Our_Activities/Operations/Space_Situational_Awareness/SSA_Programme_overview (last visited Mar. 27, 2019); *ESA’s Clean Space Initiative*, ROOM, https://room.eu.com/article/ESAs_CleanSpace_Initiative_and_the_role_of_the_LCA_tool (last visited Mar. 27, 2009).

66. See generally 2014 Compendium of Space Debris Mitigation Standards, *supra* note 64; see also *Compendium of Space Debris Mitigation Standards Adopted by States and International Organizations*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, <http://www.unoosa.org/oosa/en/COPUOS/Legal/debris/index.html> (last visited Mar. 27, 2019) (showing connections with all the text on mitigation measures adopted both at international and national level).

67. See, e.g., Int’l Org. for Standardization [ISO], *Space Systems—Space Debris Mitigation Requirements*, ISO 24113:2011 (May 2011).

68. *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

This set of technical standards were elaborated and already adopted in 2002 by the Inter Agency Debris Committee (“IADC”), a scientific independent body then endorsed by the COPUOS Guidelines.

69. The Guidelines are non-binding. They have been endorsed by the UN General Assembly Resolution, where the U.N. General Assembly invited States to implement those voluntary guidelines “through relevant national mechanisms.” G.A. Res. 62/217 ¶ 27 (Feb. 1, 2008).

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space.⁷⁰ At the COPOUS's sixty-first session, the Committee adopted only the first part of the guidelines, known as "Part A," and chose not to adopt Part B, which contains guidelines for procedures in preparing and conducting operations for actively removing and destroying space objects.⁷¹ Other existing initiatives, such as the Draft International Code of Conduct for Outer Space Activities ("CoC"), aimed to achieve space sustainability, safety, and security.⁷² The Group of Intergovernmental Experts on Transparency and Confidence Building Measures in Outer Space Activities ("GGE") also aimed to achieve the same goals as the CoC.⁷³ These initiatives should be considered "interrelated and complementary, not alternative initiatives."⁷⁴ However, all these guidelines and initiatives, whether adopted or proposed, are only voluntary; thus, such guidelines do not offer comprehensive and legally-binding solutions.

70. *Long-Term Sustainability of Outer Space Activities*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, <http://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html> (last visited Mar. 27, 2019). There are four thematic areas identified by the WG concerning the sustainable space utilization supporting sustainable development on Earth: space debris, space operations and tools to support collaborative space situational awareness, space weather, and regulatory regimes and guidance for actors in the space arena.

71. Rep. of the Comm. on the Peaceful Uses of Outer Space on its Sixty-First Session, UN Doc. A/AC.105/L.315 (2018).

72. This initiative arises from the European Code of Conduct for Outer Space Activities, which follows the IADC guidelines and clarifies some aspects. The EU Code of Conduct was adopted in 2008 and revised in 2010 by the Italian Space Agency (ASI), the French Space Agency (CNES), the German Space Agency (DLR), and the UK Space Agency, besides the ESA. *European Code of Conduct for Space Debris Mitigation*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (June 28, 2004), <http://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf>.

73. See *Space Situational Awareness*, EUR. SPACE AGENCY, https://www.esa.int/Our_Activities/Operations/Space_Situational_Awareness (last visited Mar. 27, 2019); see also, e.g., INT'L ACAD. OF ASTRONAUTICS (IAA), COSMIC STUDY ON SPACE TRAFFIC MANAGEMENT, 46 (Corinne Contant-Jorgenson et al. eds., 2006).

74. Marchisio, *The Legal Dimension of the Sustainability of Outer Space Activities*, *supra* note 17, at 3.

The COPOUS guidelines do carry some measures of normative force because they represent relevant state practices⁷⁵ that serve as benchmarks and standards of due diligence for states and operators.⁷⁶ Moreover, these voluntary technical guidelines and measures also fill an important normative gap, because states cannot agree on binding rules that govern space debris remediation and mitigation, and resolve the complex legal issues regarding responsibility and liability.⁷⁷

C. Mitigation Measures

There are two main types of measures that exist to combat space debris congestion and achieve the goals of space security and sustainability. These two types are (1) remediation or active debris removal (“ADR”) and (2) mitigation.

Remediation rules have not been adopted because the practice of remediation is legally complex, technically difficult, and is still developing. However, ESA’s Clean Space Initiative proves to be a particularly interesting development. The initiative “is studying an active debris removal mission called e.Deorbit, which would target and

75. See G.A. Res. 62/217 ¶ 27 (Feb. 1, 2008) (“The voluntary guidelines for the mitigation of space debris reflect the existing practices as developed by a number of national and international organizations.”).

76. Standard of care may be defined as “the degree of care which a reasonable prudent person should exercise in same or similar circumstances. If a person’s conduct falls below such standard, he may be liable in damages . . . from his conduct.” Martha Mejía-Kaiser, *Informal Regulations and Practices in the Field of Space Debris Mitigation*, in 34 AIR AND SPACE LAW 20-28 (2009); Steven Freeland, *The Role of ‘Soft Law’ in Public International Law and its Relevance to the International Legal Regulation of Outer Space*, in SOFT LAW IN OUTER SPACE: THE FUNCTION OF NON-BINDING NORMS IN INTERNATIONAL SPACE LAW 9 (Irmgard Marboe ed., 2012).

77. See De Man, *supra* note 54, at 5; see also UNCOPUOS 2010, *supra* note 48, at 14-15. Space debris environment remediation actions consist of “efforts to manage the existing space debris population through active space debris removal with emphasis on densely populated orbit regions.” Inter-Agency Space Debris Coordination Committee [IADC], *Key Definitions of the Inter-Agency Space Debris Coordination Committee (IADC)*, IADC-13-02 (Apr. 2, 2013).

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capture an ESA-owned derelict satellite in low orbit, and safely burn it in a controlled atmospheric reentry”⁷⁸ by 2024.⁷⁹

In contrast, mitigation is directed by a multiplicity of non-binding voluntary guidelines or technical standards.⁸⁰ This section focuses only on mitigation. Mitigation guidelines generally adopt a “future-oriented approach.”⁸¹ These guidelines are applicable to future mission planning, design, manufacturing, and operational phases.⁸² Mitigation guidelines generally only apply to future missions; most older space objects lack requisite technology.⁸³ The UNCOPUOS Debris Mitigation Guidelines outline two broad types of space debris mitigation measures.⁸⁴ While both types are inherently preventive, one category of measures aims to reduce the generation of potentially harmful space debris in the near future.⁸⁵ This first category focuses on reducing mission-related debris generation and avoiding break-ups.⁸⁶ This category also includes the practice of passivation, which is the “elimination of all stored energy on a spacecraft or orbital stages to reduce the chance of dangerous break-up.”⁸⁷ In contrast, the second category focuses on long-term solutions and on “end-of-life procedures

78. *In-Orbit Servicing*, EUROPEAN SPACE AGENCY, http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit (last visited Mar. 27, 2019). The satellite in question was Envisat.

79. *Asking New Questions Leads to New Technologies*, EUR. SPACE AGENCY, http://www.esa.int/Our_Activities/Space_Engineering_Technology/Talking_technology/Asking_new_questions_leads_to_new_technologies (last visited Mar. 27, 2019).

80. See *2016 Compendium of Space Debris Mitigation Standards*, *supra* note 17, ¶¶ 1-2. Since 1979, after the conclusion of the Moon Treaty, space law has progressed by way of soft law. See, e.g., MARBOE, *supra* note 53, at 405.

81. Taking into consideration the “future-oriented approach” of the IADC and UN guidelines, and the unclear state of measures, potential international obligations with respect to active removal of existing debris are *a fortiori* of an even more opaque nature. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 57, at 63.

82. *Id.* at 62.

83. See *id.*

84. UNCOPUOS 2010, *supra* note 48, at 1.

85. Marchisio, *supra* note 17, at 1.

86. *Id.* at 2-3.

87. Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 6-7. Stored energy primarily includes batteries and fuel.

that remove decommissioned spacecraft and launch vehicle orbital stages from regions populated by operational spacecraft.”⁸⁸

This article focuses on long-term mitigation of space debris. In such cases, two available options exist, re-orbiting or de-orbiting. Re-orbiting indicates a manoeuvre that moves the space object to a higher orbit.⁸⁹ In particular, this entails the repositioning of a spacecraft that has reached its end-of-life into a so-called graveyard or disposal orbit.⁹⁰ For space objects located in the GEO, the UNCOPUOS has suggested to move such objects towards an “orbit above the GEO region such that they will not interfere with, or return to, the GEO region.”⁹¹

For space debris located in the LEO, de-orbiting is the preferred method in certain circumstances. De-orbiting is “the intentional changing of orbit for re-entry of a spacecraft or orbital stage into the Earth’s atmosphere to eliminate the hazard it poses to other spacecraft and orbital stages, by applying a retarding force, usually via a propulsion system.”⁹² With respect to de-orbiting, current mitigation standards require space objects located in LEOs to be removed within twenty-five years from the end of their operational life.⁹³ NASA originally set the standard for this mitigation measure, which was to “maneuver to an orbit where atmospheric drag would remove the object within 25 years.”⁹⁴ Rather than becoming a binding rule, these debris

88. *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

89. Carmen Pardini & Luciano Anselmo, *The Effectiveness of End-of-Life Re-orbiting for Debris Mitigation in Geostationary Orbit*, 1:3 SPACE DEBRIS 173, 174 (1999).

90. *Where Do Old Satellites Go When They Die?*, NASA, <https://spaceplace.nasa.gov/spacecraft-graveyard/en/> (last visited Mar. 27, 2019).

91. Rep. of the Comm. on the Peaceful Uses of Outer Space on its Sixty-Second Session, at 50, UN Doc. A/62/20 (2007).

92. Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 7.

93. This is a measure conventionally adopted by guidelines and codes of conduct. See, e.g., *European Code of Conduct for Space Debris Mitigation*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (June 28, 2004), <http://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf>.

94. NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, *LIMITING FUTURE COLLISION RISK TO SPACECRAFT: AN ASSESSMENT OF NASA’S METEOROID AND ORBITAL DEBRIS PROGRAMS*, 57 (2011).

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mitigation standards were adopted by the IADC,⁹⁵ the ESA,⁹⁶ and the ISO.⁹⁷ IADC guidelines are particularly important because they arguably reflect “the fundamental mitigation elements of a series of existing practices, standards, codes and handbooks developed by a number of national and international organizations.”⁹⁸

Re-entry can be controlled and uncontrolled. This article is particularly interested in the *controlled* re-entry of space debris into the Earth’s atmosphere, because re-entry location can only be chosen in such circumstances.⁹⁹ Controlled re-entry remains the only option if the casualty risks of uncontrolled re-entry is above a certain threshold.¹⁰⁰ In this case, the re-entry shall occur in a manner that will reduce the impact footprint over an ocean area where risks of population casualties or property damage is negligible.¹⁰¹

Despite the international space community’s efforts in solving the issue of space debris, a comprehensive approach does not exist today. For this reason, the international space community may expect an increase in controlled re-entries and ocean splashdowns in the short term. These splashdowns achieve both the goal of space debris management and safety under international space law and the

95. Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 9.

96. See generally R. Walker et al., UPDATE OF THE ESA SPACE DEBRIS MITIGATION HANDBOOK (July 2002).

97. Int’l Org. for Standardization [ISO], *Space Systems—Space Debris Mitigation Requirements*, ISO 24113:2011 (May 2011). The ISO standard has been also incorporated by ESA as its own reference standard in 2014, thus superseding earlier mitigation standards requirements. See European Space Agency [ESA], *Space Debris Mitigation Policy for Agency Projects*, at 1, ESA/ADMIN/IPOL (2014) 2 (Mar. 28, 2014).

98. *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

99. *Basics About Controlled and Semi-Controlled Reentry*, EUR. SPACE AGENCY (Nov. 16, 2018), <http://blogs.esa.int/cleanspace/2018/11/16/basics-about-controlled-and-semi-controlled-reentry/>.

100. *Requirements on Space Debris Mitigation for ESA Projects*, EUROPEAN SPACE AGENCY § 5.2.3 (2008), http://emits.sso.esa.int/emits-doc/ESTEC/AD4RequirementsSpaceDebrisMitigationESA_Projects.pdf. These Requirements are now superseded by the ISO’s Space Debris Mitigation Requirements. See European Space Agency [ESA], *Space Debris Mitigation Policy for Agency Projects*, at 1, ESA/ADMIN/IPOL(2014)2 (Mar. 28, 2014).

101. *Id.*

sustainability of space activities in the outer space environment. However, these goals raise issues regarding unintended consequences on the law of the sea. Do space debris removal practices create problems or violate the law of the sea? How are ocean splashdowns related to the states' obligations to protect and preserve the marine environments beyond their national jurisdiction? These questions shall be explored in Part II. But first, this article shall examine the procedural obligations related to space debris disposal.

D. Procedural Obligations and Practices

As a general principle, the UNCOPUOS Guidelines establish that “[w]hen making determinations regarding potential solutions for removing objects from LEO, due consideration should be given to ensuring that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property, including through environmental pollution caused by hazardous material.”¹⁰² In referring to voluntarily measures, the IADC Space Debris Mitigation Guidelines recommend that a Space Debris Mitigation Plan should be prepared for each program and project.¹⁰³ Moreover, a “plan for disposal of the space system at the end of mission” should be explicitly included.¹⁰⁴ This same obligation was recognized in the 2004 European Code of Conduct for Space Debris Mitigation, which was developed and adopted by Italian, British, French, and German Space agencies, and the ESA.¹⁰⁵

The Outer Space Treaty also requires exchange of information, aiming to minimize the harmful interference of states engaging in space

102. *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

103. Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 7.

104. *Id.*

105. *European Code of Conduct for Space Debris Mitigation*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (June 28, 2004), <http://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf>. The Code includes obligations to inform, before re-entering a space object, the competent air traffic and maritime traffic authorities about the re-entry time and trajectory, and the associated ground area (guideline 5.4.2); moreover, the re-entry “should not result in harmful contamination of the Earth environment.” (guideline 4.4.1). *Id.*

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activities.¹⁰⁶ In relation to space objects no longer in the Earth's orbit, the Registration Convention imposes an obligation for states to notify the United Nations Secretary General.¹⁰⁷ A notification obligation is also contained in Article 5 of the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space ("ARRA").¹⁰⁸ However, under the ARRA, the involved third-party is expected to receive information or discover a space object returned to the Earth within its territory or in ABNJ.¹⁰⁹ These third-party states then notify the launching state and the United Nations Secretary General.¹¹⁰ The ARRA also obligates third-party states to notify the launching state or authority when a hazardous space object is discovered.¹¹¹ Furthermore, Principle 5 of the 1992 Principles Relevant to the Use of Nuclear Power Sources ("NPS") in Outer Space¹¹² establishes a duty to notify and sets the informational content of notifications.¹¹³ Principle 5 obligates notifications to concerned parties and the United Nations Secretary General during an expected re-entry of a space object with NPS on board.¹¹⁴ However, Principle 5 is also not legally-binding.

As generally implied by the Outer Space Treaty, states engaging in outer space activities are subject to general international obligations.¹¹⁵ These general obligations of cooperation include duties related to consultations and exchange of information, which also arise under general principles of international environmental law.¹¹⁶ As observed

106. Outer Space Treaty, *supra* note 35, art. IX.

107. Registration Convention, *supra* note 46, art. IV.

108. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, art. 5.1, May 14, 1969, 672 U.N.T.S. 119 [hereinafter ARRA].

109. *Id.*

110. *Id.*

111. *Id.* art. 5.4.

112. G.A. Res. 47/68, Principles Relevant to the Use of Nuclear Power Sources in Outer Space, Principle 5 (Dec. 14 1992).

113. *Id.*

114. *Id.*

115. Outer Space Treaty, *supra* note 35, art. III.

116. See PHILIPPE SANDS AND JACQUELINE PEEL, PRINCIPLES OF INTERNATIONAL ENVIRONMENTAL LAW, 211 (4th ed. 2018); see also Marchisio, *Article IX*, *supra* note 41, at 177.

in the Cologne Commentary on the Outer Space Treaty, general principles of international environmental law have clear normative significance regarding space law activities that affects areas beyond national jurisdiction.¹¹⁷

In assessing potential risks, some commentators have identified that an environmental impact assessment is not a well-established procedure under international space law.¹¹⁸ Other commentators suggest that the best practices regarding the re-entry of space objects are still under development.¹¹⁹ Moreover, relevant domestic legislation has been setting rules for impact assessments in relation to space activities¹²⁰ and to the potential effects on the environment of ABNJs.¹²¹ For example, before the launch of the International Space Station, NASA prepared an environmental impact statement in relation to both the launch and assembly of the space station and its decommissioning.¹²² NASA expected the space station's decommission to occur through a controlled re-entry and subsequent splashdown in "remote ocean areas."¹²³

117. See Marchisio, *Article IX*, *supra* note 41, at 181.

118. LOTTA VIKARI, *THE ENVIRONMENTAL ELEMENT IN SPACE LAW: ASSESSING THE PRESENT AND CHARTING THE FUTURE*, 273 (2008).

119. See Marchisio, *Article IX*, *supra* note 41, at 182.

120. For example, French legislation requires, *inter alia*, the operators to analyse the dispersion of debris falling into the seas (art. 23.1), regardless of potential interference with the territory and the territorial waters of other states, in case of controlled re-entry. An EIA is required as well for the purposes of evaluating direct and indirect, permanent or transient effects on the environment (art. 33). See *Arrêté du 31 Mars 2011 Relatif à la Réglementation Technique en Application du Décret No. 2009-643 du 9 Juin 2009 Relatif Aux Autorisations Délivrées en Application de la Loi No. 2008-518 du 3 Juin 2008 Relative Aux Opérations Spatiales* [Order of March 31, 2011 Relating to Technical Regulations Pursuant to Decree No. 2009-643 of June 9, 2009 on Authorizations Issued Pursuant to Law No. 2008-518 of June 3, 2008 on Space Operations], May 31, 2011, at 9415.

121. The United States also has legislation that mandates EIAs for activities that may have adverse effects on areas beyond national jurisdiction. Indeed, federal agencies are required to prepare environmental analyses for "major Federal actions significantly affecting the environment of the global commons outside the jurisdiction of any nation." Exec. Order No. 12114, 3 CFR § 2-3(a) (1979).

122. See generally *Final Tier 2 Environmental Impact Statement for International Space Station*, NAT'L AERONAUTICS SPACE ADMIN. (May 1996), <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960053133.pdf>.

123. *Id.* at 2-19.

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Some practices can also be assimilated to project-specific environmental assessments or program-wide assessments that resemble the Strategic Impact Assessment. For example, IADC conducts an annual re-entry prediction test campaign in preparation for the re-entry of hazardous object.¹²⁴ However, the impact assessment usually aims to ensure the safety and well-being of human beings with little consideration for the protection of the Earth's environment.¹²⁵

In conclusion, while binding rules do not exist and the best practices are still developing, exchange of information can foster a spirit and a practice of mutual assistance. This exchange of information and cooperation is also sanctioned in Principle 7 of the NPS Principles and Article IX of the Outer Space Treaty.¹²⁶ This duty of cooperation was evident during the Mir Space Station's splashdown when re-entry was conducted according to an agreement between Russia, NASA, and the ESA.¹²⁷ Moreover, the Mir splashdown reflects duties of cooperation that are crucial in the context of international environmental law and the international law of the sea.

II. FROM OUTER SPACE TO OCEAN DEPTHS: RE-ENTRY DISPOSALS OF SPACE DEBRIS IN THE "SPACE CEMETERY"

A. *The Spacecraft Cemetery*

As discussed above, the "spacecraft cemetery" is located very far from any land. This huge ocean area is centered on *Point Nemo*, which

124. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, **Error! Bookmark not defined.** at 94.

125. *See generally* *Final Tier 2 Environmental Impact Statement for International Space Station*, *supra* note 122. However, there are provisions that focus also on potential effects on Earth. *See generally* *The Liability Convention*, *supra* note 8; *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, 3-4 (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

126. *See* G.A. Res. 47/68, Principles Relevant to the Use of Nuclear Power Sources in Outer Space, Principle 7 (Dec. 14, 1992); Outer Space Treaty, *supra* note 35, art. IX.

127. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 73, at 82.

is the farthest point from any land on the Earth.¹²⁸ The spacecraft cemetery is entirely in a marine area beyond national jurisdiction.¹²⁹ As mentioned, this region is technically known as the Oceanic Pole of Inaccessibility or South Pacific Ocean Uninhabited Area ("SPOUA").¹³⁰ This area's key characteristic is its lack of human activity, such as shipping and fishing.¹³¹ The SPOUA is entirely devoid of human life.¹³² Thus, this area fulfils the mitigation requirement to direct controlled re-entries to ocean areas to avoid liability for injuries to persons or property.¹³³

Since 1971, over 263 pieces of space debris sank in this area.¹³⁴ Among these debris, more than 190 pieces are Russian, which includes the remains of the Mir Space Station and of three Salyut military space stations.¹³⁵ Fifty-two pieces of the debris belong to the United States, including the remains of the space station Skylab.¹³⁶ As for the remaining pieces, eight are European and six are Japanese.¹³⁷ Some space cemetery debris even came from private space operations.¹³⁸ High-tech fragments are spread throughout the SPOUA area because

128. The spacecraft cemetery is located at 48°25.6 South latitude and 123°23.6 West longitude and the nearest land is 2,700 kilometres south to Antarctica. Luigi Bignami, *supra* note 6.

129. Stirone, *supra* note 2.

130. Smith-Strickland, *supra* note 1.

131. However, this area falls under the regulatory competence area of the South Pacific Regional Fisheries Management Organisation. *Illustrative Map of the SPRFMO Area*, SOUTH PAC. REGIONAL FISHERIES MGMT. ORG., <https://www.sprfmo.int/about/illustrative-map-of-sprfmo-area/> (last visited Mar. 28, 2019).

132. Kruse, *supra* note 1 ("SPOUA has been designated as entirely void of human life; it contains no islands and very few shipping lines.").

133. Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 10.

134. Stirone, *supra* note 2.

135. See INTERNATIONAL ACADEMY OF ASTRONAUTICS, IAA SITUATION REPORT ON SPACE DEBRIS, *supra* note 22, at 85.

136. *Id.*

137. *Id.*

138. For example, the second stages of a Space X launch left debris in the ocean. The Joint Space Operations Center of the US Strategic Command have catalogued 24,000 objects that have re-entered into Earth's atmosphere. As of July 2016, the corresponding total re-entering mass amounted to roughly 32,000 tons. The current total of orbiting mass amounts to 7,000 tons. *Id.*

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they do not fall as a single piece but rather, as a shower of smaller debris.¹³⁹ However, some debris might be a considerable size.¹⁴⁰

Moreover, due to the increasing urgency of reducing space debris and the fostering of outer space activities, re-entries of large space objects will plausibly occur in the near future. The SPOUA is considered “an ideal place for spacecrafts to plunge back to Earth and die, far from any humans that might be injured by falling debris.”¹⁴¹ Even the International Space Station (“ISS”) might be de-orbited in the spacecraft cemetery at the end of its operational life.¹⁴²

B. Ocean Splashdowns and Their Implications for the Marine Environment

Presently, about 24,000 objects have entered into the Earth’s atmosphere.¹⁴³ Most objects were uncontrolled re-entries.¹⁴⁴ Importantly, about 10 to 40% of the re-entered material survived the impact with Earth’s atmosphere.¹⁴⁵ Approximately 75% of re-entries lead to deposition of materials in oceans areas.¹⁴⁶

Significantly, controlled re-entries accounted for approximately 47% of the re-entry mass due to the large size of space debris sinking during controlled splashdowns.¹⁴⁷ Because ocean splashdowns occur in the isolated and deserted waters of the space cemetery, re-entry allows launching and operating authorities to minimize risks of liability

139. See, e.g., Rachel Williams, *Q&A: Space junk The facts about orbital febris*, GUARDIAN (Feb. 12, 2009), <https://www.theguardian.com/science/2009/feb/12/space-junk-debris-questions>.

140. Stirone, *supra* note 2.

141. Indeed, the SPOUA is considered “an ideal place for spacecraft to plunge back to Earth and die, far from any humans that might be injured by falling debris.” Smith-Strickland, *supra* note 1.

142. Stirone, *supra* note 2.

143. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 73, at 85.

144. *Id.*

145. See INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 89.

146. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 73, at 85.

147. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 85. The report observes in this respect that “[t]he survivability of re-entering mass depends on the re-entry process and trajectory, and the materials. Typically, 10% to 40% of the space object’s dry mass tends to survive for objects with mass greater than 1.000kg.” *Id.* at 89-90.

caused by falling space debris.¹⁴⁸ Ocean splashdowns are likely to increase in the future because re-entry is an established mitigation measure that aims to limit the risks created by space debris.¹⁴⁹

However, actual splashdowns will only involve space objects that do not disintegrate when re-entering the Earth's atmosphere.¹⁵⁰ The survival rate for space objects is approximately between 10 to 40% of the original mass.¹⁵¹ This residual re-entry mass may contain harmful substances, which poses issues for the protection and preservation of the marine environment.

The primary risk related to space debris is kinetic risk.¹⁵² This is primarily relevant during collisions between orbiting debris and other debris, or functional space objects.¹⁵³ Kinetic risk is also relevant during re-entries because space objects or its remnant pieces may pose risk to airplanes or maritime vessels when they have re-entered the atmosphere.¹⁵⁴ In such cases, the norms regulating liability are

148. Space law provides for both state responsibility. Outer Space Treaty, *supra* note 35, arts. VI, VII; The Liability Convention, *supra* note 8, arts. II, III.

149. See, e.g., Inter-Agency Space Debris Coordination Committee, *supra* note 50, at 7; *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

150. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 89; *Compare Final Tier 2 Environmental Impact Statement for International Space Station*, NAT'L AERONAUTICS SPACE ADMIN., vi (May 1996), <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960053133.pdf>. In the case of the International Space Station's future re-entry, NASA estimated a potential survival rate of 6% to 19%. See Sidharth Raval, *Decoding the Mystery of Destruction Re-entry*, SPACE SAFETY MAG. (Apr. 12, 2015), <http://www.spacesafetymagazine.com/space-debris/falling-satellite/>.

151. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 89.

152. See *ESA Space Debris Mitigation Compliance Verification Guidelines*, EUR. SPACE AGENCY, 59, 61 (Feb. 19, 2015), [https://www.iadc-online.org/References/Docu/ESSB-HB-U-002-Issue1\(19February2015\).pdf](https://www.iadc-online.org/References/Docu/ESSB-HB-U-002-Issue1(19February2015).pdf).

153. *Id.* at 5, 88.

154. *Id.* For this purpose, there exist regulations for notifying the relevant air and maritime authorities. See, e.g., European Code of Conduct for Space Debris Mitigation, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS (June 28, 2004), <http://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf> (“[B]efore re-entering a space system, the appropriate launching state should apply the relevant air traffic and maritime traffic regulations,” which means the state should inform “the

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contained in the Outer Space Treaty and in the Liability Convention. While the kinetic risks associated with actual landing in the deep seabed may cause damages, these risks will not be the immediate focus of this article.

Two other types of risk are more relevant to the issues raised in this article. The first type is chemical risk, which focuses on the surviving components, substances or materials that may come from advanced equipment, and hazardous materials or substances.¹⁵⁵ For example, hydrazine is a widely-used rocket propellant, and its toxicity has promoted a “world-wide initiative looking for less hazardous [. . .] rocket propellants.”¹⁵⁶ Hydrazine is a substance of “very high concern,”¹⁵⁷ and is “very toxic to aquatic organisms.”¹⁵⁸ Several reports estimate that hydrazine, when present in fuel tanks at the time of re-entry, rarely survives the re-entry into the atmosphere.¹⁵⁹

corresponding authorities on the re-entry time and trajectory, and the associated ground area.”).

155. As suggested in the relevant literature, “recovered space debris and numerous reentry survivability analyses, fuel tanks are of particular concern. Some of these materials or substances pose a chemical risk.” Robert Kelley & Nicholas Johnson, *Evaluating and Addressing Potential Hazards of Fuel Tanks Surviving Atmospheric Reentry*, NAT’L AERONAUTICS AND SPACE ADMIN., 1, <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20110008637.pdf> (last visited Mar. 27, 2019).

156. Eckert Schmidt & E.J. Wucherer, *Hydrazine(s) vs. Nontoxic Propellants—Where Do We Stand Now?*, PROC. OF THE 2ND INTERNATIONAL CONF. ON GREEN PROPELLANTS FOR SPACE PROPULSION (ESA SP-557) (June 7, 2004), at 1. Indeed, the European Union might ban hydrazine in 2021. Tereza Pultarova, *Hydrazine ban could cost Europe’s space industry billions*, SPACE NEWS (Oct. 25, 2017), <http://spacenews.com/hydrazine-ban-could-cost-europes-space-industry-billions/>.

157. European Chemicals Agency [ESA], *Agreement of The Member State Committee on the Identification of Hydrazine as a Substance of Very High Concern*, arts. 57, 59, Regulation (EC) 1907/2006 (May 26, 2011).

158. The National Institute for Occupational Safety and Health (NIOSH), *Hydrazine*, CENTERS FOR DISEASE CONTROL AND PREVENTION (Mar. 13, 1995), <https://www.cdc.gov/niosh/ipcsneng/neng0281.html>. Moreover, a Canadian report concluded “[t]here is significant empirical evidence to suggest that hydrazine is harmful to aquatic organisms at low concentrations.” Environment Canada and Health Canada, *Screening Assessment for the Challenge Hydrazine*, at 21, Chemical Abstracts Service Registry Number 302-01-2 (Jan. 2011). The sources referred to freshwater ecosystems.

159. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 93.

However, some hydrazine will likely survive re-entry.¹⁶⁰ Re-entry survival predictions are not always accurate, because re-entry survivability models appear to “underestimate component survivability.”¹⁶¹ Under the right conditions, even living organisms and biological material have been deemed capable of surviving re-entry.¹⁶²

In addition to chemical risk, spacecrafts may contain radioactive material that are associated with either nuclear reactors or radioisotope thermoelectric generators (“RTGs”).¹⁶³ These RTGs may pose significant risks to the environment. UNCOPUOS has also dealt with the risks associated with radioactivity through relevant NPS principles and the Safety Framework.¹⁶⁴

III. RE-ENTRY DISPOSALS OF SPACE DEBRIS AND THE PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT IN AREAS BEYOND NATIONAL JURISDICTIONS

A. *Introduction to the International Legal Framework*

Space activities are generally regulated by the relevant space law treaties. However, Article III of the Outer Space Treaty provides that space activities must be carried out “in accordance with international

160. As in the case of USA-193 in 2008, which held a large amount of frozen hydrazine and was expected to perform an uncontrolled re-entry. For these reasons, USA-193 was shot down with a ground-based missile. *Id.* at 93; *see also, e.g.,* Kelley & Johnson, *supra* note 155, at 4; Andrew Gray, *U.S. has high confidence it hit satellite fuel tank*, SCI. NEWS REUTERS (Feb. 22, 2008), <https://www.reuters.com/article/us-usa-satellite-missile/u-s-has-high-confidence-it-hit-satellite-fuel-tank-idUSN1930844420080222>; Byers & Byers, *supra* note 21.

161. “Reentry survivability models have not been adequately tested against flight data and appear to underestimate component survivability.” Russell Patera & William Ailor, *The Realities of Reentry Disposal*, GLOBALSECURITY.ORG, 1 (1998), <https://www.globalsecurity.org/space/library/report/enviro/reentrypaper.pdf>.

162. *See, e.g.,* Nathaniel Szewczyk & William Mclamb, *Surviving Atmospheric Spacecraft Breakup*, 16 WILDERNESS AND ENVTL. MED., 27, 30 (2005); Dina Fine Maron, *DNA Can Survive Reentry from Space*, SCI. AM. (Nov. 26, 2014), <https://www.scientificamerican.com/article/dna-can-survive-reentry-from-space/>.

163. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 94.

164. *See* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm., Safety Framework for Nuclear Power Source Applications in Outer Space, UN Doc. A/AC.105/934 (2009).

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law, including the Charter of the United Nations.¹⁶⁵ This serves the interest of maintaining international peace and security, and promoting international co-operation and understanding.”¹⁶⁶ The legal framework regulating space activities cannot be seen in isolation, and any outer space activity must be consistent with general international law.¹⁶⁷ The Liability Convention recognizes the necessary interactions between general international law and outer space activities.¹⁶⁸ Further, the applicability of relevant rules and principles relating to the protection and preservation of the marine environment to space activities is well recognized in the literature.¹⁶⁹ This reflects the fact that space law does not independently consider the Earth’s environment. Space law only makes a few exceptions for effects on human health and property.¹⁷⁰

Under the Liability Convention, the definition of “damage” illustrates the limits of space law. According to Article I of the Liability Convention, “damage” means “loss of life, personal injury or other impairment of health; or loss of or damage to property of states or of persons, natural or juridical, or property of international intergovernmental organizations.”¹⁷¹ The following section shall outline the relevant legal questions that may be raised when splashdowns occur in the spacecraft cemetery. This analysis shall focus on the perspective of marine environment protection and preservation, especially through the rules and principles established in part XII of LOSC.

165. Outer Space Treaty, *supra* note 35, art. III.

166. *Id.*; *see also* Breccia, *supra* note 40.

167. *See* Marchisio, *supra* note 41, at 178-179.

168. INTERNATIONAL ACADEMY OF ASTRONAUTICS, *supra* note 22, at 142; *see also* The Liability Convention, *supra* note 8, art. XII. The Liability Convention states that the compensation to be paid by the liable state “shall be determined in accordance with international law”

169. *See* Marchisio, *supra* note 17, at 9 n.17 (making explicit reference to international environmental law).

170. *See, e.g., Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, UNITED NATIONS OFFICE FOR OUTER SPACE AFFAIRS, 3-4, (Jan. 2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

171. *See generally* The Liability Convention, *supra* note 8, at 9 n.17.

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B. General Legal Framework for the Protection and Preservation of the Marine Environment

The LOSC sets a broad legal framework for the protection and preservation of the marine environment.¹⁷² While the Preamble sets general goals, Part XII sets the framework in detail.¹⁷³ Article 192 establishes a general duty for states to protect and preserve the marine environment, including in areas beyond national jurisdiction.¹⁷⁴ This duty, while expressed in general terms, is given substantive content by the provisions in Part XII.¹⁷⁵ Additionally, other relevant rules and principles of international law play an important role in Article 192's interpretation. Article 237 of the LOSC recognizes the "complementary relationship between the LOSC and other conventions on protection and preservation of the marine environment."¹⁷⁶ This complementary relationship was reaffirmed by the Arbitral Tribunal in the South China Sea case.¹⁷⁷

The general duty for states has two prongs: it encompasses the *preservation* and *protection* of the marine environment from future damages, which means maintaining or improving its present condition.¹⁷⁸ The relevant corpus of international environmental law helps further specify the general duty enshrined in Article 192 of the LOSC.¹⁷⁹ This general duty attaches to all state activities within the

172. The LOSC is often referred to as the "constitutions of the oceans," and as such sets broad principles that address all aspects of ocean law and governance. *See, e.g.,* Davor Vidas et al., *International Law for the Anthropocene? Shifting perspectives in Regulation of the Oceans, Environment and Genetic Resources*, 9 ANTHROPOCENE, 5 (2015), <http://dx.doi.org/10.1016/j.ancene.2015.06.003>.

173. *See* United Nations Convention on the Law of the Sea, Part XII, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter LOSC]. The applicable section is entitled "Protection and Preservation of the Marine Environment."

174. LOSC, *supra* note 173, art. 192.

175. *See generally id.* Part XII, §§ 1, 5 and 6.

176. Robin Warner, *Conserving Marine Biodiversity in Areas Beyond National Jurisdiction: Co-Evolution and Interaction with the Law of The Sea*, in OXFORD HANDBOOK OF THE LAW OF THE SEA, 753 (Donald Rothwell et al. eds, 2015).

177. The South China Sea Arbitration (Phil. v. China), Case No. 2013-19, ¶ 941 (Perm. Ct. Arb. 2016), <https://pcacases.com/web/sendAttach/2086>.

178. *Id.*

179. *Id.*

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states' jurisdiction and control,¹⁸⁰ and is not only relevant in relation to other states' environments, but also, importantly, to the marine environment in areas beyond national jurisdiction.¹⁸¹ The International Court of Justice ("ICJ") has stated the "existence of the general obligation of States to ensure that activities within their jurisdiction and control *respect* the environment of . . . areas beyond national control is now part of the corpus of international law relating to the environment."¹⁸² Thus, the ICJ reinforced and confirmed the specific duties under the laws of the sea, which was established by Article 192 of the LOSC.¹⁸³

LOSC's Part XII sets other general rules to prevent, reduce, and control pollution.¹⁸⁴ Article 194(3)(a) is especially relevant because it obligates states to enact measures that "minimize, to the fullest possible extent: the release of toxic, harmful or noxious substances, especially those which are persistent . . . from or through the atmosphere . . ."¹⁸⁵ Article 194(3)(a) should be also read with Article 194(5), which focuses on fragile and rare ecosystems.¹⁸⁶ Generally, Article 194(5) is considered as a gateway to ecosystem-based ocean governance.¹⁸⁷ Thus, Article 194(5) may have a series of important implications for Part XII's scope and thresholds, especially with regard to precaution and to cumulative effects.

The LOSC's Article 195 is also an important provision. Article 195 is titled "Duty not to transfer damage or hazards or transform one type of pollution into another" and contains two rules.¹⁸⁸ The first rule relates to the transfer of environmental damages or hazards from one

180. PHILIPPE SANDS & JACQUELINE PEEL, *supra* note 116, at 201.

181. *Id.*

182. *See* Legality of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8); *see also* The South China Sea Arbitration (Phil. v. China), *supra* note 177, ¶ 941.

183. *See id.* (interpreting international environmental law).

184. LOSC, *supra* note 173, art. 194.

185. *Id.* § 3.

186. *Id.* § 5.

187. *See* Martin Belsky, *Using Legal Principles to Promote the "Health" of an Ecosystem*, 3 TULSA J. OF COMP. & INT'L LAW 183, 194 (1995); H. Wang, *Ecosystem Management and Its Application to Large Marine Ecosystems: Science, Law, and Politics*, 35 OCEAN DEV. & INT'L LAW 41, 49 (2010).

188. LOSC, *supra* note 173, art. 195.

location to another, while the second relates to the transformation of one type of pollution into another.¹⁸⁹

Besides the general rules, the LOSC's Part XII also sets specific rules for addressing all forms of pollution in the marine environment.¹⁹⁰ This framework includes duties to "prevent, reduce or control" pollution that originate from land-based sources,¹⁹¹ from seabed activities in areas within and beyond national jurisdiction,¹⁹² and from vessels.¹⁹³ Part XII's framework also includes duties to prevent, reduce, or control pollution by dumping¹⁹⁴ and pollution "from or through [the] atmosphere."¹⁹⁵ The duty to prevent pollution "from or through the atmosphere" is the most relevant and is recognized under Article 212. When Article 212 was adopted, the focus was not on how pollution could reach marine environments *through* the atmosphere *from outer space*.¹⁹⁶ However, Article 212 may now be interpreted to also address space debris entering the ocean through the atmosphere.

Areas beyond national jurisdiction include two distinct maritime zones that fall under different legal regimes.¹⁹⁷ The first maritime zone is considered "the high seas," which are regulated under Part VII of LOSC;¹⁹⁸ the second zone, called the Area, covers the "seabed, ocean floor and subsoil thereof" beyond the limits of national jurisdiction, and is regulated by Part XI of LOSC.¹⁹⁹ "The high seas" is a residual notion that encompasses the water column of marine areas beyond national jurisdiction.²⁰⁰ Although Part XII's general rules equally apply to both

189. *Id.*

190. *See generally* LOSC, *supra* note 173, arts. 207-12. The LOSC only recognizes forms of pollution known at the time the LOSC was negotiated and adopted.

191. LOSC, *supra* note 173, art. 207.

192. *Id.* arts. 208-09.

193. *Id.* art. 211.

194. *Id.* art. 210.

195. *Id.* art. 212.

196. ALEXANDER PROELSS, UNITED NATIONS CONVENTION ON THE LAW OF THE SEA, A COMMENTARY, 1443-51 (2017).

197. *See* LOSC, *supra* note 173, arts. 1, 35, 56, 86.

198. *See id.* art. 86.

199. *Id.* art. 134.

200. *Id.* art. 86.

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maritime zones, specific rules also apply to each zone.²⁰¹ Both of these maritime zones are global commons, but their legal regimes are different.²⁰²

IV. EXPLORING LEGAL ISSUES RAISED BY SPLASHDOWNS RELATED TO THE MARINE ENVIRONMENT

A. *Whether Splashdowns Pollute the Marine Environment*

Under LOSC's Article 1(4), the meaning of pollution is "the introduction by man, directly or indirectly, of substances or energy into the marine environment . . . which results or is likely to result in such deleterious effects as harm to living resources and marine life [and] hindrance to . . . legitimate uses of the sea."²⁰³ While it aimed to set a comprehensive framework for pollution regulations on the marine environment, the LOSC explicitly lists only a limited number of pollution sources.²⁰⁴

A sunken space object can only be a form of pollution if: (1) it is introduced by man, directly or indirectly; (2) it consists of substances and/or energy; and (3) its introduction does or may result in deleterious effects to living resources or marine life.²⁰⁵ While the sunken space objects easily fit the first two criteria,²⁰⁶ the third requirement demands

201. See LOSC, *supra* note 173, arts. 86, 136. Article 86 applies Part XII to the high seas and article 134 applies Part XII to the Area.

202. The high seas are subject to a regime of freedom. *Id.* art. 87. The Area is subject to a regime of common heritage of mankind. *Id.* art. 136.

203. The South China Sea Arbitration (Phil. v. China), *supra* note 177, ¶ 941.

204. LOSC, *supra* note 173, arts. 207-212. The LOSC imposed regulations on pollution from land-based activities, from seabed activities subject to national jurisdiction, activities in the Area, from or through the atmosphere, and dumping from vessels.

205. Indeed, the conservation of marine living resources is unequivocally an integral part of the protection and preservation of the marine environment. ITLOS, *Southern Bluefin Tuna Cases* (New Zealand v. Japan; Austl. v. Japan), Case Nos. 304, Order of Aug. 27, 1999, ITLOS Rep. 280, 295, ¶70.

206. In the London Convention there is also reference to the introduction of "matter." See generally Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, *opened for signature* Dec. 29, 1972, 1046 U.N.T.S. 120. According to article 1 section 10 of the LOSC, pollution is, in fact, defined as any direct or indirect human introduction of wastes or other matter into the sea, under condition of its resulting or being likely to result in "such deleterious effects

further investigation. A preliminary investigation on splashdown practices is one way to explore the third requirement. However, preliminary assessments of potential risks can be difficult if one lacks detailed knowledge about the materials and substances that are sunk in the SPOUA and the ecosystems where splashdown materials sink. Due to this difficulty, this article will assume sunken space debris are likely to cause harm to the marine environment and are therefore a form of pollution.

A further inquiry lies in what form of pollution does space debris fall into and whether this form of pollution falls under the relevant LOSC provisions. If so, then space debris constitutes a form of pollution that states are obliged to prevent, reduce, or control.

Part XII provides for measures that address pollution from a limited number of sources: land-based sources,²⁰⁷ seabed activities both in areas within and beyond national jurisdiction,²⁰⁸ dumping,²⁰⁹ vessels,²¹⁰ and “from and through the atmosphere.”²¹¹ However, Article 194 in Part XII establishes a general obligation to prevent, reduce, and control pollution of the marine environment *from any source*.²¹² This conforms to the LOSC’s general purpose, which is to establish a comprehensive regime regulating marine pollution. Because the general obligation provision is “very wide,”²¹³ it arguably opens the scope of Part XII’s application to sources of pollution not known or contemplated at the time of the LOSC’s adoption. The open-ended character of LOSC’s definitions allows for a dynamic or evolutionary interpretation. Evolutionary interpretation builds on the idea that a “[t]reaty is not static, and is open to adapt” to new norms and new

as harm to living resources and marine ecosystems . . . hindrance to marine activities, including fishing and other legitimate uses of the sea,” among other things. *See* LOSC, *supra* note 173, art. 1 § 1(4).

207. *See* LOSC, *supra* note 173, art. 207.

208. *Id.* art 208-09.

209. *Id.* art 210.

210. *Id.* art 211.

211. *Id.* art 212.

212. *Id.* art. 194 § 1. Article 194 section 3 then uses the expression “*all* sources of pollution” (emphasis added), which for the purposes of this section is an equivalent expression. *Id.* art. 194 § 3.

213. UNITED NATIONS CONVENTION ON THE LAW OF THE SEA 1982: A COMMENTARY 1, 64 (Myron H. Nordquist, et al. eds., 1985).

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circumstances.²¹⁴ Accordingly, “current standards” of environmental protection should be taken into account.²¹⁵ Moreover, terms and concepts constantly change meaning, urgency, and relevance throughout time; thus, it “hardly seems conceivable”²¹⁶ that meanings should be frozen in time.²¹⁷

The legitimacy of evolutionary interpretation and its consistency with the Vienna Convention on the Law of Treaties (“VCLT”) hinges on two factors. The first factor depends on the presence of generic terms, which justify a presumption of the evolutionary intent of the parties.²¹⁸ The second factor depends on the treaty’s existence and the continuing duration of the treaty’s interpretation.²¹⁹ Once the expression “any source” is considered generic, the expression’s generality indicates the evolutionary intent of the parties.

Two additional considerations may be added to further support the interpretation of the relevant LOSC provisions or expressions in an evolutionary manner. First, the LOSC is peppered with references to external rules and standards as well as practices and procedures.²²⁰ These rules, standards, and practices should be considered in relation to state obligations to protect and preserve the marine environment.²²¹ Further, while LOSC obliges state parties to develop and adopt these rules and standards in a cooperative manner, these rules and standards

214. Gabcikovo-Nagymaros Project (Hung. v. Slov.), *supra* note 15, at 68 ¶¶ 112, 140.

215. *Id.* at 77 ¶ 140.

216. Aegean Sea Continental Shelf (Greece v. Turkey), Judgment, 1978 I.C.J. Rep. 32, ¶ 77.

217. Indeed, evolutive interpretation “is not a separate method of interpretation but rather the result of a proper application of the usual means of interpretation.” Georg Nolte, *Between Contemporaneous and Evolutive Interpretation: The Use of “Subsequent Practice” in the Judgment of the International Court of Justice Concerning the Case of Costa Rica v. Nicaragua*, in COEXISTENCE, COOPERATION AND SOLIDARITY (2 VOLS.) 1675, 1683 (Holger P. Hestermeyer et al. eds., Nov. 25, 2011).

218. Dispute Regarding Navigational and Related Rights, (Costa Rica v. Nicaragua), Judgment, 2009 I.C.J. Rep. 213, 243 ¶ 66.

219. *Id.*

220. See, e.g., LOSC, *supra* note 173, art. 207 § 1. However, there are twenty-seven references to “international rules and standards” and only thirteen are “rules, standards and recommended practices and procedures” in Part XII. See *id.* at 100.

221. See, e.g., LOSC, *supra* note 173, arts. 207-212.

remain external to LOSC. They function as an evolutionary mechanism that keeps the LOSC general provisions current and coherent with evolving legal and technical standards.²²² This means the LOSC's signatories intended for the LOSC to exist as a living treaty that is susceptible to evolutionary interpretation, subject only to the general limits set by the VCLT and the LOSC itself.²²³

As a second consideration, evolutionary reading is no different from consistently interpreting the LOSC according to its object and purpose. According to the LOSC's preamble, its signatories sought to establish a "legal order for the seas and oceans,"²²⁴ which shall facilitate the protection and preservation of the marine environment.²²⁵ This goal might be severely and negatively impacted if LOSC interpretations could not evolve within the appropriate limitations²²⁶ to address environmental threats that were unknown at the time of the LOSC's adoption.

Lastly, the list of pollution sources in Part XII is arguably non-exhaustive, because article 194(3) provides that the pollution prevention measures taken pursuant to Part XII "shall include, *inter alia*," (emphasis in the original) those listed in letters (a) through (d).²²⁷ This wording indicates that other measures can be used to minimize the effects of "any" and "all" sources of pollution.²²⁸

B. *Whether Splashdowns Can be Characterized as Dumping*

As another issue, pollution from sinking space debris may also be subsumed under one of the codified forms of pollution under LOSC. In particular, the issue is whether splashdowns can be characterized as pollution by dumping. While pollution is an effect, dumping is a source

222. Doris König, *Marine Environment, International Protection*, in MAX PLANCK ENCYCLOPEDIA OF PUB. INT'L L. §§ C(1)(7), C(1)(a)(12) (2013).

223. See, e.g., LOSC, *supra* note 173, art. 311.

224. *Id.* at 25, ¶ 4.

225. *Id.*

226. For example, interpretation does not mean substitution, and evolutionary interpretation, while useful and sometimes even necessary, cannot be applied uncritically and too lightly. *Gabcikovo-Nagymaros Project (Hung. v. Slov.)*, Separate Opinion of Judge Bedjaoui, 1997 I.C.J. 7, ¶ 12 (Sep. 25).

227. *Id.* art. 194 § 3(a)-(d).

228. *Id.* art. 194 § 1, 3.

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or modality of pollution.²²⁹ The LOSC addresses pollution by dumping through specific provisions.²³⁰ The LOSC's provisions are highly relevant, because splashdowns are materially a form of dumping and may be legally characterized as dumping under LOSC's Article One.²³¹ The LOSC's Article One Section Five offers a good starting point²³² because it defines the meaning of dumping as either "any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea" or as "any deliberate disposal of vessels, aircraft, platforms or other man-made structures at sea."²³³ However, space debris splashdowns may arguably be a form of deliberate disposal of waste from parts of space objects²³⁴ or entire space objects. Consequently, space debris splashdowns may be

229. See LOSC, *supra* note 173, art. 210. This LOSC provision regulates pollution that occurs by means of dumping.

230. See generally *id.*

231. See *id.* art. I.

232. Though it reproduces, with only some drafting changes, the definition of dumping contained in the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, adopted in London on 29 December 1972. It is important to note that there are no "fundamental inconsistencies between the two Conventions and that the London Dumping Convention should be interpreted in the light of developments in international law since its adoption in 1972, including those reflected in Part XII" of LOSC, as agreed in the Tenth Consultative Meeting of Contracting Parties to the London Dumping Convention in 1988. *United Nations Convention on the Law of the Sea, A Commentary Online*, CTR. FOR OCEANS L. AND POL'Y, 43 n.22 (Myron Nordquist et al. eds., 2014), <https://referenceworks.brillonline.com/browse/united-nations-convention-on-the-law-of-the-sea> (site requires login and password) [hereinafter *Virginia Commentary*].

233. The same provision also explicitly spells out what the concept of "dumping" does *not* include: "(i) the disposal of wastes or other matter incidental to, or derived from the normal operations of vessels, aircraft, platforms or other man-made structures at sea and their equipment, other than wastes or other matter transported by or to vessels, aircraft, platforms or other man-made structures at sea, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such vessels, aircraft, platforms or structures; (ii) placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this Convention." LOSC, *supra* note 173, art. 1 § 1(5)(b).

234. Parts of space objects may arguably be a form of deliberate disposal in specific cases, such as the sinking of upper stages and other spent parts of space objects.

correspondingly subsumed under either part (a) or part (b) of the LOSC's Article One Section Four.

The issue then turns to whether space debris may be subsumed under the definition of "vessel," "aircraft," "platforms," or "other man-made structures."²³⁵ Because splashdowns were neither actual nor potential when the LOSC was negotiated, Article One Section Four does not appear to include space objects.²³⁶ Given the LOSC's intent to regulate "any source of pollution," an analogical application of the definition of dumping may be used to interpret Article One Section Four.

Regardless of whether splashdowns can be characterized as "dumping" within the meaning of LOSC, a review of the rules on dumping provides useful insight. The rules of dumping are set out in the LOSC's Part XII, specifically in Article 210 and Article 216.²³⁷ Article 210 establishes two relevant rules. First, states shall adopt laws and measures that prevent, reduce, or control pollution upon the marine environment through dumping,²³⁸ and states adopt such laws and measures either individually or "through competent international organizations or diplomatic conference[s]."²³⁹ Second, with regard to the first obligation of states to adopt laws and other measures, domestic legislation shall not be "less effective" than global rules and standards.²⁴⁰

The 1996 London Protocol on dumping reproduces LOSC's definition of dumping with one significant and notable difference.²⁴¹ The 1996 London Protocol defined dumping as "any deliberate disposal *into the sea* of wastes or other matter from vessels, aircraft, platforms

235. We will follow the rules on treaty interpretations set forth in the Vienna Convention of the Law of Treaties, without feeling obliged to rehearse them explicitly, as we assume readers will be familiar with their content. See VIENNA CONVENTION ON THE LAW OF TREATIES: A COMMENTARY, arts. 31-32 (Oliver Dörr, et al. eds., 2012).

236. See LOSC, *supra* note 173, art. 1 § 1(45).

237. *Id.* art. 210, 216.

238. *Id.* art. 210 § 1.

239. *Id.* art. 210 § 4.

240. *Id.* art. 210 § 6.

241. 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. 1, Nov. 17, 1996, 36 ILM 1 [hereinafter London Protocol].

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or other man-made structures at sea”; or alternatively as “any deliberate disposal *into the sea* of vessels, aircraft, platforms or other man-made structures at sea.”²⁴² This language is similar to the 1972 London Dumping Convention’s “at sea” expression.²⁴³ The use of such language may lead some people to believe that the term “at sea” is narrowly related to platforms or other man-made structures located at sea. Under this interpretation, space objects and space debris may fall under the general category of man-made structures but not under the more narrow category of man-made structures *at sea*, which could mean as located in, on, or under the sea. However, in order to achieve the LOSC’s objective in preserving and protecting the marine environment, space objects should be included within the meaning of the 1996 London Protocol’s provisions.

Splashdowns may still constitute a form of pollution regardless of whether or not they can be characterized as dumping. In the next section, this article will explore whether the LOSC’s Article 195 applies to splashdowns and pollution from space debris.

C. *Whether Splashdowns Entail a Form of Cross-Media Pollution*

As discussed above, the LOSC contains a provision that prohibits the transfer and transport of pollution across environmental media or areas.²⁴⁴ This is known as the principle of cross-media pollution. The LOSC’s Article 195 sets out a duty to “not . . . transfer damage or hazards, or transform one type of pollution into another.”²⁴⁵ Specifically, Article 195 contains two rules. The first rule relates to the transfer of environmentally-damaging effects from one location to another.²⁴⁶ The second rule relates to the transformation of one type of pollution into another.²⁴⁷ Both provisions are relevant to the practice of splashdowns, which can be considered as a form of pollution upon the marine environment.

242. *Id.* art. 4 § 1-4.

243. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. III § 1(a), *opened for signature* Dec. 29, 1972, 1046 U.N.T.S. 120.

244. *See* LOSC, *supra* note 173, art. 195.

245. *Id.*

246. *Id.* art. 195 § 1.

247. *Id.* art. 195 § 2.

The principle of cross-media pollution exists in treaties and international legal instruments, such as Article Three of the London Protocol.²⁴⁸ Additionally, Article Two Section Four of the Convention for the Protection of the Marine Environment of the North-East Atlantic also obliges state parties to “prevent” an increase of pollution in areas or environments outside the regulatory area of the Convention.²⁴⁹

However, serious considerations must be given to the complexities involved in any risk assessments across media, and to the equally complex and comprehensive application of the precautionary principle.²⁵⁰ The idea of cross-media pollution is complex and its practical applications are not straightforward. Thus, in the context of water laws, the International Law Association noted that:

all pollution is cross-media pollution. Pollution is the placing of a resource into a medium in which it does not belong, transforming the resource from potentially useful and ecologically important into a waste and a potentially dangerous substance. Efforts to prohibit cross-media pollution are bound to fail unless one can identify a single resource into which it is always and everywhere preferable to dispose of wastes. The question is how to dispose of wastes in the manner that causes the least net harm to the environment rather than singling out one or another resource and laying down that nothing can be disposed of in that resource.²⁵¹

Some may argue that the practice of ocean splashdowns is an effective disposal method that causes the least net harm. However, relevant disposing states would need to substantiate their claims before making such arguments. Any assessment would need to account for both the precautionary principle and the ecosystem approach to marine

248. See London Protocol, *supra* note 241, art. 3; see also Convention for the Protection of the Marine Environment of the North-East Atlantic, art. 2 § 4, Sept. 22, 1992, 2354 UNTS 67 [hereinafter Oskar Convention].

249. Oskar Convention, *supra* note 248, art. 2 § 4.

250. Andre Nollkaemper, “What You Risk Reveals What You Value,” and Other Dilemmas Encountered in the Legal Assaults on Risks, in *THE PRECAUTIONARY PRINCIPLE AND INTERNATIONAL LAW, THE CHALLENGE: THE CHALLENGE OF IMPLEMENTATION*, 93 (David Freestone & Ellen Hey eds. 1996).

251. Int'l Law Association, *The Berlin Rules on Water Resources*, at 17, Berlin Conference (Aug. 2004), http://www.cawater-info.net/library/eng/1/berlin_rules.pdf.

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environmental protection, both of which encourages the consideration of cumulative effects.

D. Whether a States Have an Obligation to Carry Out Environmental Impact Assessments, and Whether This Obligation Is Met

An environmental impact assessment (“EIA”) is a “procedure for evaluating the likely impact of a proposed activity on the environment.”²⁵² EIAs are now a “requirement under general international law.”²⁵³ These assessments concretely operationalize the broader principles of prevention and of precaution.

The principle of prevention has also become a general principle of international law.²⁵⁴ The duty of prevention descends from states’ general obligation to ensure that activities within their jurisdiction and control do not cause harm to the environment of other states, *or to areas beyond national jurisdiction*.²⁵⁵ As noted above, the LOSC’s general rules on the protection and preservation of the marine environment must

252. Convention on Environmental Impact Statement in a Transboundary Context, art. 1 § VI, February 25, 1991, 1989 U.N.T.S. 309.

253. Case Concerning Pulp Mills on the River Uruguay, (Arg. v. Uru.), Judgment, 2010 I.C.J. Reports 14, at 803 (April 20); *see also* Gabčíkovo-Nagymaros Project (Hung. v. Slov.), *supra* note 15, ¶ 140; Responsibilities and Obligations of States Sponsoring Persons and entities with Respect to Activities in the Area, Case No. 17, Advisory Opinion Order of Feb. 1, 2011, 10 ITLOS Rep. 51, https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf.

254. *See, e.g.*, Arbitration Regarding The Iron Rhine Railway (The Kingdom of Belgium v. The Kingdom of Netherlands), 27 R.I.I.A 35, 66-67, ¶ 59 (Per. Ct. Arb. 2005) [hereinafter the Iron Rhine Case]. In the Iron Rhine Case, the tribunal opined that the duty to prevent, or at least mitigate potentially significant environment harm “has now become a principle of general international law.” This duty descends from the general obligation of States to ensure that activities within their jurisdiction and control do not cause harm to the environment of other States or of areas beyond national jurisdiction already acknowledged by the ICJ. *See* Legality of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8). The Iron Rhine case cites the I.C.J.’s Advisory Opinion.

255. Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8). In the eyes of the I.C.J., the duty of prevention obligation is “now part of the corpus of international law relating to the environmental.” *Id.* (emphasis added). This decision, as already mentioned, is also referred to in *Iron Rhine* in relation to the duty of prevention. Iron Rhine Case, *supra* note 254, ¶ 222.

be integrated and supplemented by the rules and principles of international environmental law. This integration would concretely and comprehensively effectuate the LOSC's provisions.

With regard to the marine environment, the arbitration panel in the South China Sea case held "[t]he corpus of international law relating to the environment . . . informs the content of the general obligation in Article 192," precisely referring to the general principle of prevention.²⁵⁶ The principle of prevention requires an obligation of due diligence and EIA helps fulfil such obligation.²⁵⁷

Space law does not provide for a broad and comprehensive set of rules related to EIAs. Although some procedures have been implemented, there is no rule that requires compliance with EIAs because most guidelines related to space debris are voluntary. On the other hand, the LOSC does provide a set of rules related to environmental impact assessments.²⁵⁸

With regard to the marine environment, the LOSC sets forth useful general obligations. Article 204 imposes a general duty to monitor activities carried out under their jurisdiction or control by providing that "[s]tates shall, consistent with the rights of other states, endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyse, by recognized scientific methods, the risks or effects of pollution of the marine environment."²⁵⁹ Additionally, Article 204 Section Two states that "[s]tates shall keep under surveillance the effects of any activities which they permit or in which they engage in order to determine whether these activities are likely to pollute the marine environment."²⁶⁰ Thus, states have a duty to engage in "a continuing environmental impact assessment"²⁶¹ on activities that may have effects on the marine

256. The South China Sea Arbitration (Phil. v. China), *supra* note 177, ¶ 941; *see also* Legality of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8).

257. Case Concerning Pulp Mills on the River Uruguay, (Arg. v. Uru.), Judgment, 2010 I.C.J. Reports 14, ¶ 204 (Apr. 20).

258. *See* LOSC, *supra* note 173, art. 204-206

259. *Id.* art. 204.

260. *Id.* art. 204 § 2.

261. ALEXANDER PROELSS, *supra* note 196, at 1357.

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environment but that do not necessarily originate at sea.²⁶² This means space activities are included in the expression “any activities.” The preventive duty to assess an activity’s effects triggers when there is “reasonable grounds for believing that planned activities . . . may cause substantial pollution of or significant and harmful changes to the marine environment.”²⁶³ The duty to monitor and assess activities also includes the publication of relevant reports, either directly or through dissemination to competent international organizations.²⁶⁴

CONCLUSION

State interaction, or lack thereof, is or can be a key determinative of material consequences for the marine environment. Fragmentation is a known problem and a much-debated issue in international law.²⁶⁵ Even if it may not pose intractable problems, a certain degree of fragmentation may even be useful to foster legal diversity. However, lack of coordination between complementary and materially interacting states may lead to damaging, yet avoidable, consequences.²⁶⁶

Depending on the legal perspective, the same practice may be considered lawful and unlawful simultaneously. Hans Kelsen considered legal rules as schemes of interpretation that permit the assignment of normative consequences to otherwise factual

262. LOSC indeed regulates the conduct of States in relation to pollution from land-based sources, including duties to adopt relevant laws, rules, standards, practices and procedures. *See* LOSC, *supra* note 173, arts. 204-206.

263. *Id.* art. 206.

264. *Id.* arts. 204-206.

265. *See, e.g.,* Martti Koskenniemi § Päivi Leino, *Fragmentation of International Law? Postmodern Anxieties*, 15 LEIDEN J. OF INT’L L. 553, 553 (2001); Int’l Law Comm’n, Rep. of the Study Group on the Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law on its Fifty-Eight Session, U.N. Doc. A/CN.4/L.682 (Apr. 13, 2006); *see also, e.g.,* Rakhvun Kim & Klaus Bosselmann, *International Environmental Law in the Anthropocene: Towards a Purposive System of Multilateral Environmental Agreements*, 2:2 TRANSNATIONAL ENVTL. L. 285 (2013) (applying fragmentation in the context of environmental law).

266. Kim & Bosselmann, *supra* note 265, at 292.

occurrences.²⁶⁷ The choice of one scheme of interpretation over another has a different consequence for whether certain facts or actions acquire normative significance, and in what manner. The rules and schemes of interpreting space law consider splashdowns as lawful. By contrast, if approached through the rules and schemes of the law of the sea, splashdowns breach one or more substantive and/or procedural rules.

The idea and threshold of harm presents another set of questions. Environmental harm *per se* is not considered by space law in any meaningful way, except when the *space* environment is under consideration or when environmental damages lead to injuries to persons or damages to property. From the perspective of the law of the sea and international environmental law, the duty to protect and preserve the marine environment is no longer solely linked to human well-being; it also encompasses the “well-being” associated with the ecological integrity²⁶⁸ of the marine environment.²⁶⁹

Finally, the rules governing state responsibility for environmental harm determine the consequences of characterizing splashdowns as a breach of binding rules. Although these rules traditionally regulate transboundary harm, they are linked to environmental harm that occurs in ABNJ,²⁷⁰ where there is no injured party. The obligations to protect and preserve the marine environment of the high seas and of the sea

267. See generally HANS KELSEN, *PURE THEORY OF LAW* (2005); see also Andrei Marmor, *The Pure Theory of Law*, STAN. ENCYCLOPEDIA OF PHIL. (Jan. 4, 2016), <https://plato.stanford.edu/archives/spr2016/entries/lawphil-theory/>.

268. See Kim & Bosselmann, *supra* note 265, at 292; see also Rakhyun Kim and Klaus Bosselmann, *Operationalizing Sustainable Development: Ecological Integrity as a Grundnorm of International Law*, 24:2 REV. OF EUROPEAN COMMUNITY AND INT'L ENVTL. L. 194, 199 (2015).

269. Despite the fact that an indirect link still exists, this is a question increasingly taken up by the legal environmental literature. See, e.g., Vito De Lucia, *Competing Narratives and Complex Genealogies: The Ecosystem Approach in International Environmental Law*, 27 J. ENVTL. L. 91 (2015); see also Vito De Lucia, *Beyond Anthropocentrism and Ecocentrism: A Biopolitical Reading of Environmental Law*, 8:2 J. HUM. RTS. AND ENV'T 181 (2017).

270. See Jorge Viñuales, *The Contribution of the International Court of Justice to the Development of International Environmental Law: A Contemporary Assessment*, 32 FORDHAM INT'L L.J. 232, 241 (2008).

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floor are obligations *erga omnes*.²⁷¹ Additionally, Article 48(1)(b) of the International Law Commission's Articles on State Responsibility provides that "[a]ny [s]tate other than an injured [s]tate is entitled to invoke the responsibility of another [s]tate . . . if: . . . the obligation breached is owed to the international community as a whole."²⁷² In considering such provisions, the ICJ has recognized, as customary international law, the principle that states must ensure that activities under their jurisdiction and control do not cause harm to the environment in ABNJ.²⁷³ Because the marine environment in ABNJ is recognized as an "essential interest" or common concern²⁷⁴ of all states,²⁷⁵ every state may possibly have standing to institute proceedings before the International Tribunal for the Law of the Sea or the ICJ.²⁷⁶

Of course, many questions still remain. A key question is whether there is an actual or imminent peril to the essential interests of any state

271. Responsibilities and Obligations of States Sponsoring Persons and entities with Respect to Activities in the Area, Case No. 17, Advisory Opinion Order of Feb. 1, 2011, 10 ITLOS Rep. 51, ¶ 180, https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_17/17_adv_op_010211_en.pdf.

272. Int'l Law Comm'n, Rep. on the Work of its Fifty-Third Session; ILC, UN Doc. A/56/10, art. 48 (2001). Article 48(1)(a) could also be relevant, because it deals with obligations *erga omnes partes* (of the LOSC, for example). However, given that 48(1)(b) is significantly more far-reaching (and would cover key space exploration players that are not parties to LOSC), we chose to focus on it.

273. See Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, 1996 I.C.J. 226, ¶ 29 (July 8). The LOSC also contains the same rule, insofar as the duty is in relation to the marine environment, which arguably includes marine ABNJ. See LOSC, *supra* note 173, art. 193.

274. Common concern and common interest are sometimes used interchangeably and while they initially had a generic and almost "narrative" meaning, they have acquired a more specific and concrete legal meaning after the Rio Declaration. See Michael Bowman, *Environmental Protection and the Concept of Common Concern of Mankind*, in RESEARCH HANDBOOK ON INTERNATIONAL ENVIRONMENTAL LAW, 497-511 (Malgosia Fitzmaurice et al., eds. 2010).

275. Gabcikovo-Nagymaros Project (Hung. v. Slov.), *supra* note 15, ¶ 53; Int'l Law Comm'n, Addendum- Eighth Report on State Responsibility by Mr. Roberto Ago, Special Rapporteur, UN Doc A/CN.4/318/Add.5-7, at 27 ¶ 33 (1980). See also DUNCAN FRENCH, *Common Concern, Common Heritage and Other Global(-ising) Concepts: Rhetorical Devices, Legal Principles or a Fundamental Challenge?*, in RESEARCH HANDBOOK IN BIODIVERSITY AND LAW, 335 (2016).

276. This is precisely the direction in which Duncan French tries to bring the principle of common concern. FRENCH, *supra* note 275, at 350.

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in relation to the marine environment. Another key question is whether there is any detrimental effect for marine life after assuming that splashdowns are identified as pollution. Additionally, an inquiry should ascertain what constitutes “due diligence” under several procedural obligations. Given its general role in protecting and preserving the environment around the sea floor, the International Seabed Authority’s role should also be discussed as an issue.²⁷⁷

This article has outlined the relevant rules related to the practice of splashdowns to provide a preliminary map of legal issues that may be raised in the future, particularly from the perspective of the law of the sea. This article did not aim to be comprehensive nor exhaustive but rather to fill a gap and provide a map of legal issues that may be raised to protect and preserve the marine environment. This preliminary exploration hopes to promote further comprehensive and detailed discussions regarding the interaction, or lack thereof, between space law and the law of the sea.

277. See, e.g., Tullio Scovazzi, *The Concept of Common Heritage of Mankind and the Genetic Resources of the Seabed beyond the Limits of National Jurisdiction*, 14:25 *Agenda Internacional*, 2007, 11, 11 (2007) (discussing arguments towards expanding the conservation role of the ISA, albeit developed in relation to marine genetic resources).