

THE PUBLIC TRUST DOCTRINE, OUTER SPACE, AND THE GLOBAL COMMONS: TIME TO CALL HOME ET

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INTRODUCTION

Space exploration is heating up. Governments and private interests are on a fast track to develop technologies to send people and equipment to celestial bodies, like the moon and asteroids, to extract their untapped resources.¹ Near-space is rapidly filling up with public and private

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1. See Andrew R. Brehm, Note, *Private Property in Outer Space: Establishing a Foundation for Future Exploration*, 33 WIS. INT'L L.J. 353, 354 (2015); Ezra J. Reinstein, *Owning*

satellites, causing electromagnetic interference problems and dangerous space debris from collisions and earlier launches.² The absence of a global management system for the private commercial development of outer space resources will allow these near space problems to be exported further into the galaxy.³ Moreover, without a governing authority or rules controlling entry or limiting despoliation, outer space could turn into the “Wild West” of the twenty-first century.⁴

Space treaties executed in the last century espoused the principle that space should be developed for the benefit of all mankind and banned both private ownership and militarization of space resources.⁵ But, they left development of a system for managing non-military activities in outer space to another day.⁶ Private commercial interests, which would be absorbing the risks and paying the high costs of space development, oppose any management scenario premised on that principle, as it would enable less developed countries to free ride on their investments.⁷ These interests, unsurprisingly, support privatizing outer space.⁸ But acceding to their wishes by establishing a system of property-based rules would transport Earth’s current division between haves and have-nots into outer space, and could lead to destabilizing hostilities—the exact consequences that the early treaty drafters hoped to avoid.⁹

To date, most scholars in this area have focused on developing management systems premised on private ownership or possession of the

Outer Space, 20 NW. J. INT’L L. & BUS. 59, 59–60 (1999); Wilbur Ross, *That Moon Colony? Maybe Not Far Off*, N.Y. TIMES, May 25, 2018, at A23.

2. Reinstein, *supra* note 1, at 64. This area is called the Geo-Stationary Orbit (GSO). *Id.* “The GSO is a loop of space about Earth’s equatorial surface,” where most satellites are placed. *Id.* This narrow band of space is cluttered with “electromagnetic interference from rival satellites . . . and with ‘space junk,’ debris from past launches that threatens to rip holes in the orbiting equipment.” *Id.* At the same time, the GSO is “the most valuable of all space resources to date.” *Id.* at 65. “[T]he private-sector investment in telecommunications satellites has become a billion-dollar industry.” Carol R. Buxton, *Property in Outer Space: The Common Heritage of Mankind Principle vs. the “First in Time, First in Right” Rule of Property Law*, 69 J. AIR L. & COM. 689, 703 (2004).

3. See Reinstein, *supra* note 1, at 62–63.

4. See *id.* at 72 (“Any legal regime should guard against inefficient exploitation, waste, and environmental despoliation. Furthermore, space should not become the next Wild West. Destruction and sabotage must be discouraged.”).

5. See *id.* at 62, 66, 69.

6. See *id.* at 71–72.

7. See *id.* at 74.

8. See Reinstein, *supra* note 1, at 72; see also Brehm, *supra* note 1, at 355.

9. See Buxton, *supra* note 2, at 700 (“Referring to the ‘first in time, first in right’ property principle that dominated the earth for thousands of years, Arthur J. Goldberg, the U.S. Representative to the United Nations General Assembly stated, ‘[A]s we stand on the threshold of the [S]pace [A]ge, our first responsibility as governments is clear: we must make sure that man’s earthly conflicts will not be carried into outer space’”).

surface of some celestial body.¹⁰ This Article explores an alternative concept, the commons, in which no individual owns the property in question or can exclude others from it. Viewing property as a commons is closer to the principles set out in the various space treaties than implementation of a private property regime, and also offers a workable property regime. This Article demonstrates these conclusions by showing similarities between a large, Earth-bound commons, like the ocean and outer space, and how various commons management scenarios allow equitable use of resources, while preventing their despoliation and devolution into hostile disputes over entitlements to them. However, each of these commons management scenarios is flawed in some way and runs a similar risk to management approaches for private property of allowing the resource to be over-used or inequitably distributed.

The public trust doctrine (PTD), an ancient doctrine that governments and individuals have used effectively for centuries to protect the public's interests in terrestrial common pool resources (CPR) and to fill regulatory gaps, can be helpful in both respects.¹¹ An examination of the doctrine identifies commonalities between outer space and terrestrial public trust resources.¹² The ease and low cost of its implementation and enforcement, as well as its infinite malleability, are additional reasons to select it as a stopgap measure with some modification.¹³

This Article's structure is straight forward. Part I acquaints the reader with the problem. It explains why the need to develop a management regime for space is becoming increasingly critical as advancing technology is allowing more and more private commercial interests to play at the edge of outer space with attendant negative externalities.¹⁴ Soon these technological advances will allow private commercial interests to invade outer space with the potential for similar adverse impacts.¹⁵ Part II examines the international legal framework governing those activities and finds it lacks any capacity to regulate

10. See, e.g., Brehm *supra* note 1, at 374; Reinstein, *supra* note 1, at 72.

11. See Hope M. Babcock, *Using the Federal Public Trust Doctrine to Fill Gaps in the Legal Systems Protecting Migrating Wildlife from the Effects of Climate Change*, 95 NEB. L. REV. 649, 651 (2017).

12. See *id.* at 651–52.

13. See *id.* at 678–79.

14. See Ross, *supra* note 1.

15. See *id.* (describing touting the creation of a Space Policy Advancing Commercial Enterprise Administration in the Secretary of the Department of Commerce's office to establish a one-stop shop to assist "the budding private space sector"); see also Mike Ives, *China Makes Move Into Outer Space*, N.Y. TIMES, May 24, 2018, at A11 (describing China's ambitious plans to land an unmanned space craft on the far side of the moon by the end of this year, as well as put a person on the moon and send a mission to Mars by 2025).

activities in outer space, in part because it is riddled with ambiguities and contradictions when it comes to ownership of outer space and its resources.

Part III turns to that problem by discussing two types of property: private property and property owned in common with others. It examines the key features of each as well as their positive and negative attributes, how each might function in outer space, and what the consequences might be if one or the other prevailed. Because any property arrangement that results in its appropriation by the owner and the exclusion of others violates international space law, Part III also identifies various less-than-full fee property arrangement, like leases and easements, to see if these problems can be avoided and concludes they cannot.¹⁶ It then examines property held in common to determine its viability under international space law and finds it consistent.

Part IV investigates various approaches to managing property in outer space, be it held in private ownership or in common. Different approaches for managing private property in space are explored, including the right of first possession, tradable property claims, and establishing an exclusive economic zone, as well for managing an open access commons, such as the application of stewardship principles, norms, and the PTD. Each approach is evaluated in terms of its consistency with international law; its ability to promote and protect a sustainable, equitable, non-monopolistic, non-hostile environment in outer space; its efficiency; and its cost effectiveness. Only the PTD, which has been used for centuries to protect the public's interests in CPRs and has demonstrated its ability to adapt to new circumstances, may be able to meet these goals.¹⁷ This Article finds commonalities between outer space and Earth-bound public trust resources, like the oceans. Additionally, the doctrine's open access purpose resonates with language found in international treaties governing activities in outer space.¹⁸

This Article concludes that using the PTD will lead to a durable, equitable management regime in a commons where the wealthy are neither able to accumulate and control the resources that outer space has to offer nor over-exploit and deplete them. However, neither the doctrine nor ownership in common supplies any incentives for development, which may lead private enterprises to question whether development of outer space resources is worth the risks and costs.¹⁹ But, limited use of

16. See Brehm, *supra* note 1, at 360.

17. See Babcock, *supra* note 11.

18. See *id.* at 678.

19. See Reinstein, *supra* note 1, at 61.

private property management approaches, like lotteries and tradable development claims—a form of overlapping hybridity between one type of property, a commons, and a management regime from another, private property—may fill this gap.²⁰ This Article’s contribution to the literature on managing outer space resources and commons theory is using the PTD to bridge the gap between them and to suggest a hybrid management approach that melds commons theory with private property incentives.

I. OFF TO THE RACES

*“As we push human exploration deeper into space, we will unleash the boundless potential of America’s pioneering commercial space companies.”*²¹

Humans have always looked to the heavens and marveled, wondering what is there.²² Today, we know more about what might be there, which has spurred a race among nations and private enterprises to be the first to reap the economic benefits that outer space may have to offer.²³ This Part introduces the reader to the modern history of that race and some of the benefits and perils that it presents.

There is not a single definition of exactly what outer space is.²⁴ The United States employs a functional definition—i.e., outer space exists “wherever a preordained set of outer space activities takes place,” such as an orbiting satellite.²⁵ A competing “popular” definition draws “a line above which everything is considered to be outer space.”²⁶ The boundary line used for this theory “is approximately 96 to 110 kilometers above the [e]arth’s surface, which is the lowest altitude at which a satellite can currently maintain orbit.”²⁷

However, while the precise legal contours of what constitutes outer space is relevant for treaties governing activities in outer space, it is of less concern here than are the resources that are on celestial bodies in outer space and the claims that nations and private entities make to

20. See discussion *infra* Part V.

21. Vice President Mike Pence, Remarks at the 34th Space Symposium (Apr. 16, 2018), <https://www.whitehouse.gov/briefings-statements/remarks-vice-president-pence-34th-space-symposium-colorado-springs-co/>.

22. See Davin Widgerow, Comment, *Boldly Going Where No Realtor Has Gone Before: The Law of Outer Space and a Proposal for a New Interplanetary Property Law System*, 28 WIS. INT’L L.J. 490, 493 (2011) (“[T]he natural human tendency to explore uncharted frontiers demands a human return to space.”).

23. See *id.* at 492–93.

24. Reinstein, *supra* note 1, at 95.

25. *Id.*

26. *Id.*

27. *Id.*

them.²⁸ Some of these resources are very valuable and, if they exist on Earth, are extremely rare.²⁹ It is the economic benefit of these resources that fuels the current space race among the numerous nations and private enterprises.³⁰ The history of this current space race and space exploration in general, commonly referred to as the “Space Age,” can be traced back to the mid-1950s.³¹

The Space Age began in 1957 with the Soviet launch of the first satellite (“Sputnik I”) into space, followed shortly by the United States’ launch of Explorer I.³² Fifty years after Sputnik I, over 115 countries owned or shared ownership of an orbiting satellite.³³ Since then, countries and private companies have made 5,000 launches.³⁴ As of 2011, there were over 950 operational satellites circling the earth.³⁵

By 2005, China, which established its space program a scant thirteen years earlier in 1992, employed “tens of thousands of scientific, manufacturing and planning personnel in more than 3,000 factories.”³⁶ The Chinese beat their goal of launching a manned flight to outer space in 2005 by nearly two years.³⁷ Five countries intend to go to the moon by 2020, and the United States expects to establish a permanently staffed station by 2024.³⁸ In fact,

28. See Stephen DiMaria, Note, *Starships and Enterprise: Private Spaceflight Companies’ Property Rights and the U.S. Commercial Space Launch Competitiveness Act*, 90 ST. JOHN’S L. REV., 415, 419 (2016). Resources in outer space are either *res communis*, “to be enjoyed and shared by all people in common,” or *res nullius*, not subject to being owned, “but attainable by the first person to occupy or capture the property.” *Id.* “In line with the international obligations guiding [the U.S. Space Launch Competitiveness Act], outer space is no longer purely *res nullius*, because the Outer Space Treaty has imposed some environmental restrictions and a requirement of international cooperation.” *Id.* at 433.

29. Sarah Coffey, Note, *Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space*, 41 CASE W. RES. J. INT’L L. 119, 120 (2009) (“The moon, Mars, and other celestial bodies contain resources that are scarce or non-existent on Earth and which could have immense value. One example is helium-3, a substance common on the moon but exceedingly scarce on Earth. Helium-3 has better potential for providing clean, efficient energy than any other source currently known on Earth.”).

30. Widgerow, *supra* note 22, at 492–93.

31. See Jared B. Taylor, Note, *Tragedy of the Space Commons: A Market Mechanism Solution to the Space Debris Problem*, 50 COLUM. J. TRANSNAT’L L. 253, 258 (2011).

32. *Id.*

33. *Id.*

34. Emily M. Nevala, Comment, *Waste in Space: Remediating Space Debris Through the Doctrine of Abandonment and the Law of Capture*, 66 AM. U.L. REV. 1495, 1497 (2017).

35. Taylor, *supra* note 31, at 256.

36. April Greene Apking, Note, *The Rush to Develop Space: The Role of Spacefaring Nations in Forging Environmental Standards for the Use of Celestial Bodies for Governmental and Private Interests*, 16 COLO. J. INT’L ENVTL. L. & POL’Y 429, 434–35 (2005).

37. *Id.* at 435.

38. Coffey, *supra* note 29, at 120; see also *id.* at 123 (“[A]t least six nations and numerous private companies have plans to go to the moon in the near future. NASA’s Vision for Space

[a] recent [National Aeronautics and Space Administration (NASA)]-funded study estimated that the United States, in partnership with private industry, could return humans to the moon in as little as five to seven years for about \$10 billion. That same study also contemplated the possibilities of an estimated \$40 billion lunar base, which would dramatically cut costs in future missions to Mars.³⁹

“In March 2004, the European Space Agency successfully launched the Rosetta Spacecraft from Kourou, French Guiana. Over \$1.5 billion, ten years, and four billion miles later, the [spacecraft] released a sophisticated 220-pound probe called the ‘Philae,’ which landed on Comet 67P/Churyumov-Gerasimenko on November 12, 2014,” the first time any country or company has achieved this.⁴⁰ “During its year-long stay on Comet 67P, the Philae probe has drilled into the surface to collect samples, taken a series of photographs, and conducted a swath of experiments, . . . provid[ing] never-before-seen data that has the potential to shed light on the origins of the universe.”⁴¹

Once the European Union demonstrated the ability to land on a comet, the idea of landing on a resource rich asteroid came closer to reality.⁴² Asteroids, the “similarly situated cousins” of comets, “present potentially extraordinary incentives for mining and exploitation.”⁴³ The low gravity of asteroids decreases the amount of fuel required to land and take off from the asteroid’s surface, reducing the cost of asteroid mining to a more “palatable” level.⁴⁴ Additionally, “[w]ater, extracted from hydrated clay minerals present on asteroids, can be harvested and turned into hydrogen rocket fuel, giving asteroids the potential to be deep space

Exploration aims to send astronauts back to the moon in 2020 and to establish a permanently staffed base by 2024.”); Apking, *supra* note 36, at 437 (“Japan, Brazil, France, and the European Union . . . represent examples of countries only recently venturing into space.”). *But see* Brehm, *supra* note 1, at 371 (“As of 2013, only eleven nations had functioning space programs. There are even fewer countries where private space exploration entities exist.”).

39. DiMaria, *supra* note 28, at 415.

40. Elliot Reaven, Note, *The United States Commercial Space Launch Competitiveness Act: The Creation of Private Space Property Rights and the Omission of the Right to Freedom from Harmful Interference*, 94 WASH. U.L. REV. 233, 233 (2016).

41. *Id.*

42. See Kevin MacWhorter, *Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism*, 40 WM. & MARY ENVTL. L. & POL’Y REV. 645, 652 (2016) (“With the European Space Agency successfully landing the Philae Lander on Comet 67P, it is much more plausible to land a mining operation on an asteroid.”); Reaven, *supra* note 40, at 234 (“[P]roof of our ability to land on a comet makes the idea of landing on and potentially excavating an asteroid more realistic.”).

43. See Reaven, *supra* note 40, at 234.

44. *Id.*

gas stations.”⁴⁵

Not just countries are launching spacecraft into outer space; space flights by private ventures are thriving.⁴⁶ Companies like Planetary Resources, Inc., and Deep Space Industries (DSI) have initiated programs and actual launching tests for prospecting profitable resources on asteroids.⁴⁷ A study by the Keck Institute for Space Studies estimates that bringing an asteroid back to Earth’s orbit would cost only \$2.6 billion, which would be offset by the economic benefits of “harvesting precious metals, helium-3, and even water.”⁴⁸

Private investment in space, not foreseen when the international framework regulating activities in space was put into place, has grown, while government investment in space has “shrunk.”⁴⁹ Although the expenditures of NASA have increased since 1958, its overall budget “as a percentage of U.S. spending has decreased dramatically.”⁵⁰ NASA, in the aftermath of retiring its shuttle fleet in 2011, has relied increasingly on private contractors to design and build spacecrafts.⁵¹ In response to these federal cutbacks, the private space industry has grown dramatically.⁵²

Illustrating that trend, between 1996 and 2001, experts predicted that “private-sector investment in telecommunications satellites alone” would equal \$54.3 billion (including launch)—an amount that does not include other commercial space ventures or investment in Russian and Chinese

45. *Id.* at 235. “Since asteroids can serve as a water source throughout the galaxy, incentivizing commercial asteroid development serves the additional purpose of increasing the capacity for human space flight.” *Id.* at 252.

46. Brehm, *supra* note 1, at 378 (“The dawning of the new millennium has coincided with the creation of a new vehicle for understanding outer space—private space exploration.”).

47. DiMaria, *supra* note 28, at 415.

48. *Id.* at 415–16.

49. See Reinstein, *supra* note 1, at 98 (stating that an indication of this shrink is that commercial space activities currently “generate more revenues than government contracts”); Widgerow, *supra* note 22, at 499 (“The apparent reason for this explosion in space investment is that private space ventures promise great profits should they be realized . . .”).

50. MacWhorter, *supra* note 42, at 650. Contradicting this trend, in 2014, NASA requested a budget that included “\$105 million to begin work on a mission that would send a robotic spacecraft to capture an asteroid as early as 2019 and haul it back so that astronauts could rendezvous with it by 2022.” *Id.* at 653. In 2017, NASA closed out its mission to collect a large boulder from an asteroid and bring it back to Earth. Jeff Foust, *NASA Closing Out Asteroid Redirect Mission*, SPACE NEWS (June 14, 1017), <http://spacenews.com/nasa-closing-out-asteroid-redirect-mission>.

51. MacWhorter, *supra* note 42, at 650 (“That year, NASA awarded four private space companies—SpaceX, Blue Origin LLC, Boeing Co., and Sierra Nevada Corp.—contracts worth a combined total of \$269.3 million to transport cargo and crew to and from the International Space Station. More companies, such as Orbital Sciences, have followed suit.”).

52. *Id.*

satellites.⁵³ An additional “\$70 billion was projected to be invested in satellite communications ground stations over the same period.”⁵⁴ Research is discovering “phenomena unique to the low- and no-gravity environment of space” with the possibility of “space-based processing of new alloys.”⁵⁵ “Engineers have considered the possibility of capturing solar energy in massive quantities by laying out giant cells in space and on our moon.”⁵⁶

Private space flights are on the cusp of becoming a reality. In October 2012, a private company, SpaceX, launched “the first official commercial flight to the International Space Station [(ISS)].”⁵⁷ Since its first launch, SpaceX has sent sixteen missions to the ISS⁵⁸ and has successfully launched a reusable rocket.⁵⁹ Another company, Planetary Resources, has invested millions of dollars in “plans to mine asteroids for their mineral resources in the near future,” while other companies are focusing on their efforts in extracting valuable materials from the moon.⁶⁰ The founders of Google have made large investments in private space flight.⁶¹ Google offered \$30 million in prizes to any team who, before 2016, could (1) land a robot on the moon’s surface, (2) have it travel 1,640 feet over the moon’s surface, and then (3) transmit video images and data back to Earth,⁶² but as of March 2018, no one had won the prize and the competition was over.⁶³

It is indisputable that “reservoirs of great wealth sit untapped in space.”⁶⁴ However, only recently has technology advanced to a point

53. Reinstein, *supra* note 1, at 59.

54. *Id.*

55. *Id.* “The field of biotechnology is also taking advantage of zero-gravity conditions to manufacture protein crystals, which the pharmaceutical industry can use to create drugs that are able to ‘turn off’ a protein, thereby regulating metabolic processes.” *Id.* at 59–60.

56. *Id.* at 60.

57. Brian Abrams, *First Contact: Establishing Jurisdiction Over Activities in Outer Space*, 42 GA. J. INT’L & COMP. L. 797, 799 (2014).

58. *Missions*, SPACEX, <https://www.spacex.com/missions> (last visited Mar. 6, 2019).

59. *About SpaceX*, SPACEX, <https://www.spacex.com/missions> (last visited Mar. 6, 2019) (“SpaceX successfully achieved the historic first reflight of an orbital class rocket in 2017, and the company now regularly launches flight-proven rockets. In 2018, SpaceX began launching Falcon Heavy, the world’s most powerful operational rocket by a factor of two.”). Currently, SpaceX is working to create the “next generation of fully reusable launch vehicles that will be the most powerful ever built, capable of carrying humans to Mars and other destinations in the solar system.” *Id.*

60. Abrams, *supra* note 57.

61. MacWhorter, *supra* note 42, at 650.

62. *Id.*

63. Loren Grush, *It’s Official: No One Is Going to Win the Google Lunar X Prize Competition*, VERGE (Jan. 23, 2018, 3:14 PM), <https://www.theverge.com/2018/3/31/17176530/google-lunar-x-prize-competition-spaceil-moon-express-astrobotic>.

64. Reinstein, *supra* note 1, at 72.

where resources can be extracted from asteroids.⁶⁵ The most economically promising development activity in outer space is mining celestial bodies like the moon and asteroids.⁶⁶ Asteroids' "zero gravity fields and availability of metals" have made them serious "candidates for resource extraction since the beginning of the [S]pace [A]ge."⁶⁷ "The estimated [h]elium-3 reserves on our moon would create, in a controlled fusion reaction, [ten] times as much energy as is contained in Earth's recoverable coal, oil, and gas *combined*."⁶⁸ Evidence is growing that some near-Earth asteroids "contain gold, rhenium, germanium, and platinum-group metals—platinum, palladium, iridium, osmium, rhodium, and ruthenium—at concentrations of up to 100 times those that are mined on Earth."⁶⁹ Metals like iron, gold, and platinum are important to many current technologies.⁷⁰ "Astrophysicists estimate that each [asteroid] could contain 30 million tons of nickel, 1.5 million tons of cobalt, and 7,500 tons of platinum, among other minerals. To put that in economic terms, the value of each asteroid could be 'somewhere in the trillions [of dollars] or higher.'"⁷¹

The attractiveness of these resources is increased by the fact that "certain elements crucial to modern industry—such as platinum, zinc, copper, phosphorous, lead, gold, and indium—could be exhausted on Earth. Many of these have no synthetic alternative, unlike chemical elements."⁷²

[T]he energy required to extract minerals from an asteroid is considerably less than to extract from the [e]arth, or even the moon . . . , because in space there is no atmosphere to oxidise [sic] or salt to corrode, no weather, no gravity or friction to oppose transportation, dissipate energy and waste heat and unlimited heat from the sun and coldness in space for refrigeration, creating the "perfect vacuum"⁷³

These materials could augment Earth's diminishing supply of these

65. MacWhorter, *supra* note 42, at 652.

66. Reinstein, *supra* note 1, at 60.

67. MacWhorter, *supra* note 42, at 652.

68. Reinstein, *supra* note 1, at 61 (emphasis added).

69. *Id.* at 60. "Glenn Reynolds has observed, 'The smallest known near-[E]arth metal asteroid contains more metal than has been mined by humanity since the beginning of time.' It has been estimated that 2,000 NEAs larger than 1 km in diameter exist." *Id.*

70. MacWhorter, *supra* note 42, at 652.

71. *Id.*

72. *Id.* at 647. "[D]espite their high costs, platinum group metals are so useful that [one] of [four] industrial goods on Earth require them in production." *Id.* at 648.

73. Nilima Choudhury, *Asteroid Minerals Mining to be Achieved Within Five Years*, INDUS. MIN. (Mar. 14, 2014), <http://www.indmin.com/Article/3319663/Asteroid-minerals-mining-to-be-achieved-within-five-years.html> (summarizing the remarks of Chris Lewicki, President of Planetary Resources).

resources.⁷⁴ For example, the moon may contain a sufficient amount of helium-3 to meet “the world’s energy needs through fusion reactors,”⁷⁵ giving it one of the best “potential[s] for providing clean, efficient energy [of all the] other possible source[s] currently known on Earth.”⁷⁶ The development of helium-3 and other resources on the moon, like water, “could provide the raw materials for a manned outpost’s fuel, construction materials, and life support systems” in outer space.⁷⁷ Asteroids are also “rich in ruthenium, rhodium, osmium, iridium, and platinum,” which are not found in any significant quantities on Earth.⁷⁸ These materials are important for the development of electronics.⁷⁹ Development of these materials could lower the cost of electronics.⁸⁰ An additional inducement to developing outer space resources is that the terrestrial extraction of these materials can cause significant environmental damage.⁸¹ The fact that exploiting the mineral resources found on asteroids would avoid completely, or reduce significantly, the harmful environmental and sociological effects of terrestrial mining⁸² and would be enabled by investment dollars warrants “serious inquiry” into the activity’s future.⁸³

74. Apking, *supra* note 36, at 432. Apking also notes that the availability of these resources makes outer space livable, which might help counter Earth’s “swelling population.” *Id.*

75. David Johnson, Comment, *Limits on the Giant Leap for Mankind: Legal Ambiguities of Extraterrestrial Resource Extraction*, 26 AM. U. INT’L L. REV. 1477, 1480 (2011) (“The moon alone is believed to contain enough [h]elium-3 to supply the world’s energy needs through fusion reactors.”).

76. Coffey, *supra* note 29, at 121–22.

77. Johnson, *supra* note 75, at 1480–81. “Thus, the fate of space exploration and enterprise may depend on whether astronauts can make use of the celestial environment, rather than rely on terrestrial resources.” *Id.* at 1481.

78. Brehm, *supra* note 1; *see also* Reinstein, *supra* note 1, at 60 (“Many of these [near-Earth asteroids] seem to be rich in raw materials that are either rare and valuable on Earth, or common on Earth, needed in space, but expensive to launch.”).

79. Brehm, *supra* note 1 (“These elements are extremely rare on Earth and are important materials in developing electronics. . . . [E]ach of these platinum group elements draws a high market price, creating incentives to explore space for entrepreneurs and investors alike.”).

80. *Id.* at 355.

81. *See* Reinstein, *supra* note 1, at 65.

82. MacWhorter, *supra* note 42, at 647–48.

[B]y extracting tiny amounts of metals from relatively large quantities of ore, the mining industry contributes the largest portion of solid wastes in the world. The Environmental Protection Agency . . . describes the industry as the source of “more toxic and hazardous waste than any other industrial sector [in the United States], costing billions of dollars to address the public health and environmental threats to communities.”

Id. at 648.

83. *Id.* at 646–47. “The economic benefits of mining need not be sacrificed for the sake of the environment.” *Id.* at 649.

Colonization of outer space might also help with terrestrial overpopulation.⁸⁴ The moon has potential for use as a base that might allow for testing of equipment and development of necessary skills for a manned mission to Mars.⁸⁵ By providing the platform for “a deep space observatory,” the moon might “replace the Hubble space telescope and allow for better quality pictures” because the orbit of the Hubble telescope is only 250 miles from Earth, while the [m]oon’s orbit is 240,000 miles.⁸⁶

An indication of how seriously private companies view the possibility of mining asteroids is several billionaire investors—including two Google executives, a Hollywood director, and Ross Perot, Jr.—who in 2012 announced that they were investing heavily in a company called Planetary Resources, which is developing the technology to mine a near-Earth asteroid and bring those materials back to Earth.⁸⁷ The company hopes to do this by creating small spacecrafts that can “hitch a ride into space with larger, primary payloads.”⁸⁸ Another company, DSI, which was created for the purpose of extracting and harvesting materials from asteroids,

is developing a four-stage system for mining in space: Prospecting, Processing, Harvesting, and Manufacturing. It has already invented one spacecraft to be used for the Prospecting stage: a tiny probe, called FireFly, designed to scout asteroids and study their “size, shape, spin and composition . . .” For the Processing phase, DSI is creating technology required to “transform regolith to raw materials” for manufacture. The company is currently developing another spacecraft, called a Harvester, for the third stage to collect and transport resources. Finally, the company is creating technology to manufacture finished products in space.⁸⁹

Planetary Resources also “hopes to mine hydrogen fuels” from asteroids, which could then be used to power expeditions deeper into space.⁹⁰ DSI has “an end goal of using the materials to support outer space

84. *See id.* at 60 (“Colonization—pushing humanity’s living room beyond its ‘surly bonds’—might, depending on how it [is] implemented, represent a complete answer to the potential disaster of overpopulation and its effects.”).

85. Apking, *supra* note 36, at 440. *But see* Reinstein, *supra* note 1, at 63 (noting that while the moon may be a very “promising [site] for mining, energy-capture projects, and spaceship refueling,” it has a limited amount of usable water).

86. Apking, *supra* note 36, at 440 (saying the moon could take the place of the behind-schedule and over-budget the ISS, which is of limited use anyway).

87. Brehm, *supra* note 1; MacWhorter, *supra* note 42, at 650–51.

88. MacWhorter, *supra* note 42, at 653.

89. *Id.* at 653 (internal footnotes omitted); *see also* Brehm, *supra* note 1.

90. Brehm, *supra* note 1.

communities and fuel further exploration.”⁹¹ “In 2011, Microsoft billionaire Naveen Jain announced the creation of Moon Express, a private space exploration entity that plans to mine for platinum and titanium on the [m]oon.”⁹² And in that same year, a “venture start-up Shackleton Energy Company launched fund-raising efforts, ultimately seeking to mine the Shackleton Crater in the [m]oon’s south pole for fuels to propel deeper space expeditions.”⁹³

Space tourism by private companies is “on the rise.”⁹⁴ Experts estimate that space tourism will be worth \$1 billion by 2023.⁹⁵ Private companies are developing the capacity to take passengers on a “quick jaunt into outer space.”⁹⁶ These ventures will

include space hotels (profits estimated at \$5 billion a year by 2015), contracting with NASA to send humans to Mars (profits at \$400 billion by 2030), orbital labs for the development of microchips and biotech devices (profits at \$10 billion by 2015), solar satellites and electricity (\$100 billion by 2020), a space elevator that aims to replace rockets (\$2 billion by 2021), asteroid mineral mining (\$10 billion by 2030), [and] lunar mining (\$354 billion by 2050). . . . Clearly, private industry has economic incentives motivating it to invest in space exploration and technologies.⁹⁷

The sale of land on asteroids and the moon is also proceeding apace. Some believe that “[p]eople will line up to pay money for recognized titles to acres of speculative Lunar real estate just because they are part of mankind’s first permanent space settlement, which offers regular transportation back and forth, so the land could someday be developed, and theoretically, they could visit someday.”⁹⁸ Denis Hope, founder of Lunar Embassy,

sold 3,500 “properties” in the first sixteen years of the [company’s existence], and since 1998 he has managed a two-tier “reselling” program, whereby current owners of Hope’s lunar property could, in turn, sell their properties to other buyers. In December 2005, there were

91. *Id.* at 354–55.

92. *Id.* at 355.

93. *Id.*

94. MacWhorter, *supra* note 42, at 650; *see also* Apking, *supra* note 36, at 444 (describing various initiatives by private companies to develop tourist trade, including sending capsules containing personal property of customers like business cards, jewelry, and even cremated remains, to the moon).

95. Widgerow, *supra* note 22, at 499.

96. Abrams, *supra* note 57, at 799–800.

97. Widgerow, *supra* note 22, at 499 (internal footnote omitted).

98. Alan Wasser & Douglas Jobes, *Space Settlements, Property Rights, and International Law: Could a Lunar Settlement Claim the Lunar Real Estate It Needs to Survive?*, 73 J. AIR L. & COM. 37, 75 (2008).

twenty-seven reselling agents in the United States, and his “Ambassadorship” program has representatives in fifteen countries. While the international community has thus far ignored Hope, the proliferation of copycat companies selling lunar realty symbolizes the persistent enthusiasm that space ownership holds for thousands of people.⁹⁹

All this activity in space has not been without environmental cost. For example, one residue of the presence of humans and their equipment in outer space has been space debris, which can cause damage to functional satellites.¹⁰⁰ Even microparticulate debris like paint chips can cause damage to the surface of satellites and spacecraft, an example of which was the need to replace part of the Space Shuttle Challenger’s windshield as a result of a crack caused by a single paint chip.¹⁰¹ In 2009, the first time two intact satellites crashed into each other, a non-functional Russian satellite crashed into a functioning American communications satellite, releasing “upwards of 2,000 pieces of orbital debris.”¹⁰² Two years earlier, China destroyed a weather satellite as part of an anti-satellite missile test that produced “2,500 pieces of orbital debris.”¹⁰³

99. Widgerow, *supra* note 22, at 501–02 (internal footnotes omitted).

This issue was brought under consideration when Greg Nemitz brought suit against NASA seeking declaratory judgment concerning alleged property rights in the asteroid Eros. Nemitz officially published a claim of ownership to Asteroid 433, Eros. Eleven months later, NASA’s NEAR Shoemaker spacecraft landed on Eros. Nemitz sent NASA a twenty-dollar invoice for parking and storage fees. NASA refused to pay and Nemitz brought suit. Nemitz’s action was dismissed, however, for failure to state a claim upon which relief can be granted. The court found that Nemitz had failed to establish a legally recognizable property interest in Eros.

Brehm, *supra* note 1, at 359–60.

100. Nevala, *supra* note 34, at 1498; *see also* Hugh Lewis, *Trouble in Orbit: The Growing Problem of Space Junk*, BBC NEWS (Aug. 5, 2015), <http://www.bbc.com/news/science-environment-33782943> (“In 2014, the [ISS] had to move three times to avoid lethal chunks of space debris.”); Jillian Scudder, *How Do We Clean Up All that Space Debris?*, FORBES (Jan. 6, 2016, 7:18 PM), <https://www.forbes.com/sites/jillianscudder/2016/01/06/astroquizzical-space-debris/#1583bce31a3b> (noting that even paint-flake debris can cause serious damage to spacecraft).

101. *See* Taylor, *supra* note 31, at 262 (“Though small, microparticulate debris can still damage the outer surfaces of satellites and spacecraft. For example, a portion of the Space Shuttle Challenger’s windshield was cracked by a paint chip only two-tenths of a millimeter in size, necessitating its replacement after the mission’s conclusion.”). In fact, “[m]ost debris orbits with enough momentum to damage or destroy anything in its path.” *Id.* at 255.

102. Nevala, *supra* note 34, at 1498.

103. *Id.* at 1497–98. “Experts consider[ed] this [to be] ‘the most prolific and serious fragmentation’ in space exploration history.” *Id.* There are “[a]pproximately 15,000 catalogued pieces of space debris currently orbit[ing] the [e]arth, and this amount increases every year.” Taylor, *supra* note 31, at 255.

Experts think that 194 satellites have come apart in orbit.¹⁰⁴

Space debris can remain in orbit up to thousands of years¹⁰⁵ and, if not controlled or removed, could “render space useless.”¹⁰⁶ Because international treaties governing space “encourage[] and facilitate[] the use of space at the expense of environmental regulation,” they have little to offer in the way of managing the debris problem.¹⁰⁷ By assuring that orbital space can be accessed and polluted by anyone “as a common property resource,”¹⁰⁸ “no country fully internalizes the costs of the space debris it creates and thus no country has a strong incentive to limit or reduce its space debris.”¹⁰⁹ The lack of physical boundaries also makes it difficult to assign property rights in and responsibilities for the removal or control of these materials.¹¹⁰

Additionally, the projected presence of humans in outer space could be a source of contamination of the surface of any celestial body they encounter.¹¹¹ Examples of this “include fuel spills from mining operations, abandoned structures cluttering the moonscape, problems of disposal of human waste in large quantities, and depletion of various natural resources.”¹¹² Although unlikely, given the fact that “only well-established companies with the capital and resources to invest in asteroid mining will be able to mine asteroids,”¹¹³ there is also the possibility that all these private ventures, particularly mining, will create something akin to the lawless California Gold Rush in outer space.¹¹⁴

104. Taylor, *supra* note 31, at 261.

105. *Id.* at 257.

106. *Id.* at 255; *see also* Reinstein, *supra* note 1, at 65 (“Orbiting litter may soon seriously hinder our ability to maintain a global communications link.”).

107. Taylor, *supra* note 31, at 255.

108. *Id.*

109. *Id.* at 260.

110. *Id.* at 258 (“[S]imilar to the ocean and its tides, the physical characteristics of [Low Earth Orbit] make the establishment of traditional, spatially demarcated property rights impractical.”).

111. Apking, *supra* note 36, at 445.

112. *Id.*; *see also* Reinstein, *supra* note 1, at 65 (“The importance of an environmentalist ethos in this context derives, in part, from the concerns we already deal with on Earth: the preservation of the natural environment for its own sake and for our communal survival, as well as the conservation of natural resources.”). *But see* MacWhorter, *supra* note 42, at 676 (“While astroenvironmentalism is a laudable goal in some areas of commercial space ventures, it does not apply to the exploitation of asteroids. Asteroids are uninhabitable. They have zero gravity, no atmosphere, and are found in ‘the ‘perfect vacuum.’” Exploiting asteroids ‘damages no ecospheres since they are lifeless rocks left over from the formation of the solar system.’”).

113. MacWhorter, *supra* note 42, at 669.

114. *Id.* at 674–75 (“First of all, the sheer number of asteroids—and the quantity of minerals contained within—limits potential disputes over claims of property. Most problems dur-

Many of these ventures and the potential to do harm may become not only technologically feasible, but also economically feasible in the not too distant future.¹¹⁵ “The price of launch has decreased due to improved technology and increased competition.”¹¹⁶ The principal reason that space is not being developed “is the uncertainty of the legal regime.”¹¹⁷ Part II examines that regime and its impact on activities in outer space, like mining.

II. LEGAL FRAMEWORK—THE RULES OF THE ROAD

*“The utility of space, however, is limited to the extent that it can be accessed and used.”*¹¹⁸

There are two principal international treaties that apply to activities in outer space—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” or “OST”)¹¹⁹ and the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the “Moon Treaty”).¹²⁰ There are other treaties of less significance for purposes of this Article, like treaties that govern liability for accidents in space¹²¹ and the rescue of astronauts.¹²² One hundred and two countries have adopted the OST, including the United

ing the California Gold Rush arose because both real estate and minerals were limited. Second, the expense of sending mining ventures to an asteroid is so prohibitive that only those companies that have the requisite funding will be able to enter the market. Finally, the amount of material any one project can ferry from an asteroid and back will necessarily be limited due to the size of spacecraft.”); *see also* Reinstein, *supra* note 1, at 61 (“Recent price estimates of launching material into orbit costs approximately \$10,000 per pound; \$25,000–30,000 per pound of material to launch to our moon. The tremendous cost of launch, retrieval, and return means that ‘if there was gold in low Earth orbit and all the shuttle had to do was go up and open its cargo bay doors and let [the gold] fall in, it would[not] be worth it, even then.’”).

115. Reinstein, *supra* note 1, at 60–61.

116. *Id.* at 61; *see* MacWhorter, *supra* note 42, at 651 (“One of the most significant obstacles for the private space industry has been the price tag of traveling into space.”).

117. Reinstein, *supra* note 1, at 61; *see* MacWhorter, *supra* note 42, at 651 (“Complicating matters, the current law governing claims of property in space is ambiguous.”).

118. Taylor, *supra* note 31, at 254.

119. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

120. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, *opened for signature* Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Treaty].

121. *See* Convention on the International Liability for Damage Caused by Space Objects, *opened for signature* Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Space Liability Treaty].

122. *See* Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Treaty].

States and the former Soviet Union; its broad acceptance “has given it the character of binding international law even on those countries who have not ratified it.”¹²³ In contrast, only thirteen countries have adopted the Moon Treaty and, therefore, it is in effect only with respect to those countries.¹²⁴ Neither treaty establishes a governance regime for outer space, and neither treaty resolves any of the property ownership questions, which motivated the writing of this Article.¹²⁵ For example, while the OST clearly bars the appropriation of “celestial bodies” by countries, it does not address private entities appropriating them.¹²⁶

The origins of the OST are in General Assembly Resolution 1348 (XIII) of December 13, 1958, one purpose of which was “to avoid the extension of present national rivalries into this new field.”¹²⁷ Its roots are in the aftermath of the Cold War and a concomitant desire to avoid turning outer space into a war zone.¹²⁸ “Concerns over space imperialism were the main impetus for the central provision of the OST: the principle of nonappropriation of space by Nation-States.”¹²⁹ The non-militarist purpose of the Outer Space Treaty was very important to the United States.¹³⁰ “Each side of the Cold War was hoping to prevent the other from advancing as a sovereign into outer space and achieving an insurmountable military and geographic superiority. As a result, the OST

123. Reinstein, *supra* note 1, at 66.

124. Coffey, *supra* note 29, at 127.

125. See Wasser & Jobes, *supra* note 98, at 58–59.

126. Outer Space Treaty, *supra* note 119, art. II; see also MacWhorter, *supra* note 42, at 660.

127. G.A. Res. 1348 (XIII), at 5 (Dec. 13, 1958).

128. Brehm, *supra* note 1, at 357 (internal footnote omitted) (“Subsequent international negotiations concerning outer space, all taking place under the shadow of Cold War political and militaristic tensions, led to the drafting of the 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, commonly referred to as the second ‘non-armament’ treaty, was signed on January 27, 1967.”); *Id.* at 371–72 (“The seminal treaty in this arena, the Outer Space Treaty, stems from the non-armament context of the Cold War and the global impact of potential militarization of outer space.”).

129. Elliott Reavan, Comment, *The United States Commercial Space Launch Competitive-ness Act: The Creation of Private Space Property Rights and the Omission of the Right to Freedom from Harmful Interference*, 94 WASH. U.L. REV. 238, 243 (2016).

130. See U.N. GAOR, 21st Sess., 1st Comm. at 8–10, U.N. Doc. A/C.1/PV.1492 (Dec. 17, 1966), http://www.unoosa.org/pdf/garecords/A_C1_PV1492E.pdf. (statement of U.S. Representative, Arthur J. Goldberg, to the General Assembly) (“We of the United States regard this treaty as an important step toward peace. . . . Therefore, as we stand on the threshold of the [S]pace [A]ge, our first responsibility as governments is clear: we must make sure that man’s earthly conflicts will not be carried into outer space. . . . [The Outer Space Treaty] responds to that desire and hope.”); see also STAFF OF COMM. ON AERONAUTICAL AND SPACE SCI., 90TH CONG., TREATY ON PRINCIPLES GOVERNING THE ACTIVITIES OF STATES IN THE EXPLORATION AND USE OF OUTER SPACE, INCLUDING THE MOON AND OTHER CELESTIAL BODIES 15 (Comm. Print 1967); Reinstein, *supra* note 1, at 62; Wasser & Jobes, *supra* note 98, at 42.

is at best ambiguous, and at worst hostile, to the privatization and commercialization of space resources.”¹³¹

The Outer Space Treaty establishes the basic framework governing activities in outer space.¹³² It broadly

declares that outer space is free for exploration and use by all states, that the moon and other celestial bodies shall be used exclusively for peaceful purposes, that outer space is not subject to national appropriation by claim of sovereignty, and that the exploration and use of outer space shall be carried of [sic] for the benefit and interest of all countries and shall be the province of all mankind.¹³³

By making it impossible for any country to control outer space, the treaty “addressed Cold War concerns about [countries] claiming space and celestial bodies as their own territory and using them to station weapons for use against other countries.”¹³⁴ While the OST encourages “[t]he exploration and use of outer space, including the moon and other celestial bodies,”¹³⁵ it fails to confront today’s concerns about claiming resources from these entities.¹³⁶ Its general principles, which were to be expanded upon in subsequent treaties, do not contain much guidance on the ownership of extraterrestrial property or resources.¹³⁷ The drafters of the treaty “did not set out to create a comprehensive legal document to govern space for all eternity.”¹³⁸ Thus, the OST is no more than “a diplomatic stopgap hurriedly prepared before the first landing on the moon could ignite a new theater of Cold War conflict.”¹³⁹ The drafters clearly “did

131. Reinstein, *supra* note 1, at 63.

132. Coffey, *supra* note 29, at 125.

133. *Id.* (citing Outer Space Treaty, *supra* note 119, arts. I–II).

134. *Id.*

135. Outer Space Treaty, *supra* note 119, art. I.

136. Coffey, *supra* note 29, at 125; *see also* Reavan, *supra* note 129, at 244 (“Taken together, it is clear that the OST precludes any claim over territorial rights in space of any kind. What is less clear, however, is whether the appropriation of space resources is consistent with the OST, as the OST does not explicitly mention the extraction or ownership of space resources.”). Coffey goes further, saying that “mining or owning natural resources is not one of the forbidden activities.” Coffey, *supra* 29, at 126. MacWhorter believes that while the United States could not extend its jurisdiction over the surface of a celestial body because this action would be barred by the OST, “[i]t could, however, unilaterally guarantee property rights in extracted minerals within its own borders.” MacWhorter, *supra* note 42, at 665.

137. MacWhorter, *supra* note 42, at 660–61. Arthur Goldberg, then head of the U.S. negotiating team on the Outer Space Treaty, in response to a question at the Senate ratification hearings about Article I, said that “the article [was] a ‘broad general declaration of purposes’ that would have no specific impact until its intent was detailed in subsequent, detailed agreements.” John W. Finney, *Space Treaty Called ‘Fuzzy’ at Senate Hearings: Rusk and Goldberg Dispute Unexpected Objections by Gore and Fulbright*, N.Y. TIMES, Mar. 8, 1967, at 20; *see also* Wasser & Jobs, *supra* note 98, at 42.

138. Johnson, *supra* note 75, at 1508.

139. *Id.* Johnson goes on to say that given the context in which the Treaty was drafted, its

not contemplate the rise of private space flight”¹⁴⁰ and the ensuing push by private companies to engage in commercial activities in outer space.¹⁴¹

Article I of the Outer Space Treaty establishes a principle of free use and open access by declaring that outer space and celestial bodies “shall be the province of all mankind”—specifically, that “exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind.”¹⁴² Article I “establishes the OST’s fundamental presumption that outer space is ‘free for exploration and use.’”¹⁴³ The generally accepted interpretation of this language is an “affirmation of general principles of access” that “confirms the freedom of use because every state has an equal right to pursue space activities . . . rather than a prohibition of certain activities.”¹⁴⁴ Therefore, a claim by any nation of exclusive jurisdiction over a part of outer space could infringe on the rights of other states to access that area.¹⁴⁵ Article I “[e]ssentially . . . establishes a presumptive freedom of use, while the succeeding provisions qualify that freedom in a manner which advances the treaty’s peaceful purpose.”¹⁴⁶

Article II is one of those succeeding provisions that curtails “the freedom of use outlined in Article [I] by declaring that outer space, including the [m]oon and other celestial bodies, is not subject to national appropriation.”¹⁴⁷ It flatly prohibits national appropriation of any celestial body in outer space “by means of use or occupation, or by any other means.”¹⁴⁸ However, “many types of ‘use’ or ‘exploitation’ . . . are inconceivable without appropriation of some degree at least of any materials taken,” like ore or water.¹⁴⁹ If this view of Article II’s prohibitory language is correct, then “it is not at all farfetched to say that

authors “could not have intended a rule against private extraction of lunar minerals since Cold War-era technology was insufficiently developed to allow for such activities.” *Id.* He finds support for that conclusion in the number of Senate floor speeches regarding the Treaty’s ratification which made no mention of space mining. *Id.* at 1509.

140. MacWhorter, *supra* note 42, at 660.

141. *Id.* at 649.

142. Outer Space Treaty, *supra* note 119, art. I.

143. Johnson, *supra* note 75, at 1500 (quoting Outer Space Treaty, *supra* note 119, art. I).

144. Johnson, *supra* note 75, at 1501.

145. *Id.*

146. *Id.* at 1486. “Ultimately, the drafters decided on the less intrusive principle, setting the tone for the rest of the treaty by establishing that the freedom to use space is a positive right that can only be defeated by a corresponding restriction found later in the treaty.” *Id.* at 1504.

147. *Id.* at 1486 (citing Outer Space Treaty, *supra* note 119, art. II).

148. Outer Space Treaty, *supra* note 119, art. II.

149. Reinstein, *supra* note 1, at 69.

the OST actually installs a blanket prohibition on many beneficial forms of development.”¹⁵⁰ However, the OST only prohibits an appropriation that constitutes a “long-term use and permanent occupation, to the exclusion of all others.”¹⁵¹

Article VI of the OST “opens the door” for private exploration of outer space and celestial bodies¹⁵² by declaring that “States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the [m]oon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities”¹⁵³ Article VIII “confers jurisdictional control over the space objects and people engaged in outer space expeditions to the state party of the treaty on whose registry the object or person appears,” while Article IX enjoins parties engaged in activities in outer space to act with “due regard” to the interests of other countries in outer space and to not contaminate celestial bodies.¹⁵⁴ Article X requires parties to the treaty to make space launches available for observation by other parties.¹⁵⁵ “Articles XI and XII impose disclosure requirements, mandating that spacefarers must keep the public informed of their activities, and allow for other parties to visit outer space installations after appropriate notice.”¹⁵⁶

Ezra Reinstein calls the Outer Space Treaty’s view on property law “oddly conflicted.”¹⁵⁷ “On the one hand, the OST seems to endorse some property rights in [outer] space” by paying at least “lip service to the ‘exploration and use’ of outer space” in the Preamble and Article I,¹⁵⁸ while on the other, seems to deny these rights by declaring that these activities “shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.”¹⁵⁹ He notes that there is “widespread disagreement regarding the force” of the phrase “province of all mankind.”¹⁶⁰ Some hold that the language is only “a non-binding guide, a moral exhortation.”¹⁶¹ Others see the language, together

150. *Id.*

151. *Id.* at 70.

152. Brehm, *supra* note 1, at 358.

153. Outer Space Treaty, *supra* note 119, art. VI.

154. *Id.* arts. VIII–IX.

155. *Id.* art. X.

156. DiMaria, *supra* note 28, at 420 (citing Outer Space Treaty, *supra* note 119, arts. XI–XII).

157. Reinstein, *supra* note 1, at 66.

158. *Id.*

159. Outer Space Treaty, *supra* note 119, art. I; Reinstein, *supra* note 1, at 66.

160. Reinstein, *supra* note 1, at 66–67.

161. *Id.* at 67.

with the Moon Treaty, “as requiring that a system be imposed whereby all development is undertaken by a unified international organization, with profits spread amongst all nations without regard to involvement.”¹⁶²

To those favoring development, interpreting Article I, in effect, to “mandate . . . wealth redistribution,” would be the end of developing outer space’s resources.¹⁶³ Such an interpretation would require that an international institution would get to “determine what degree of wealth sharing is fair to ‘all countries.’”¹⁶⁴ This would compel the entities that created and improved the technology for resource extraction as well as “the financial and physical risks that are part and parcel of the pioneering development of space . . . to defer to international political consensus.”¹⁶⁵

The purpose of the Outer Space Treaty was not to establish a detailed system of property rights; rather, it was to set out “a general set of peaceful principles.”¹⁶⁶ The result is a treaty that “is riddled with ambiguities” and unanswered questions with respect to property rights.¹⁶⁷ It says nothing about what “rights parties can claim in celestial bodies” and under what circumstances “these unspecified property rights might vest.”¹⁶⁸ These ambiguities, especially with respect to the rights of private enterprises in the resources they develop, can prohibit development of those resources, almost as much as a system that bans development completely.¹⁶⁹

The second major treaty governing activities in outer space is the Moon Treaty.¹⁷⁰ “The treaty reiterates the OST’s designation of space as for the exploration and use of all nations. It places the right to explore and

162. *Id.* “[E]vidence indicates that the U.S. Senate, while debating whether to ratify the OST, also understood this phrase to require an equitable division of space-borne wealth among all nations.” *Id.*

163. *Id.* at 68.

164. Reinstein, *supra* note 1, at 68.

165. *Id.*

166. Johnson, *supra* note 75, at 1500.

[I]t would be disingenuous to suggest that its text provides a clear statement on whether private actors may extract mineral resources from celestial bodies. The only safe conclusion is that the OST’s authority is not limited to states. Presumably, a state will act to ensure private actors are in compliance with the OST’s principles to avoid violating the treaty, lest it provoke other states to ignore the treaty. Therefore, further investigation is required to determine whether a private actor may enjoy the right to harvest extraterrestrial resources.

Id. at 1503.

167. Wasser, *supra* note 98, at 58–59.

168. In other words, “what a person must do to gain whatever property rights are available.” Reinstein, *supra* note 1, at 71.

169. *Id.*

170. *See* Moon Treaty, *supra* note 120; Brehm, *supra* note 1, at 358.

use the moon for scientific benefit above private property rights. Finally, it establishes the moon as ‘the common heritage of all mankind.’”¹⁷¹ However, only thirteen countries have ratified the Moon Treaty; hence it is binding on only those countries, even though the treaty was extensively debated in many countries, including in the United States.¹⁷² Thus, despite its greater specificity, the treaty lacks the support necessary “to bind non-signatory states.”¹⁷³ Sarah Coffey calls the Moon Treaty a “failed treaty” because no country with the capacity to send an expedition into space is bound by it; indeed all spacefaring nations and most of the rest of the international community rejected it.¹⁷⁴ Nor will any theory of customary international law bind any country that has not ratified the treaty because “[t]here is insufficient state practice to claim that the common heritage doctrine as embodied in the Moon Treaty has become legal custom.”¹⁷⁵ In fact, there are no practices yet in outer space that might qualify as a basis for legal custom for anything.¹⁷⁶

Article 1 of the Moon Treaty declares that its provisions “shall also apply to other celestial bodies within the solar system, other than the earth.”¹⁷⁷ Article 6 encourages “freedom of scientific investigation” by authorizing countries to “collect on and remove from the moon samples of its mineral and other substances,” while Article 8 allows “exploration and use of the moon anywhere on or below its surface.”¹⁷⁸ Article 6 makes it clear that “such samples shall remain at the disposal of those States Parties which caused them to be collected and may be used by them for scientific purposes.”¹⁷⁹ Article 8 additionally allows countries to land

171. MacWhorter, *supra* note 42, at 664 (citing Moon Treaty, *supra* note 120, arts. 4, 11).

172. Coffey, *supra* note 29, at 127 (“Although the Moon [Treaty] opened for signatures in 1979, it did not enter into force until 1984 when it was ratified by a fifth country. It is currently binding only on the thirteen nations that have ratified it.”); see Johnson, *supra* note 75, at 1497 (“Despite this result, the Moon Treaty has little practical impact on current space law. Though it entered into force, the treaty does not bind the spacefaring nations because it cannot regulate the behavior of non-parties without their consent.”).

173. Johnson, *supra* note 75, at 1494.

174. See Coffey, *supra* note 29, at 127 (“The Moon [Treaty] is, in effect, a failed treaty because no nation that has ever performed a manned space flight is bound by it.”).

175. Johnson, *supra* note 75, at 1497–98. However, “spacefaring nations not party to the Moon Treaty may be bound by its provisions if the provisions . . . become customary international law.” *Id.* at 1497. “Nothing . . . precludes a rule set forth in a treaty from becoming binding upon a third State as a customary rule of international law, recognized as such.” Vienna Convention on the Law of Treaties art. 38, May 23, 1969, 1155 U.N.T.S. 331.

176. See Johnson, *supra* note 75, at 1498 (“As for space mining, neither states nor their private actors have attempted to harvest celestial resources, so there is no demonstrated practice by commission. Since technological hurdles prevent such an attempt at the present time, there is also no example of state practice by omission.”).

177. Moon Treaty, *supra* note 120, art. 1.

178. *Id.* arts. 6, 8.

179. *Id.* art. 6.

on the moon and launch space objects from it, and to “[p]lace their personnel, space vehicles, equipment, facilities, stations, and installations anywhere on or below the surface of the moon.”¹⁸⁰ The treaty also allows “[p]ersonnel, space vehicles, equipment, facilities, stations, and installations [to] move or be moved freely over or below the surface of the moon.”¹⁸¹ But those activities “shall not interfere with the activities of other States Parties on the moon.”¹⁸² Article 9 elaborates on Article 8, by authorizing states to “establish manned and unmanned stations on the moon,” but limiting this use to only an area necessary to meet the “needs of the station,” and not done in a way that might “impede the free access . . . of other States.”¹⁸³ These provisions may allow the location of an unmanned space station on the moon’s surface because doing this does not amount to possession of the moon’s surface.¹⁸⁴

Article 11 declares that “the moon and its natural resources are the *common heritage of mankind*” and, among other things, prohibits “national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.”¹⁸⁵ Article 11 extends the ban against physical appropriation of celestial bodies and their resources to non-governmental entities, stating, in part, that “neither the surface nor the subsurface of the [m]oon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.”¹⁸⁶ This provision was included in response to scientists who feared the possibility of competitive space settlements and wanted the moon reserved for research only.¹⁸⁷ Article 11 also requires “States Parties to

180. *Id.* art. 8.

181. *Id.*

182. Moon Treaty, *supra* note 120, art. 8.

183. *Id.* art. 9; *see also* Buxton, *supra* note 2, at 702.

184. Moon Treaty, *supra* note 120, art. 9; Buxton, *supra* note 2, at 702.

185. Moon Treaty, *supra* note 120, art. 11 (emphasis added). “[T]he very fact that the framers of the Moon Treaty felt the need to write a new specific ban on private property indicates that they did not feel the earlier Outer Space Treaty had already accomplished such a prohibition.” Wasser & Jobs, *supra* note 98, at 43.

186. Moon Treaty, *supra* note 120, art. 11; *see also* Brehm, *supra* note 1, at 358–59.

187. Wasser & Jobs, *supra* note 98, at 47–48. Space activist Paul Beich wrote,

[C]apitalism is a disincentive for any activity that does not directly or indirectly result in the production of wealth for the elite. The profit motive is capitalism’s euphemism for greed, and greed is a poor motivation for anything, especially the noble and exciting human endeavor of moving into the universe.

Paul Beich, *Letters: Will Capitalism Work?*, AD ASTRA, May/June 1998, at 3; Wasser & Jobs, *supra* note 98, at 48 n.45. This is an example of the view of private property as an

[the] Agreement . . . to establish an international regime . . . to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible.”¹⁸⁸ But the absence of the United States and Russia, neither of whom has ratified the Treaty, and the limited number of signatories severely limits the provision’s “practical effect.”¹⁸⁹

The most controversial of the Treaty’s provisions is its “common heritage of mankind” principle,¹⁹⁰ which is similar to language in the Outer Space Treaty that space is the “province of mankind.”¹⁹¹ Under Article 11’s common heritage of mankind principle, countries do not own land, but can manage resources in designated international zones.¹⁹² Therefore, no individual country has sovereignty over these areas; international law, including international custom, “governs.”¹⁹³ Although the common heritage of mankind principle is undefined, “subsequent clauses [in] Article 11 give substance to [that] provision”¹⁹⁴ by, among other things, (1) establishing an international body for directing the use of outer space’s natural resources; (2) declaring that outer space “is not subject to national appropriation . . . by means of use or occupation, or by any other means”; (3) requiring the equitable apportionment of the benefits from exploitation of the moon, including by countries that do not have exploratory programs; and (4) requiring the rational management of the moon’s resources, thereby providing protection and preservation of these resources for the benefit of mankind.¹⁹⁵

Lacking a defined meaning, the phrase can only have limited effect.

“abomination” and which “should be made illegal in the new world of space.” Wasser & Jobes, *supra* note 98, at 48; *see also* Henry R. Hertzfeld & Frans G. von der Dunk, *Bringing Space Law into the Commercial World: Property Rights without Sovereignty*, 6 CHI. J. INT’L L. 81, 91 (2005) (“Corporations exist to make profits, and property rights only matter to the extent that they are necessary to fulfill the objective of maximizing profit. Popular literature and the statements of corporate executives gives the impression that unless companies can obtain ownership to space territory, they will not be able to invest in space activities profitably. But in the reasonably near future, no company operating in space will likely need outright ownership of space territory, including land on the moon.”).

188. Moon Treaty, *supra* note 120, art. 11.

189. *See* Brehm, *supra* note 1, at 359.

190. *See, e.g.*, Johnson, *supra* note 75, at 1483 (emphasis omitted) (“Much controversy over space law revolves around a third concept that expands upon *res communis omnium*—the common heritage of mankind principle.”); Lynn M. Fountain, Note, *Creating Momentum in Space: Ending the Paralysis Produced by the “Common Heritage of Mankind” Doctrine*, 35 CONN. L. REV. 1753, 1759–60 (2003) (arguing that the Common Heritage doctrine should not apply to outer space because it represents a classic “tragedy of the commons” problem and fails to efficiently allocate resources).

191. Outer Space Treaty, *supra* note 119, art. I.

192. *See* Moon Treaty, *supra* note 120, art. 11; Buxton, *supra* note 2, at 691–92.

193. *See* Moon Treaty, *supra* note 120, art. 11; Buxton, *supra* note 2, at 692.

194. Johnson, *supra* note 75, at 1496.

195. Moon Treaty, *supra* note 120, art. 11; Johnson, *supra* note 75, at 1496.

Nonetheless, it is highly controversial and subject to widely conflicting interpretations.¹⁹⁶ Some argue that the phrase “vaguely” limits property rights; others go further and say it actually reserves resources “to common use in line with the Roman law principle of *res communis*.”¹⁹⁷ Brian Abrams assumes that the phrase “‘province of mankind’ means ownership of mankind. Thus[,] the [United Nations] or other [intergovernmental organization] acts as the owner of outer space on behalf of all mankind.”¹⁹⁸ Carol Buxton argues that “[t]he common heritage of mankind principle deals with international management of resources *within* a territory, rather than the territory itself.”¹⁹⁹ And David Johnson criticizes the language because it “goes beyond the principle of a *res communis* in that even the ownership of movable resources in a common heritage area is forbidden without international consent.”²⁰⁰

Non-spacefaring and less developed countries favor an interpretation that makes clear that “international areas designated for the common heritage of mankind do not belong to any one sovereign, but instead to all nations. Therefore, any resource or benefit derived from those resources, or the use of them, should serve all of mankind.”²⁰¹ They consider the principle to create a “common property,” which should be under “common management,” with one group “possessing exclusive rights to exploit natural resources and distribute those resources *equally* to all nations, regardless of which nations actually funded the effort (either economically or by developing the technology or both).”²⁰² Buxton finds this interpretation “inherently unfair,” and its application unlikely to provide an incentive for spacefaring nations to undertake any expeditions to outer space.²⁰³ She argues additionally that this interpretation robs the principle of any incentive it might have had to encourage less-developed nations to acquire the know-how to participate in the Space Age or fund exploration by them or others.²⁰⁴

“Developed nations interpret the principle as meaning that ‘anyone can exploit these natural resources so long as no single nation claims

196. *See id.* at 1483.

197. DiMaria, *supra* note 28, at 423. “[T]he United States and other spacefaring States opposed the agreement’s use of the *res communis* ‘common heritage of mankind’ principle, especially after that same principle caused [the United Nations Convention on the Law of the Sea] to fail.” *Id.* at 424.

198. Abrams, *supra* note 57, at 812 n.90.

199. Buxton, *supra* note 2, at 692 (emphasis added).

200. Johnson, *supra* note 75, at 1484 (emphasis omitted).

201. Buxton, *supra* note 2, at 692.

202. *Id.* (emphasis added).

203. *See id.* at 693.

204. *Id.*

exclusive jurisdiction' over the area from which they are recovered."²⁰⁵ In other words, "every nation enjoys access and each nation must make the most of that access. The heritage lies in the access to the resources, not the technology or funding to exploit them."²⁰⁶ They reason that since "they spend their time and money developing the technology that enables them to harvest resources, and they fund the expeditions that collect the resources, forcing them to share those benefits with countries that have contributed little or nothing to the effort would be unjust."²⁰⁷ These countries do not want the principle included in any new treaties because it substantially reduces the economic incentive to develop "technology to exploit natural resources."²⁰⁸

Given the fact that so few countries have acceded to its terms and its operative principle is continually controverted, Coffey is right; the treaty is a failure.²⁰⁹ Kevin MacWhorter attributes this to the unwillingness of spacefaring countries to accept the treaty's limitation on property ownership.²¹⁰ He compares the Moon Treaty to the United Nations Convention on the Law of the Sea (UNCLOS),²¹¹ which he says was accepted globally "because every nation with a coastline stood to gain from the extension of coastal jurisdiction," and they, as well as their citizens, could "benefit from the possibility of unlimited mineral extraction."²¹² This the Moon Treaty did not do.²¹³ Nonetheless, together with the Outer Space Treaty, it provides the framework for handling property rights in outer space, and it is to that topic the Article now turns.²¹⁴

205. *Id.*

206. Buxton, *supra* note 2, at 693.

207. *Id.*

208. *Id.* (finding this position "all too clear for capitalistic societies").

209. *See* Coffey, *supra* note 29, at 127.

210. MacWhorter, *supra* note 42, at 671.

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

212. MacWhorter, *supra* note 42, at 671. "The practical difficulties of traveling to space and carting minerals back to Earth is self-limiting enough to prevent any one company from obtaining more than its fair share." *Id.* *But see* Reinstein, *supra* note 1, at 79–80 (criticizing UNCLOS and its requirements "regarding [the] mining of Earth's deep seabed"). "The [UNC]LOS establishes an 'Authority' and an 'Enterprise.' Mining companies must receive approval from the Authority. Approval . . . is only granted if the applicant company satisfies a set of rigorous conditions." *Id.* (internal footnotes omitted). Under the first condition, "[t]he applicant must present two sites of equal value, one of which will be reserved by the Authority for development by the Enterprise." *Id.* "If space law follows the [UNC]LOS's lead and asks developed nations to make similarly-excessive sacrifices for the benefit of developing nations, the same political impasse with the resultant disparate and incoherent legal regimes will no doubt reoccur." *Id.* Although Reinstein disapproves of this proposal, it is none the less interesting. *See id.* at 79–80.

213. *See* MacWhorter, *supra* note 42, at 671.

214. *See id.* at 657–58.

III. PROPERTY IN OUTER SPACE

*“Space law must take into account private needs and build on private opportunities; to do this, it must embrace the principle of private property.”*²¹⁵

In our legal system, there are three types of property ownership—private, public, and communal.²¹⁶ Private property usually involves a single owner, either “a legal person like a corporation” or “a natural person.”²¹⁷ Public property, on the other hand, is owned by the state or its agents, while “common property” usually involves at least two entities who “hold the property in question either as joint tenants or as tenants in common.”²¹⁸ If neither of these situations is involved, the property may be “characterized as null property, open-to-entry property, or *res nullius*, and the resources covered by these arrangements are open to use by one and all without restrictions.”²¹⁹

The debate over the property ownership provisions of the OST and the Moon Treaty is between private and common ownership with commercial interests favoring the first, and those concerned with assuring the sustainability of outer space resources and equitable access to them favoring ownership in common.²²⁰ This Part explores these two types of ownership in the context of outer space,²²¹ identifying their benefits and flaws before concluding that considering outer space as common property owned by the citizens of the globe is more closely aligned with overarching international principles of how space should be managed.²²²

At its heart, the debate about property type is about rights in that property. Property rights, like any other right, are “social artifacts.”²²³ They are neither fixed nor assumed, and may “vary from one society to another and over time within the same society.”²²⁴ They consist of

215. Reinstein, *supra* note 1, at 98.

216. See Oran R. Young, *Rights, Rules, and Common Pools: Solving Problems Arising in Human/Environment Relations*, 47 NAT. RESOURCES J. 1, 6 (2007).

217. *Id.*

218. *Id.*

219. *Id.*

220. See *id.* at 12–13.

221. This Article does not address public ownership because of the clear ban under international law on nations owning property on celestial boundaries, as discussed in Part II. Further, it would be very difficult and contentious to determine which nations own which celestial body, like the moon or parts of it.

222. “[P]roperty law has an important role in addressing widespread economic inequality by protecting those goods most essential to the well-being of a broad swath of society, rather than just protecting the goods that are disproportionately held by the wealthy.” Sheila R. Foster & Christian Iaione, *The City as Commons*, 34 YALE L. & POL’Y REV. 281, 285 (2016).

223. Young, *supra* note 216, at 5.

224. *Id.*

“bundles of rights that can be and often are separated or combined in complex ways.”²²⁵ Some forms of property management, like custodial or stewardship management, allow for disaggregating those bundles.²²⁶

At a minimum, these bundles include possessory rights or the entitlements of ownership per se, usufructuary rights or rights to make use of property in specified ways, exclusion rights or rights to prevent others from using property without permission, and disposition rights or rights to dispose of property according to the wishes of the owner.²²⁷

Some of these rights, such as exclusion rights, the right to prevent access to or use of the property, and disposition or alienation of the property, may be problematic in outer space under international law, as discussed in Part IV.²²⁸

Possessory rights, a stick in the property rights bundle, can be “subdivided.”²²⁹ Some of the ways this can be done are discussed in Part VI and are worth considering in the context of outer space.²³⁰ “[E]ven relatively full bundles of rights are not unlimited or unrestricted.”²³¹ Imagining property regimes of less than full and unimpeded ownership in outer space is conceivable, as is altering the structure of property rights to eliminate or lessen perverse incentives, like competition, from the implementation of those rights.²³²

For private property rights to emerge out of a common property regime or from null property where there is no ownership, like outer space, “cost-effective technologies for measuring, monitoring, and

225. *Id.* at 6.

226. *See* discussion *infra* Part IV (discussing stewardship as a means of managing property without owning the property); *see also* Martin Hirschprung, *Ownership is Nine-Tenths of Possession: How Disparate Concepts of Ownership Influence Possession Doctrines*, 41 VT. L. REV. 143, 149 (2016) (internal footnote omitted) (“[T]he stewardship model [of property management] facilitates an understanding of resource protection that extends beyond the traditional ownership model and embodies a notion of mutual trusteeship. It also allows for a disaggregation of title, possession, and exclusion.”).

227. Young, *supra* note 216, at 6.

228. *See* discussion *supra* Part IV.

229. Young, *supra* note 216, at 6 (“Possessory rights can be subdivided as in cases where owners sell or give away development rights while retaining the rest of the bundle of entitlements, or where different parties share such rights as in systems of common field agriculture in which one party is entitled to grow crops on the land, while others have rights to graze cattle on the same land once the crops have been harvested.”).

230. *See* discussion *infra* Part VI.

231. Young, *supra* note 216, at 6.

232. *Id.* at 8 (“[P]lans for solving a wide range of problems relating to the environment and natural resources commonly take the form of proposals for altering prevailing structures of property rights in order to eliminate perverse incentives by creating exclusion mechanisms or, less often, by encouraging efforts to increase the supply of goods in order to alleviate conditions of rivalness.”).

enclosing private property must emerge” to enable the claiming and transferring of “identifiable units of the resource.”²³³ If there is no private rights technology or “the distributional cost hurdle is too high, private property rights cannot emerge because the transaction cost wedge is simply too large.”²³⁴ Instead, “political or regulatory property rights will emerge.”²³⁵ While property rights are continually created and abandoned, depending on economic conditions, the act of defining property “has a high fixed cost element,” such as the cost of establishing and defending boundaries, which can have an effect on the emergence of property rights.²³⁶

One of the problems facing the creation of private property rights in outer space is the emergence of technology to define those rights in an area that is without static geographic and political boundaries.²³⁷ Another problem is how to grant, let alone enforce, those rights without violating international space law that bans the appropriation of outer space and its resources. So, the presence of potential entrepreneurs eager for the development of that technology, like Bruce Yandle and Andrew Morriss’s cattlemen of yore and the development of barbed wire, may not

233. Bruce Yandle & Andrew P. Morriss, *The Technologies of Property Rights: Choice Among Alternative Solutions to Tragedies of the Commons*, 28 *ECOLOGY L.Q.* 123, 131 (2001).

According to this model, the process begins when the common-access resource is made more valuable by growing demand. As demand increases, the potential profits from defining private property rights bring the common access resource to the threshold at which it is worth incurring the transaction costs necessary to define rights.

Id. For property rights to emerge from a commons, any wealth distribution effects must also be “successfully resolved.” *Id.*

234. *Id.* (applying this lesson to the advent of barbed wire, the ability to record and enforce land ownership, and alienate ownership in the West).

235. *Id.*

236. Yandle & Morriss, *supra* note 233, at 135. These costs include defining the boundaries of each tract, development of the means to defend each tract, ranging from fences to trespass lawsuits, and market protection from force of fraud. *Id.* at 136. These same types of cost exist if common land is to be converted to public property like a park, but here there must be enforceable rule for the park’s use if the land is to be made “regulatory property,” governed by permits then the terms of the permits must be stated and defended. *Id.*

237. See Reinstein, *supra* note 1, at 95 (“[A] right of ownership over space itself, for several reasons, the most basic and fatal of which is that there would be no way to define static boundaries.”); cf. Zachary C.M. Arnold, Note, *Against the Tide: Connecticut Oystering, Hybrid Property, and the Survival of the Commons*, Note, 124 *YALE L.J.* 1206, 1231 (2015) (“[A]s cultivators pushed further out into the Sound, where town jurisdiction was uncertain and state regulation nonexistent, disputes seemed sure to multiply.”). Various proposals for establishing boundaries in the GSO, whether based on extending terrestrial property rights extending upward from a “negotiated floor” or assigning rights based on gravitation force, have no application to outer space. See Reinstein, *supra* note 1, at 96–97; see also Buxton, *supra* note 2, at 704–05 (explaining the so-called Bogota Declaration gravitational force).

stimulate its production because its application would conflict with international prohibitions.²³⁸

Robert Ellickson suggests that “bottom-up, somewhat ad hoc property systems can [emerge and] reproduce most or all of the benefits of formal property law with a minimum of economic investment, procedure, and social disruption.”²³⁹ “Informal governance, like formal regulation, can ‘privatize’ [CPRs]”; Zachery Arnold points to “the ‘lobster gangs’ chronicled by James Acheson” as a “classic example of informal privatization.”²⁴⁰ Elinor Ostrom writes about how communities under the right “sociopolitical conditions” can protect valuable CPRs from over-consumption or damage.²⁴¹ But, none of these approaches appears appropriate for circumstances in outer space where small groups are unlikely to form around CPRs or where communication among entities will be intermittent at best, making any sharing of informal management approaches unlikely.²⁴² With this as background, the Article

238. See Yandle & Morriss, *supra* note 233, at 131–32.

Without the potential customers for a new rights technology offered by private property, entrepreneurs will not invest in creating such technologies. Just as the demand for a means to exclude others created the incentive for the invention of barbed wire, so opportunities for entrepreneurs would stimulate the production of new technologies to provide environmental goods. The regulatory property path forecloses such developments, however, by eliminating the opportunity to profit from developing such technologies.

Id. at 142–43.

239. Arnold, *supra* note 237, at 1214.

240. Arnold, *supra* note 237, at 1215; see James M. Acheson, *The Lobster Fiefs Revisited: Economic and Ecological Effects of Territoriality in the Maine Lobster Industry*, in *THE QUESTION OF THE COMMONS: THE CULTURE AND ECOLOGY OF COMMUNAL RESOURCES* 37–65 (Bonnie J. McCay & James M. Acheson eds., 1987) (discussing, among other things, why private property has not emerged in the Maine lobster fishing industry and how Hardin’s tragedy of the commons is avoided).

241. Arnold, *supra* note 237, at 1215 (“Elinor Ostrom has enumerated sociopolitical conditions under which communities can effectively protect and sustain valuable resources while maintaining such open systems. She argues that the community enjoying access to the commons must be, among other traits, well-defined and self-governed, so that it is able to define rights, exclude outsiders, and monitor and discipline insiders as needed.”); see Elinor Ostrom, *Institutional Arrangements for Resolving the Commons Dilemma: Some Contending Approaches*, in *THE QUESTION OF THE COMMONS*, *supra* note 240, at 250–65 (using two case studies to examine the validity of theoretical statements about the commons); see also Pamela Quinn Saunders, *A Sea Change off the Coast of Maine: Common Pool Resources as Cultural Property*, 60 *EMORY L.J.* 1323, 1369 (2011) (“[R]esearch by social scientists concludes that, under the right conditions, groups can cooperate and self-regulate to sustainably manage CPRs under their control.”).

242. See Foster & Iaione, *supra* note 222, at 323–25. The authors point out that “Ostrom’s study focused on small-scale resources affecting a relatively small number of persons ([50] to 15,000) who are heavily dependent on the resource for economic returns.” *Id.* at 324 n.174.

describes what space might look like under the two basic property regimes—private ownership and ownership in common.

A. Space Under a Traditional Private Property Regime

Private property is the cornerstone of American ideals and “a foundation of the Constitution as well as its philosophical precepts.”²⁴³ Indeed, “private property—and individual ownership specifically—runs throughout the DNA of this Nation.”²⁴⁴ Private property is often considered a driver of our economy because it creates incentives for investments in new technology and resource development, both of which are in play in the development of outer space.²⁴⁵ Property ownership can also encourage people to care about their property, protect adjacent land owners from the external effects of activities undertaken on their property, and assure its sustainability for future generations.²⁴⁶ Self-interest can motivate a property owner to preserve their property to attract future buyers.²⁴⁷ To Richard Posner, the value of possession lies in its “economic efficiency” because it “tends to allocate resources to those

This raises questions as to its relevance to this Article.

243. M. Alexander Pearl, *The Tragedy of the Vital Commons*, 45 ENVTL. L. 1021, 1058 (2015). Pearl adds that “this is not necessarily a good thing.” *Id.* An important insight Pearl attributes to Carol Rose based on *Johnson v. M’Intosh*, is that “[i]t seems that individual ownership of property was engrained early in American legal thought and consciousness.” *Id.* at 1033.

244. Pearl, *supra* note 243, at 1060; *see also* Saunders, *supra* note 241 (“Furthermore, CPRs can sometimes be the most effective form of resource management. This conclusion stands in contrast to the traditional assumption, which still permeates U.S. property law, that resources can be managed only by private ownership or central governmental control.”).

245. *See* Reinstein, *supra* note 1, at 74–75 (“So, ideally, celestial bodies should be put to the uses most beneficial to humanity. This is guaranteed by a system that puts land in the hands of those for whom the territory is most profitable.”); *see also* Hanoch Dagan, *Why Markets? Welfare, Autonomy, and the Just Society*, 117 MICH. L. REV. (forthcoming 2019) (manuscript at 15) (on file with author) (“[B]y allowing people to secure a temporally extended control of things, property facilitates our ability to carry out (on our own or with the cooperation of others) meaningful projects and pursue comprehensive goals which require a temporal horizon of action.”).

246. *See* Reinstein, *supra* note 1, at 78 (“[O]wnership . . . protects the interests of others: both those nearby (who instantly feel the effects of more care given to, e.g., waste disposal and water management), and those who come later.”); *see also* Coffey, *supra* note 29, at 140 (“[A]llowing ownership of real property on celestial bodies would reduce wasteful use of the land. . . . If the expeditions owned the land, however, they would have incentive to use it efficiently and carefully consider all of its possible uses to maximize the investment.”); Pearl, *supra* note 243, at 1035 (“Express in Heller’s conclusion is the idea that property should work toward public goals. Another way of phrasing this is that private property should externalize some benefits to the public.”).

247. *See* Coffey, *supra* note 29, at 140 (“Even if the [outer space] expedition did not extract all the possible resources, an owner of celestial property would have an incentive to preserve as much as possible to make it attractive to a future buyer when the expedition sells the land.”).

persons best able to use them productively, for they are the people most likely to be willing to incur the costs involved in possession.”²⁴⁸ Possession of property puts the rest of the world on notice of that possession.²⁴⁹ While possession is most commonly understood as physically holding onto an object, a more modern view sees it as a “form of control.”²⁵⁰

But, private property can also “enhance income disparity, exacerbate[] economic tensions among individuals, and consolidate[] power among the one percent.”²⁵¹ M. Alexander Pearl calls property privatization “a black hole focused solely on centralization of power and economic wealth without regard to the sustainability of an essential resource or the communities that depend upon its continued existence.”²⁵² Hanoch Dagan goes further, quoting Eric Posner and Glen Weyl, by saying,

The key remedy for this predicament is to eradicate the institution of private ownership. Since “private ownership of any asset, except homogenous commodities, may hamper allocative efficiency,” we need to reconstruct markets so they are “competitive by design.” More precisely, we must discard private property and adopt in its stead a regime that partly transfers property’s “two most important ‘sticks’”—the right to use and the right to exclude—from the possessor to the public at large.”²⁵³

When the value of a resource is increasing, it is more likely to be privatized so that the entity responsible for developing it can “fully capture the resulting benefits.”²⁵⁴ Indeed, a movement from common to private property occurs when the efficiency gains from private property are more than the costs of creating and maintaining it, such as “the basic costs of exclusion (fences, guards, and so on) and the extra vigilance

248. Hirschprung, *supra* note 226, at 147.

249. *Id.* (“Carol Rose opines that possession forms the basis of property ownership because of the value of communication through possession. Essentially, possession is notice of an individual’s ownership to the rest of the world.”)

250. *Id.* (“A working legal definition must necessarily expand beyond the physical holding of an object; any definition of possession must trace itself back to that root, possession as a form of control.”) In differentiating between possession and ownership, “possession was regarded as physical control[,] whereas ownership was regarded as the ultimate right, the title to property.” *Id.* at 153.

251. Pearl, *supra* note 243, at 1059.

252. *Id.*

253. Dagan, *supra* note 245, at 7. Dagan further states that Posner and Weyl’s property proposal is “designed to fix existing markets by supplanting private property with a regime in which people can only be ‘lessees from society,’ whose ‘lease terminates when a higher-value user appears, whereupon the lease is automatically transferred to that user.’” Dagan, *supra* note 245, at 4.

254. Arnold, *supra* note 237, at 1212.

needed to deter interlopers from absconding with rising-value resources.”²⁵⁵ This balancing of costs and benefits may be irrelevant in outer space, as the costs of establishing private property in the first place would be huge, and the complexity and cost of technological innovations called for in outer space would be magnitudes greater than what is required on Earth.²⁵⁶

1. *The Positive and Negative Features of Private Property*

Many believe that transporting the concept of private property to space should cause no concern; in fact, they view it positively.²⁵⁷ “By guaranteeing rights in extracted minerals taken from space, private industry could usher all of humanity into a new technological era.”²⁵⁸ Among the advantages of private property ownership in space is the “reduc[tion] of wasteful use” and the right to transfer alienability to others, which “would compensate for positive externalities, thereby creating added incentive to productively develop space.”²⁵⁹ Private property would also enable colonization of celestial bodies like the moon.²⁶⁰

In the absence of private ownership, there is the possibility that “each individual developer will seek to maximize his or her own gain by extracting as much value as quickly as possible without regard to the effect on the communal resource.”²⁶¹ The President’s Commission on

255. *Id.*

256. Reinstein, *supra* note 1, at 60–61. *But see* Young, *supra* note 216, at 4 (“[T]he introduction of new technologies or new social institutions can transform a non-excludable good into an excludable good at reasonable cost.”). However, none of the technological innovation examples that Young gives, like time slots governing the use of swimming pools and tennis courts, even advanced broadcasting methods, which have reduced competition for geomagnetic spectrum slots, are comparable to what would be required in outer space in scope and scale. *See id.* at 4.

257. *See, e.g.,* MacWhorter, *supra* note 42, at 676; Young, *supra* note 216, at 98.

258. MacWhorter, *supra* note 42, at 676.

259. Reinstein, *supra* note 1, at 75; *see also* Saunders, *supra* note 241, at 1335 (“Lobstermen in these communities have ‘few if any other ways to make a living on these islands.’ Accordingly, they have always been and continue to be highly motivated ‘to preserve these resources for themselves’ in order ‘to make a living, and for future generations, if the community [is] to survive.’”).

260. *See* Reinstein, *supra* note 241, at 76.

261. *Id.* at 78; *see, e.g.,* Brehm, *supra* note 1, at 359–60 (internal footnotes omitted) (“Greg Nemitz brought suit against NASA seeking declaratory judgment concerning alleged property rights in the asteroid Eros. Nemitz officially published a claim of ownership to Asteroid 433, Eros. Eleven months later, NASA’s NEAR Shoemaker spacecraft landed on Eros. Nemitz sent NASA a twenty-dollar invoice for parking and storage fees. NASA refused to pay and Nemitz brought suit. Nemitz’s action was dismissed, however, for failure to state a claim upon which relief can be granted. The court found that Nemitz had failed to establish a legally recognizable property interest in Eros.”).

Implementation of U.S. Space Exploration Policy found that although the idea of private property in space is complicated because of national and international legal issues, it was imperative that they be addressed early in the process, “otherwise there will be little significant private sector activity associated with the development of space resources, one of our key goals.”²⁶²

For those who seek development of space resources, “a reliable property rights regime will remove impediments to business activities on these bodies and inspire the commercial confidence necessary to attract the enormous investments needed for tourism, settlement, construction, and business development, and for the extraction and utilization of resources.”²⁶³ The resources supporting private space mining companies are essentially worthless if the companies have no legal right to the resources they have mined.²⁶⁴ “Without the legal right to use water and hydrogen mined from celestial bodies, and to alienate platinum group elements, the potential profitability of private space expeditions collapses along with the goals of deeper space exploration and settlement.”²⁶⁵ The lack of a stable private property regime in outer space also means that space settlements will not be able “to claim sufficient land to yield enough of the only ‘product’ the settlement can sell profitably enough to guarantee its survival.”²⁶⁶ The strong belief is that unless private property rights in outer space and its resources are recognized, commercial enterprises will be unable to sustain any type of successful commercial

262. REPORT OF THE PRESIDENT’S COMMISSION ON IMPLEMENTATION OF U.S. SPACE EXPLORATION POLICY: A JOURNEY TO INSPIRE, INNOVATE, AND DISCOVER 34 (2004), https://www.nasa.gov/pdf/60736main_M2M_report_small.pdf; see also Wasser & Jobes, *supra* note 98, at 71–72.

263. Rosanna Sattler, *Transporting a Legal System for Property Rights: From Earth to the Stars*, 6 CHI. J. INT’L L. 23, 27 (2005); see also Brehm, *supra* note 1, at 379 (“Private property rights in outer space are the foundation for the future of space exploration.”); Coffey, *supra* note 29, at 147 (“A stable legal framework will encourage progress by assuring expeditions that they will legally own the resources they extract.”).

264. Brehm, *supra* note 1, at 355.

265. *Id.*

Without the United States or other national governments recognizing property interests in outer space and celestial bodies, individuals and private entities lack the ability to sustain successful commercial outer space material extraction enterprises. Additionally, this concern is compounded by the position some commentators on space law hold, that if a nation were to recognize such property rights, recognition ‘would constitute a de facto exclusion of other states and their nationals, and thereby constitute a form of national appropriation.’ Accordingly, this national appropriation would violate Article II of the Outer Space Treaty.

Id. at 360.

266. Wasser & Jobes, *supra* note 98, at 68.

activities in outer space.²⁶⁷

The absence of “security derived from ownership and sovereign control, [means that] entities that might be interested in the development of space resources will be reluctant to undertake [the] expensive and risky path’ implicit in all space travel”²⁶⁸ without some return on their investment.²⁶⁹ In all likelihood, such a return would be “in the form of the right to exploit limited areas of space and in proceeds from the sale of space resources.”²⁷⁰ This uncertainty arguably leaves a large “legal void, a wasteland of indeterminacy and instability.”²⁷¹ According to Reinstein, “Unless people and nations are encouraged to exploit the riches of space, humanity will never know their benefit. And the more we are able to exploit, the more humanity stands to benefit. If commercialization is to be successful, space law must encourage investment in outer space development.”²⁷²

But, recognition of private property claims by the United States or by any other country could violate Article II of the OST’s prohibition against the national appropriation of space resources, including the surface of celestial objects.²⁷³ “[E]ven well-crafted domestic legislation that carefully addresses international law issues would create a significant risk of frustrating the explicit terms of the Outer Space Treaty, the intent and purpose of the treaty, or both.”²⁷⁴ No nation, including the United

267. See Brehm, *supra* note 1, at 360 (“[T]his concern is compounded by the position some commentators on space law hold, that if a nation were to recognize such property rights, recognition ‘would constitute a de facto exclusion of other states and their nationals, and thereby constitute a form of national appropriation.’ Accordingly, this national appropriation would violate Article II of the Outer Space Treaty.”).

268. Widgerow, *supra* note 22, at 492.

269. *Id.* at 519.

270. *Id.* “It is necessary to cater to these businesses because competition and individual ingenuity lead to advancement in ideas and technology, and because . . . state-run space programs are beset by limited budgets, taxpayer reticence, and shifting political attitudes.” *Id.*

271. Reinstein, *supra* note 1, at 72.

272. *Id.*

273. Outer Space Treaty, *supra* note 119, art. II; Brehm, *supra* note 1, at 362; see also MacWhorter *supra* note 42, at 661 (“A majority of scholars agree that real property ownership in space is illegal, or at the very least unenforceable. The OST, however, only bars claims of “celestial bodies,” but not extracted materials.”).

274. Brehm, *supra* note 1, at 365.

In this regard, if the United States is to hold true to the overarching goal of promoting ‘the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes,’ domestic legislation would be insufficient as the sole means of establishing a private property regime in outer space and may be discarded as a problematic approach.

Id.

States, can independently alter the current international legal framework governing activities in outer space.²⁷⁵ And amending the OST to strike the language is unlikely, since the ban against appropriation of property in outer space is a “fundamental tenet of the treaty.”²⁷⁶

Coffey believes that

full ownership rights further [violate] the OST by disregarding the concerns of developing nations. If lunar real estate were put on the market, only the wealthy, developed nations and their citizens would be able to purchase it. If developing nations tried to purchase land later when they could afford it, they would be at a disadvantage because the prime locations are likely to be taken and the land’s current owners could demand whatever price they wanted. This could perpetuate current disparities of wealth and resources on Earth to the [m]oon and outer space.²⁷⁷

This would be in violation of the Treaty’s intent as expressed in Article I that outer space and its resources shall be the “province of all mankind.”²⁷⁸ Ownership of space real estate could also lead to speculative purchases, the goal being not to develop the property, but to hold it until market conditions are more favorable, and then sell it for a large profit—again, leading to the exclusion of poorer nations from the market.²⁷⁹ In all likelihood, the international community would react unfavorably to “a private property regime in outer space” because it would be perceived as benefiting large space-faring nations, like the United States and Russia, “at the expense of nations that do not have such capabilities.”²⁸⁰ But restricting ownership to anything less than fee simple absolute, like a lease or a license,²⁸¹ means that the rights-holder could not alienate their property in any way, which decreases any significant incentive to acquire the right in the first place.²⁸²

275. *See id.* at 374 (“[I]t is not the prerogative of the U.S. government, or any government, to implement unilateral legislation that would significantly alter outer space and the current space law framework. It would frustrate the common conception of outer space as a free and open place, as well as the current legal framework, to simply enact domestic legislation that allows for the acquisition of private property rights in outer space.”). However, Brehm notes that “the Outer Space Treaty is silent on the issue of commercial extraction of resources.” *Id.* at 373.

276. Coffey, *supra* note 29, at 141. Coffey believes that an amendment is “unthinkable,” certainly before expeditions to the moon happen. *Id.*

277. *Id.*

278. Outer Space Treaty, *supra* note 119, art. I.; Coffey, *supra* note 29, at 125–26.

279. *See* Coffey, *supra* note 29, at 141–42.

280. Brehm, *supra* note 1, at 372. Brehm added that “it would be no easy task to gain international support for an agreement to establish a system of private property rights in outer space without aggravating numerous non-spacefaring nations.” *Id.*

281. Abrams, *supra* note 57, at 811–12.

282. *See id.* at 812 (“Granting inalienable territory would likely decrease the incentive of

2. *The Rule of First Possession*

The “most extreme proposal” with respect to implementing a property regime in outer space is to apply “first possession rules.”²⁸³ Under these rules, a country could claim territory it discovered, and then decide whether “to open up settlement in its new territory to its own citizens or to the international community as a whole.”²⁸⁴ Within its own territory, the discovering nation’s sovereignty “would extend to its outer space territory, where it could govern as it pleased.”²⁸⁵ Such an approach would directly conflict with international space law forbidding countries from appropriating outer space or its resources.²⁸⁶ MacWhorter also worries that a first possession rule in space could devolve into “a space race and colonialism in a situation that requires limitation and prudence,” and would be difficult to sell to other nations, especially non-space faring ones.²⁸⁷ If the rules were applied to commercial enterprises, without a “centralized mechanism for demarcating the property”²⁸⁸—such as a sovereign²⁸⁹—the inevitable result would be disputes among putative property owners, like what happened in the West during the homesteading era.²⁹⁰ Reinstein agrees: “If the rule of ownership was no more than ‘first come, first served,’ with ownership going to the first person to grab a celestial body, an unmitigated land-rush would ensue.”²⁹¹

private entities to purchase it from an IGO. The more sticks in the bundle of property rights one receives, the more likely one is to buy.”)

283. *Id.* at 810–11 (“Perhaps the most extreme proposal is to open up outer space following first possession rules. This proposal treats celestial bodies as real property and allocates property rights along a ‘first in time, first in right’ rule similar to homesteading in the nineteenth century United States.”); *see also* Hirschprung, *supra* note 226, at 162 (“First possession rules are common to a variety of legal schemes across the broadest range of cultures, including Native American, African, Civil, and Islamic law.”).

284. Abrams, *supra* note 57, at 811.

285. *Id.*

286. *See* MacWhorter, *supra* note 42, at 667–68.

287. *See id.* at 670.

288. Abrams, *supra* note 57, at 810–11.

289. MacWhorter, *supra* note 42, at 670 (“First possession works well in the context of Earth, because a sovereign has claim to the property first. In all of the author’s examples, including *Johnson v. M’Intosh*, homesteading, and the General Mining Statute of 1872, private individuals came into possession of property after a sovereign—through principles of law—granted those claims. They can protect private claims, because the property is within the umbrella of the sovereign.”).

290. *See* Abrams, *supra* note 57, at 810–11.

291. Reinstein, *supra* note 1, at 84–85; *see also* Reavan, *supra* note 129, at 257 (“Many still question the wisdom of a U.S. law creating commercial property rights. Some commentators suggest that the impact of passing the [U.S. Commercial Space Launch Competitiveness Act of 2015 (USCSLC)] will not be on international law, but rather on international politics. It is also reasonable to suggest that the USCSLC could trigger mirroring legislation in other space-faring nations, which could create heated competition, controversy, and possibly

But MacWhorter also believes that limited property rights under a first possession rule might be an “appropriate first step,” if, for example, the property claim extended no further than to the claimed materials brought back to Earth.²⁹²

Those who are concerned that less technically adept nations would be severely disadvantaged by a property rights regime that is premised “on the ‘right of [first] grab,’ the first-come, first-served theory of property acquisition,” oppose such an approach.²⁹³ “By the time space-incapable nations develop the technological prowess and capital reserves to fund meaningful development of outer space, the earlier space-faring nations [and their citizens], left unchecked, might already have locked up the most accessible and valuable resources.”²⁹⁴ This would carry forward current disparities in global wealth distribution into the “Space Age.”²⁹⁵

The argument against a right of first possession gains salience from the fact that prior wrongs inflicted on less developed countries may be the reason they are not “space-capable.”²⁹⁶ This inequitable situation would persist, as those who profit from private property rules like the right of first possession will have the political ties, money, and understanding of the “rules of the game” to prevent their reform.²⁹⁷ An additional problem with the proposal is its enforceability. The fact that outer space is infinite makes it more difficult to “police” and to enforce

chaos.”); *cf.* Abrams, *supra* note 57 (“It is conceivable that in the future human behavior beyond Earth’s boundaries will more closely resemble the extent and nature of human activity on Earth.”). Reinstein adds that since the amount of wealth a claimant might receive depends on their being first in time, the result will be “the criminality and outright sabotage witnessed in the American West of the gold rush era.” Reinstein, *supra* note 1, at 84–85.

292. MacWhorter, *supra* note 42, at 670.

293. Reinstein, *supra* note 1, at 64.

294. *Id.*

295. *Id.* at 64–65; *see also* Arnold, *supra* note 237, at 1213 (“The key for understanding . . . variation in property rights institutions is recognizing that the property rights that are devised to reduce the wastes of the common pool simultaneously define a distribution of wealth and political power.”). Later in his article, Reinstein notes that “[i]n the absence of prior existing property rights, . . . there seems to be nothing inherently immoral about a right of grab.” Reinstein, *supra* note 1, at 79. But, a right of grab still “may severely disadvantage the lower-tech nations in [the] future.” *Id.*

296. Reinstein, *supra* note 1, at 79 (“The perpetuation of past wrongs thus makes the right of grab doubly objectionable in the eyes of developing nations.”). Reinstein provides two answers to this issue: “First, the universe, for practical purposes, is not finite. Whenever developing nations become space-capable, there will be plenty of available unused space real estate. Second, corporations based in space-incapable nations could, of course, contract out to a space launch company from a space-capable nation.” *Id.*

297. Arnold, *supra* note 237 (“Current owners of resources are also more likely to have developed strategic political ties and an understanding of the ‘rules of the game’ that will aid them in lobbying against reform.”).

the various treaties that apply to it.²⁹⁸ In outer space, “a breaching private party could pursue its interests outside the scope of such an agreement with relative impunity before it was discovered by the relevant international authority.”²⁹⁹

3. *Less than Fee Ownership*

There are less than fee ownership property regimes that can give the holder of a defeasible fee all the rights of an owner with complete title to the property, except the right to alienate it.³⁰⁰ Thus, “leaseholds, licenses, reversionary interest, easements, and covenants” might work well in outer space without violating international laws.³⁰¹ There are also three types of defeasible fees that might be useful in outer space.³⁰² “Defeasible fees, unlike fee simple absolute,” might convey property to a company, but are encumbered by an “automatic reversion or right of entry interest.”³⁰³ The first of these is a “fee simple subject to condition subsequent.”³⁰⁴ These conditions, “if triggered, would revert the realty back into the control of the multinational community.”³⁰⁵ So to the extent space resources have been appropriated, the withdrawal is not permanent.³⁰⁶

Then there is a “fee simple determinable,” which is like a fee simple subject to condition subsequent, “except that a fee simple determinable

298. See Widgerow, *supra* note 22, at 507.

299. *Id.*; see also Young, *supra* note 216, at 12–13 (“When the areas involved are large and government agencies are poorly endowed with capacity and resources, individual users may exploit the relevant resources without worrying about the impact of enforcement operations.”).

300. See Widgerow, *supra* note 22, at 513.

301. *Id.* at 513.

[A] new property law regime, modeled after U.S. common law property principles, can open outer space to private ventures while retaining the best aspects of the common sovereignty philosophy at the heart of current space law. Although this argument concedes that exclusive possession of any portion of space, the planets, and other celestial bodies is both inconceivable under space law and undesirable, it argues that a system of leaseholds, licenses, reversionary interests, easements, and covenants are ideal for a newly configured space law regime.

Id. at 494.

302. *Id.* at 511.

303. *Id.* at 513.

304. Widgerow, *supra* note 22, at 511.

305. *Id.* at 513.

306. See *id.* at 513; see also Saunders, *supra* note 241, at 1386 (“[G]eneral statutory recognition of a small group’s right to stake property or property-like claims (such as legally enforceable usufructuary claims) would eliminate the type of politics that led to the controversial recommendation of the subzone task force committee.”).

creates an automatic reversion to the grantor upon the occurrence of the condition—the grantor need not assert the right of reverter in order to reestablish possession of the property.”³⁰⁷ A third type of defeasible fee is a “fee simple subject to executory limitation[, which] reverts ownership upon the occurrence of a specified event or condition not back to the grantor, but to an heir or third party.”³⁰⁸ In each of these situations, a fee simple is less than absolute because it can revert back to the grantor or a third party if some later condition occurs.³⁰⁹ In the case of development of outer space resources, examples of later changes in circumstances that could revert title to the grantor might be those that damage the resource or make its continued development non-sustainable, or the developer’s violation of international law or any terms regulating or otherwise limiting their actions.

Leases and licenses are additional examples of impermanent types of property transfers.³¹⁰ While a lease transfers exclusive possession of property from a grantor to a grantee, the transfer is only for a limited period of time; a license does not transfer any property and merely allows one party to use property that is managed and controlled by another party.³¹¹ Then there are easements, which “are rights, conveyed with the property.”³¹² Easements generally allow the property owner who owns the transferred property to continue to make some specified use of it.³¹³ A negative easement, on the other hand, allows the entity that transferred property to prohibit the person who received it from using it in a specified way.³¹⁴ Covenants are found in property conveyances and may prevent the grantee from using the property in some specific way.³¹⁵

In each situation, not only is less than a full fee interest in property

307. Widgerow, *supra* note 22, at 511.

308. *Id.*

309. *See id.* at 511.

310. *Id.* at 512.

311. *Id.*

312. Widgerow, *supra* note 22, at 512 (describing life estates where the estate terminates when the holder dies, at which point the estate can revert back to the grantor or a third party). However, these appear of limited utility in outer space this early in space development. *See id.* at 513.

313. *Id.* at 512.

314. *Id.*

315. *Id.* at 512–13 (“A covenant is an agreement between the grantor and grantee in a property conveyance that particular actions or conditions will or will not arise in connection with the grantee’s possession of the property. More specifically, a negative covenant restricts the grantee from performing a specified action in connection with the property, and a restrictive covenant limits the use of the property by the grantee in some way. . . . [A]ffirmative [covenants require] that the grantee perform some action or maintain some situation as a condition of the conveyance.”).

conveyed, but that interest can be restricted in a multitude of ways.³¹⁶ In some situations, when the restrictive conditions are not complied with, the property can revert back to its original holder; in other cases, the reversion is automatic if conditions contained in the grant occur.³¹⁷ But, each situation is predicated on some entity owning or holding the property in question, which would violate the terms of international space law unless the entity was some international authority.³¹⁸ An international organization could establish specific rules governing activities in outer space, oversee their implementation, and enforce them.³¹⁹ The International Seabed Authority (ISA), established by UNCLOS, could serve as a model for such an authority.³²⁰ The ISA was established in 1994 and since then it has issued new regulations governing exploring and prospecting for marine mineral resources and has contracted with seven nations granting them exclusive fifteen-year prospecting rights.³²¹

However, “[t]here are drawbacks to forming a new international body to oversee the exploitation of space resources.”³²² They can be expensive to establish and support.³²³ Non-spacefaring nations might not want to invest money in a venture which might “freeze them out of the decision-making process and put them at a disadvantage if they someday are able to participate in lunar missions.”³²⁴ There are the inevitable questions that arise whenever a new international governing organization is created, such as whether it should be under the authority of the United Nations or be completely independent, and how power should be allocated between spacefaring nations and developing countries without the expertise of money to venture into space.³²⁵ Further, there is an underlying equity question about spending money to create a new

316. See Widgerow, *supra* note 22, at 511–13.

317. See *id.* at 511–12.

318. *Id.* at 513.

319. See Coffey, *supra* note 29, at 133. “This proposal aligns with [A]rticle 11(5) of the Moon [Treaty], which requires that an international regime be created to govern the exploitation of natural resources on the moon when such exploitation is about to become feasible.” *Id.*

320. See *id.* at 134 (“The ISA is divided into separate bodies with designated functions. Every party to UNCLOS is represented in the Assembly, which makes decisions about sharing mining revenues and considers problems of a general nature. The Assembly appoints seats in the ISA’s executive body, the Council, to ensure that both developing nations and those with a substantial interest in mining are represented. Remaining seats are distributed to assure equitable geographic distribution.”).

321. See *id.* at 135.

322. *Id.* at 136.

323. Coffey, *supra* note 29, at 136.

324. *Id.*

325. *Id.*

administrative authority.³²⁶ That authority will spend money that might otherwise have helped poorer countries develop the capacity to participate in outer space directly.³²⁷

An alternative to creating a new entity and new laws to administer a private property system in outer space is to extend terrestrial property law to outer space.³²⁸ Coffey proposes dividing the ISS between participating nations and then allowing each participant nation to apply its law to its assigned portion.³²⁹ But, this alternative suffers from some of the same flaws that establishing a centralized authority suffers—namely, it allows the powerful countries to control activities in outer space, specifically access.³³⁰ It allows those countries to collectively “set precedent for property rights in space instead of establishing formal international laws that the international community agrees upon.”³³¹ The proposal “disregards the ‘common heritage’ provision of the OST,” because it completely excludes developing nations, who likely are not participants in the ISS, and provides them with no benefits from resources derived from space unless they eventually become technically proficient.³³² Allowing countries to dictate any agreement that governs behavior in outer space also presents a risk that a country may be excluded from participation for unrelated reasons, like “diplomatic problems between the nations, unwillingness to share equipment and resources, or pressure from other members.”³³³

Thus, while establishing a private property regime in outer space might encourage development of celestial resources, it is hard to design a way around the ban against appropriating property and to establish a

326. *See id.*

327. *See id.* (“There is also questionable value in creating a structure which is supposed to allocate profits and benefits to developing countries but which consumes funds that might have otherwise been put toward helping those nations directly.”); *see also* DiMaria, *supra* note 28, at 437–38 (“Protecting the resource interests of non-spacefaring countries represents a further issue in forming this organization. One possible solution entails language that results in resource sharing only after the entity that obtained the resources makes a fair profit for its risk. Alternatively, this organization could set a flat rate, obtaining a small portion of all resources acquired and distributing them to non-spacefaring members of the organization.”).

328. Coffey, *supra* note 29, at 142 (discussing such a proposal with respect to the ISS).

329. *See id.* (“Each member registers its own components of the ISS and retains jurisdiction over them subject to provisions of overall station management. Thus, Russian law governs in the sections Russia contributed to the space station, and American law governs in the modules that the United States supplied.”).

330. *See id.* at 144.

331. *Id.* at 143. “This means that when other nations eventually do participate in such activities, they likely will be bound by customary law that they did not play a role in shaping and that is disadvantageous to them.” *Id.* at 143–44.

332. Coffey, *supra* note 29, at 144.

333. *Id.*

system that is both workable and protects the interests of less developed countries.

B. Space Under a Commons Property Regime

This Section discusses what about space makes it more like a commons than private property. Indeed, early space treaties treated space as though it was a commons.³³⁴ But, like private property, commons also have negative features that may be problematic in space, and simply declaring something a commons does not dictate the rules under which it should be managed. When various commons management approaches are tried, like the law of first possession under a private property regime, they are also found wanting.³³⁵

1. Early Treaties and Analogous Areas of the Globe

Early treaties, such as the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts, and the Return of Objects Launched into Outer Space, which “requires space-faring nations to rescue stranded astronauts and wayward objects and return them to the appropriate country,” “envisions space as a commons beyond the possession and control of any one nation or people.”³³⁶ So too, the 1972 Convention on International Liability for Damage Caused by Space Objects, which “was established to resolve concerns over financial liability in the event that a spacecraft or other space machine causes damage to other space-based or [e]arth-bound assets,” and the 1975 Convention on Registration of Objects Launched into Outer Space, which “imposes a requirement that states maintain and submit to the [United Nations] thorough records of all objects launched into outer space.”³³⁷

Indeed, the 1967 OST “allocates the use of orbital space as if it were a common property resource”³³⁸ by declaring outer space an open access resource and banning appropriation by any country.³³⁹ Jared Taylor notes that “during the Treaty’s preliminary negotiations, one drafter analogized the absence of property rights in space to the absence of property rights

334. Taylor, *supra* note 31, at 259–60; Widgerow, *supra* note 22 at 504.

335. See Pearl, *supra* note 243, at 1036 (“Economic principles recognize that depending on ‘whether the resources are common pool or amenable to privatization, particular natural resource configurations, technological constraints, and transactions costs may make common property a superior solution to private property.’”).

336. Widgerow, *supra* note 22, at 504 (citing Rescue Treaty, *supra* note 122).

337. *Id.* (first citing Space Liability Treaty, *supra* note 121; and then citing Convention on Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15).

338. Taylor, *supra* note 31, at 259.

339. Outer Space Treaty, *supra* note 119, arts. I–II.

in the ocean.”³⁴⁰ According to Taylor, later treaties, as well as the practices engaged in by spacefaring nations and private companies, “have confirmed the spirit of the Outer Space Treaty: space is a resource from which no nation or private entity can be excluded”³⁴¹—a true open access commons.³⁴²

The 1959 Antarctic Treaty³⁴³ established “the foundation for international space law.”³⁴⁴ Like outer space, Antarctica and the oceans “presented a dilemma regarding habitation and defense. No nation occupied these territories and no nation desired a ‘race to own’ without a guarantee of who would emerge victorious.”³⁴⁵ Both the Antarctic Treaty and the Deep Seabed Hard Mineral Resources Act (the “Deep Seabed Act”)³⁴⁶ eschewed the concept of private property as well as the rights of first possession, in part, because the riches of those areas might allow developing nations to share in those riches as opposed to remaining economically marginalized.³⁴⁷ The Deep Seabed Act provides a model for how to regulate activities in a commons, like outer space, which it manages to do without privatizing the marine resource.³⁴⁸ As a result, it is “customary and accepted legal reasoning” to analogize between private

340. Taylor, *supra* note 31, at 259.

341. *Id.* at 259–60.

342. *See* Nevala, *supra* note 34, at 1512.

Even though a satellite appears on a State’s registry, the private owner retains his property rights in the satellite. Under the Outer Space Treaty, ‘[a] State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object.’ . . . Furthermore, the [OST] establishes that themere [sic] fact that an individual launches an object into space does not impact his ownership.

Id. at 1512–13 (internal footnotes omitted). Since “property rights are essentially expressions of sovereignty, questions arise as to whether governments can extend their property laws to objects in outer space.” *Id.* at 1513.

343. Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

344. Brehm, *supra* note 1, at 357. “[A]s early as 1958, scholars recognized that space law could draw on the Antarctic model, as another territory ‘placed under an internationalized or “trust” arrangement.’” Johnson, *supra* note 75, at 1493 n.84. “In September 1960, President Dwight D. Eisenhower proposed that the principles of the Antarctic Treaty be used to form an international agreement governing outer space.” Brehm, *supra* note 1, at 357.

345. Buxton, *supra* note 2, at 691; *see also* Johnson, *supra* note 75, at 1515 (“Space is indeed very much like the high seas in that it is physically difficult to maintain exclusive control over a given area.”).

346. Deep Seabed Hard Mineral Resources Act, Pub. L. No. 96-283, 94 Stat. 553 (1980) (codified as amended at 30 U.S.C. §§ 1401–1542 (2012)).

347. Buxton, *supra* note 2, at 691; Widgerow, *supra* note 22, at 509.

348. 30 U.S.C. § 1402(a); Widgerow, *supra* note 22, at 509. “Thus, the Deep Seabed Act is a notable achievement in that it succeeds in spurring and protecting private investment in an area of the global commons while simultaneously reserving such areas as the ‘common heritage of mankind.’” Widgerow, *supra* note 22, at 509.

ownership rights outside of national sovereignty, like those the Deep Seabed Act granted, and a “land claims recognition law for celestial bodies.”³⁴⁹

“The oceans and Antarctica . . . have much in common with the moon. They can be harsh environments that are difficult to reach to extract minerals [and are resource rich]. They are also designated international areas in which no nation has a sovereign claim.”³⁵⁰ The history of the earth’s oceans is a progression from “the domain of conquering armadas and privateers, when good legal title required as little as arbitrary lines drawn on a map,” to the concept of a “free sea” open to all countries, where no single country could “obstruct the use of that privilege.”³⁵¹ International space law built on that history of open passage and “free sea.”³⁵² The roots of the idea of granting non-space faring nations right of access can also be found in the 1958 Geneva Convention on the High Seas, which granted “landlocked states the right to sail the oceans by requiring their coastal neighbors to grant free passage over land and through territorial waters.”³⁵³ The legal framework of UNCLOS united “a broad spectrum of national and private interests into a shared agreement on the possession and usage of a seemingly borderless area of the global commons,” setting another useful precedent for outer space.³⁵⁴ However, UNCLOS, as a model, is impractical in “the vast reaches of outer space”—space is simply too vast and unlimited.³⁵⁵

2. Common Property

Common property is property, the rights to which belong to more than one entity.³⁵⁶ Like private property, common property is endemic to

349. Wasser & Jobes, *supra* note 98, at 62; *see also* Widgerow, *supra* note 22, at 509 (“Specifically, Section 3 of the Deep Seabed Act, entitled, ‘Disclaimer of Extraterritorial Sovereignty,’ states that the United States ‘exercises its jurisdiction over United States citizens and vessels . . . in the exercise of the high seas freedom to engage in exploration for, and commercial recovery of, hard mineral resources of the deep seabed in accordance with generally accepted principles of international law,’ but that the United States ‘does not thereby assert sovereignty or exclusive rights or jurisdiction over, or the ownership of, any areas or resources in the deep seabed.’”). *But see* Young, *supra* note 216, at 7. Although “[v]arious forms of land ownership have emerged and played influential roles in most societies over several thousand years[.] . . . there are few parallel practices pertaining to marine systems or seas and oceans,” which have more in common with space than terrestrial property. *Id.*

350. Coffey, *supra* note 29, at 129.

351. Johnson, *supra* note 75, at 1488.

352. *See id.* at 1489.

353. *Id.* (citing Convention on the High Seas art. 3, Apr. 29, 1958, 13 U.S.T. 2312, 450 U.N.T.S. 82).

354. *See* Widgerow, *supra* note 22, at 507.

355. *Id.*

356. *See* Saunders, *supra* note 241, at 1357. “Because law typically evolves incrementally,

life in the United States and always has been, even though many Americans view it ambivalently.³⁵⁷ There is considerable overlap between property held in common and that which is privately owned. Carol Rose suggests that collective, but privately owned property, like a tenancy in common, “has all the hallmarks of individual private property,” and, therefore, should not be seen as “fundamentally problematic or prone to inefficient use.”³⁵⁸ Additionally, the plasticity of the commons, demonstrated by the appearance of new commons, like the “knowledge commons, cultural commons, infrastructure commons, and neighborhood commons,” indicates that the concept might fit in outer space.³⁵⁹

A commons, or CPR, is frequently asserted to resist “privatization and/or commodification of those resources,” making it oppositional to a claim that something is private property.³⁶⁰ Sheila Foster and Christian Iaione’s suggestion that the “language of the ‘commons’” is often used to prevent the enclosure of public urban space “by economic elites,” resonates with the situation in outer space where wealthy countries or private companies want to claim or enclose space that the public owns.³⁶¹ A claim that something is a commons acknowledges that “it is a shared resource that belongs to all of its inhabitants,”³⁶² like outer space, which

a group-level right is most likely to emerge as the logical extension of an analogous right that is already well accepted.” *Id.* at 1328. “If property law does develop like water law, it will increasingly exist as a collection of use-rights, rights defined in specific contexts and in terms of similar rights held by other people.” Eric T. Freyfogle, *Context and Accommodation in Modern Property Law*, 41 *STAN. L. REV.* 1529, 1531 (1989).

357. See Pearl, *supra* note 243, at 1060–61 (“Rose explored the American legal culture’s deeply ingrained skepticism of collective ownership of property and the marginalization of community property forms.”).

358. *Id.* at 1032–33; see also Foster & Iaione, *supra* note 222, at 292–93 (“Rose found that some British courts considered these resources [ones used by the public, like for Maypole dancing,] ‘inherently public property,’ on the basis of the enhanced value that public use generated, and vested in the public the right to use property otherwise subject to exclusive private control.”). “Rose famously described commons ownership structures as ‘commons on the inside’ and ‘[private] property on the outside.’” Pearl, *supra* note 243, at 1051.

359. Foster & Iaione, *supra* note 222, at 284 (“More recently, scholars across an array of specialties have conceptualized and articulated new kinds of commons, beyond those recognized in the traditional fields of property and environmental law. These ‘new’ commons include knowledge commons, cultural commons, infrastructure commons, and neighborhood commons, among others.”).

360. *Id.* at 283–84. “[T]he commons is less a description of the resource and its characteristics and more of a normative claim to the resource. In these situations, the claim is to open up (or to re-open) access to a good—i.e., to recognize the community’s right to access and to use a resource which might otherwise be under exclusive private or public control—on account of the social value or utility that such access would generate or produce for the community.” *Id.* at 287 (internal footnotes omitted).

361. See *id.* at 283.

362. *Id.* at 287.

is the “province of all mankind.”³⁶³

But there are problems with the idea of declaring anything a commons, just like there are problems with declaring something private property. One problem with the commons approach is the inability to exclude members of the commons from using the resource.³⁶⁴ Lacking the right to exclude, a user of CPRs has no incentive to do anything other than fully exploit the commons because if she refrains, her co-users will.³⁶⁵ The result is an “open access resource vulnerable to the tragic conditions of rivalry, overexploitation, and degradation.”³⁶⁶ Another problem is that since under a commons property regime the rights and interests of the present generation dominate those of future generations, there is no assurance that the claims of an unidentified future generation will have any effect on how the commons is managed.³⁶⁷ There are also

363. Outer Space Treaty, *supra* note 119, art. I.

364. Pearl, *supra* note 243, at 1053 (“The absence of the right to exclude is what allows the tragedy of the ‘privatized commons’ to exist.”).

Ostrom frames the problem of collective action as an absence of the right to exclude. In an unmanaged commons, a member of the group “cannot be excluded from obtaining the benefits of a collective good once the good is produced.” There is no legal right for anyone to oust another individual. Therefore, there is “little incentive to contribute voluntarily to the provision of that good.”

Id. at 1030 (internal footnotes omitted).

365. *Id.* at 1029 (“The right to exclude . . . is the basis for incorporating the needs of future generations in the present management of the CPR.”).

366. Foster & Iaione, *supra* note 222, at 287.

Limited-access commons are able to avoid tragic outcomes because they operate through a set of explicit or implicit usage and membership constraints designed to protect against overconsumption and exploitation. On the other hand, truly open access resources, like Hardin’s pasture, in which exclusion is impossible or costly, are vulnerable to the tendency toward rivalry, exploitation and degradation or exhaustion of the resources.

Id. at 292 (internal footnote omitted). However, Rose has noted that “there are some open-access resources, particularly land, in which increased use does not create rivalry but rather enhanced utility or value for the public, such that these resources become essential or highly functional resources for city inhabitants.” *Id.*

367. See Pearl, *supra* note 243, at 1028–29 (“In effect, an owner of a private right to use land acts as a broker whose wealth depends on how well he takes into account the competing claims of the present and the future. But with communal rights there is no broker, and the claims of the present generation will be given an uneconomically large weight in determining the intensity with which the land is worked. Future generations might desire to pay present generations enough to change the present intensity of land usage. But they have no living agent to place their claims on the market. Under a communal property system, should a living person pay others to reduce the rate at which they work the land, he would not gain anything of value for his efforts.”).

management difficulties.³⁶⁸ “Under a communal system, one member wishing to preserve the CPR for future generations’ use faces significant—and perhaps insurmountable—transaction costs of negotiating with all members of the community and paying them to use the resource suboptimally.”³⁶⁹ And, exiting a commons when group action causes individual harm, without destroying “social gains from cooperation,” can be difficult.³⁷⁰

There is no one-size-fits-all solution to these problems, and there may be multiple approaches to the development of solutions.³⁷¹ In the search for solutions, various legal scholars have promoted variations on the concept of a commons, highlighting different features.³⁷² Pearl proposes something he labels the “vital commons,” which includes CPRs that are “essential to human existence,” like air or water, and which may require a different approach to their management.³⁷³ Pearl’s vital commons has five key traits:

- (1) the benefits of the CPR are internalized by nearly all members of a given massive population;
- (2) the costs of the CPR’s depletion are externalized among nearly all members of that same massive population;
- (3) augmentation or depletion of the CPR by one party affects the ability to use the CPR by another party within the same massive population;
- (4) the CPR itself is necessary for sustenance; and
- (5) damage or depletion of the CPR is non-remediable or extremely difficult to correct.³⁷⁴

Outer space has most of these traits—the potentially affected

368. *See id.* at 1033 (“Rose makes an important distinction between the forms of collective management of CPRs. On the one hand, she notes the well-known lobster fishing community that has institutions which govern the resource in a sustainable manner. However, she notes that the institutions operate via low-level violence.”).

369. *Id.* at 1029. “Heller points out that while there may very well be circumstances where commons resources are inefficiently overused, excessive privatization of a commons resource may result in underuse, which is similarly inefficient.” *Id.* at 1034.

370. *Id.* at 1035–36 (internal footnotes omitted) (“Heller and Dagan . . . posit that preserving the right to exit is an essential attribute of a liberal commons and must exist. At a minimum, it must exist as a form of self-defense from harm caused by the group. The other component of their goal is to promote cooperation while maximizing economic gains and recognizing social value. Cooperation can result in benefits of economies of scale and risk spreading.”).

371. Young, *supra* note 216, at 15.

372. *See* Pearl, *supra* note 243, at 1029–38 (outlining the variations on the commons of multiple legal scholars, including Elinor Ostrom, Carol Rose, Hanoch Dagan, Michael Heller, and Lee Anne Fennell). From her work on the commons, Ostrom concludes that an error of CPR scholars is “oversimplification.” *Id.* at 1032.

373. *Id.* at 1040. “Two types of CPRs immediately meet this definition: major groundwater aquifers and the [e]arth’s atmosphere.” *Id.* at 1041

374. *Id.* at 1041.

population is the entire globe; its resources, as far as is known, are not renewable; and the benefits and costs of development of outer space resources could be widely internalized or externalized.³⁷⁵ Additionally, restoration of any depleted resources in outer space may be difficult, and the impact on any of those resources may be so dire that its overuse and depletion could be “the epitome of apocalypse.”³⁷⁶ Finally, the vastness of outer space makes it difficult to subject it to “local” regulation—i.e., regulation by individual nations, which might opt not to regulate certain activities or to regulate lightly.³⁷⁷

Similar to Garrett Hardin’s open pasture, a major problem with a commons is that, “absent a system that allocates use rights, it is difficult, if not impossible, to restrain the impulse of users to pursue their individual self-interests, even when pursuit of those interests result in the degradation or exhaustion of the resource.”³⁷⁸ This is why, he argued, “‘freedom in the commons’—i.e., the lack of controls on individual behavior and self-interest—ultimately leads to its ruin and hence to the ‘tragedy.’”³⁷⁹ If the amount of use of a CPR or the intensity of that use is too much, then the result can be “congestion” that decreases the values of those resources.³⁸⁰ “Similarly, certain types of uses can create

375. See Reinstein, *supra* note 1, at 59.

376. Pearl, *supra* note 243, at 1053.

377. See Pearl, *supra* note 243, at 1056–57 (“The problem with allowing certain areas to be unregulated or lightly regulated is that the Ogallala Aquifer is not susceptible to parceling out differential rules. The aquifer stretches across eight states . . .”).

378. Foster & Iaione, *supra* note 222, at 295.

379. *Id.*; see also Arnold, *supra* note 237, at 1233–34 (quoting SHELL FISH COMM’RS OF THE STATE OF CONN., THIRD REPORT OF THE SHELL FISH COMMISSIONERS, Jan. Sess., at 13 (1884)) (“The state commissioners described this problem as a classic tragedy of the commons: . . . ‘In the free scramble for the oysters, [the natural growers] have no thought but “to keep what they get and catch what they can,” and it would be lost time to them to dredge for stars while others dredge for oysters.”); Pearl, *supra* note 243, at 1040 (“Three traits clearly exist in any tragedy of the commons: (1) resource scarcity, (2) internalization of benefits, and (3) the externalization of costs.”). The key to creating a tragedy is the imbalance between resources and consumers of those resources. *Id.* “Fennell suggests that there are many reasons why people make ‘suboptimal decisions with regard to resources under common or interdependent control.’ Participants ‘may lack information or the means to communicate with each other, they may fall prey to cognitive biases or strong emotions, or they may suffer from wealth, liquidity, or power differentials that leave some options unavailable.’” *Id.* at 1038. Oran Young uses limited fish stocks to make this point, saying, “So long as supply demonstrably and reliably exceeds the demand of all the members of the user group, the absence of rights and rules may not matter much. In other words, a system of null property may be perfectly acceptable under these circumstances. The problem occurs when rising demand exceeds supply.” Young, *supra* note 216, at 11.

380. See Foster & Iaione, *supra* note 222, at 297 (“Too much usage, either in volume or intensity, of a park or a neighborhood street, for example, can quickly result in the kind of congestion that degrades these spaces.”); see also Pearl, *supra* note 243, at 1027 (“Hardin reminds us of Aristotle’s maxim. ‘That which is common to the greatest number [of people]

incompatibilities with many ordinary uses and conservation of such spaces, creating the conditions for rivalry or subtractability.”³⁸¹

The unbounded nature of space and the variety and wealth of its resources is already attracting potential users with competing or conflicting ideas about how space should be used.³⁸² Even if space was regulated, this “magnetic pull” to occupy and develop space may create rivalry among different users, especially if those users are drawn to the same areas of outer space.³⁸³ Unless the development of outer space resources is regulated, too many entities vying for the same resource could lead not only to congestion and rivalrous behavior,³⁸⁴ but also to accidents and serious conflict—the conditions the space treaties are intended to avoid.³⁸⁵

has the least care bestowed on it.”). “The point is that the kind of open spaces, or commons, that are an essential part of cities and that give cities much of their value can be contested in ways that require rethinking the governance and management of those spaces.” Foster & Iaione, *supra* note 222, at 298.

381. Foster & Iaione, *supra* note 222, at 298. “There is no one system that can satisfactorily mediate the tensions that arise from rivalry for common resources, nor that can resolve distributional inequalities with regard to those resources.” *Id.* at 334.

382. See Reinstein, *supra* note 1, at 63–64.

383. Cf. Foster & Iaione, *supra* note 222, at 312 (“[C]onventional zoning, and other land use laws, also fall short of being able to comprehensively and satisfactorily manage or govern the city commons. . . . [T]he openness of cities and the variety of commons within them inevitably invite rivalry as different users are drawn to agglomerate in cities. This seemingly magnetic pull, along with the strain of proximity of heterogeneous users, creates the pre-conditions for rivalry even in heavily regulated spaces.”).

384. *Id.* at 298–99. Foster and Iaione contend that the tragedy of many city commons arises from “weakly or poorly regulated space . . . [also known as] ‘regulatory slippage.’ In other words, these are spaces that were perhaps once heavily regulated to avoid rivalry but where such control has slipped, for whatever reason, significantly behind previous levels of public control or management.” *Id.* “[U]nrestrained competition for collectively shared resources intensifies and the existing regulatory infrastructure is (or becomes) inadequate to manage [the] rivalry.” *Id.* at 312.

385. As noted earlier in this Article, developing an effective regulatory framework for activities in outer space is difficult to do given the absence of a single regulatory sovereign. See discussion *supra* Part II. Jessica Coulter writes about the Pacific Garbage Patch, pointing out that

“[i]ndividual consumers and manufacturers do not directly bear the costs of the negative externalities that result from plastic escaping into the sea. They do, however, realize benefits from plastic consumption . . . [j]ust as there is no international framework that holds individual actors responsible for climate change, there is no international obligation for nations to compensate an injured party for damage incurred from land-based marine pollution. Because no one nation has regulatory authority over or liability for waste problems in the Pacific Ocean, nations lack motivation to solve the problem alone.”

Jessica R. Coulter, *A Sea Change to Change the Sea: Stopping the Spread of the Pacific Garbage Patch with Small-Scale Environmental Legislation*, 51 WM. & MARY L. REV. 1959,

The way to prevent a tragedy on land held in common is not necessarily its transformation to private property, which is one solution Hardin called for.³⁸⁶ Oran Young says “[i]nstitutional innovation,” like individual transferable quotas, “can create a form of private property and, in the process, alleviate the perverse incentives arising from the condition of non-excludability.”³⁸⁷ Creating public property or, in the alternative, using regulatory controls can also avoid the tragedy to the commons.³⁸⁸ The owners of a commons can also self-regulate to control the adverse effects of non-excludability.³⁸⁹

But as Young notes, while each approach has its plus side, each approach, like privatization, can also have negative effects.³⁹⁰ “Privatization can lead to outcomes that are grossly unfair[, and] [g]overnments [may] lack both the capacity and the will to manage public property well.”³⁹¹ And common property approaches can lead to non-sustainable use of the property, and “work best in situations where the sense of community is strong and social pressure is capable of controlling behavior effectively”—characteristics uncommon in outer space.³⁹²

So, we have learned thus far that (1) the race is on to extract valuable resources from outer space and celestial bodies;³⁹³ (2) the international legal framework governing those activities is far from complete, inviting behavior that may be in the economic best interests of the actor, but not necessarily of the globe;³⁹⁴ (3) the international legal principles governing this behavior may be counter-productive when it comes to incentivizing economic behavior, but beneficial non-spacefaring

1964–65 (2010).

386. See Young, *supra* note 216, at 8 (“Well-known but divergent prescriptions, in this context, call for a transition to private property through the creation of exclusion mechanisms (e.g., effective fences) or for a transition to public property through actions on the part of a government agency to claim ownership and impose restrictions on the use of the relevant resources (e.g., rules governing the harvesting of wildlife).”).

387. *Id.* at 12.

388. *Id.*

389. *Id.* (“Common property systems also can and often do give rise to restrictions on the behavior of individual users that serve to avoid or alleviate the tragedy of the commons.”).

390. *Id.*

391. Young, *supra* note 216, at 12.

392. *Id.*; see also Saunders, *supra* note 241, at 1349 (“Ostrom concludes that a small, homogenous group that is highly dependent on the resource in question and has the autonomy to make binding rules will be more likely to develop informal rules than groups that do not share those qualities, or which share them to a lesser extent.”). “[C]ommon property arrangements are generally inadequate to manage human uses of highly migratory resources.” Young, *supra* note 216, at 13.

393. See, e.g., Brehm, *supra* note 1.

394. See, e.g., Reinstein, *supra* note 1, at 62–63.

countries;³⁹⁵ and (4) the push to privatize space, which is clearly a global commons, may lead to rivalrous behavior, which could dissolve into military activity and squeeze out poorer countries from the benefits of space, in direct contradiction of the goals of international space law.³⁹⁶

We have also learned that while privatizing open access areas, like outer space, is not necessarily good or necessary to avoid the tragedy of the commons (the over-utilization of common or shared pool resources), the features of a commons make it difficult to avoid that tragedy and to provide for future generations.³⁹⁷ So the solution may lie in crafting new property regimes, perhaps combining the best features of both approaches. It is to that task this Article now turns—the circumstances in which new forms of property might emerge and what they might be.

IV. NEW TYPES OF PROPERTY REGIMES THAT MIGHT WORK IN OUTER SPACE

The rapidly closing gap in the technological ability of countries and private companies to develop resources in outer space makes it imperative to find a property regime that will allow management of those activities. Uncontrolled activities in outer space could lead to conflict among countries and commercial enterprises, as well as irreparable damage to and over-consumption of those resources.³⁹⁸ But the problems with both property regimes studied in Part III raise the question of whether a new form of property might allow for a more successful management approach.

Generally, the process of changing from one property regime to another requires that certain conditions occur, such as changes in technology, the means of economic production, or in social circumstances.³⁹⁹ However, property in outer space is more like null property to which no claim of ownership has yet been made.⁴⁰⁰ Hence, the situation here does not involve changing from one type of property to

395. See, e.g., Buxton, *supra* note 2, at 692–93.

396. See, e.g., Coffey, *supra* note 29, at 125.

397. See Foster & Iaione, *supra* note 222, at 295.

398. See *id.*

399. See Arnold, *supra* note 237, at 1212 (“[W]hen changes in the circumstances of economic production make it more profitable to society as a whole to establish a new property regime, such a regime will tend to emerge, whether through legislation, judicial decisions, or the evolution of social mores.”). In his article, Arnold describes the changes in the property regime governing oystering in Connecticut, calling the natural oyster beds an “anomaly.” See *id.* at 1235. “Under this system, valuable beds were subjected to a common property system that reduced output and promoted waste. Yet, despite its disadvantages, this system persisted for decades.” *Id.*

400. See Young, *supra* note 216, at 6 (discussing the concept of null property).

another. Rather, it calls for the *creation* of a new *type* of property, one that can function in an unfamiliar world and open that world to terrestrial activities in an unregulated environment. These factors might create the circumstances in which a new form of property emerge.

One new type is “hybrid property,” which combines different types of property.⁴⁰¹ Hybrid property regimes sometimes emerge because they perform a particular political function.⁴⁰² Here, the political function would be the enablement of an effective regulatory regime in outer space. Hybrid property can improve the efficiency and stability of traditional property regimes and can encourage the creation of important social goods.⁴⁰³ An example of a hybrid property regime is one that is sometimes private and sometimes common; for example, where private property may be open for collective uses.⁴⁰⁴ Public dedication “reflects a peculiar hybrid doctrine which grants private rights in public spaces based on the reliance interests of those who purchased land—typically at higher prices—on the understanding that adjacent land would remain subject to public use.”⁴⁰⁵ One might find a hybrid property regime in outer space where land that has been temporarily enclosed to allow some development activity to take place is also open to public use, like government-sponsored scientific research or privately sponsored tourism.

“Property hybridity can emerge and survive not only when it is

401. Arnold, *supra* note 237, at 1211 (“[R]eality often contradicts the conventional tale of evolution toward efficient formal privatization and that alternative property systems often prove viable because they fulfill important societal needs—economic and otherwise. . . . [T]hese viable alternative property systems include hybrid regimes—that is, regimes that impose different property rules at different points in space or time.”); *id.* at 1247 (“[M]any forms of property regulation other than formal privatization can promote economic efficiency, including internally heterogeneous, or hybrid, property systems, as Connecticut’s experience demonstrates.”).

402. *Id.* at 1211 (“[H]ybrid regimes can emerge and thrive because of their political functions.”).

403. *Id.* at 1216.

404. *See id.* at 1216–17 (internal footnotes omitted) (“[Henry] Smith coined the term ‘semicommons’ to describe a regime in which a resource is sometimes common and sometimes private, and in which ‘both common and private uses are important and impact significantly on each other.’ Smith illustrated the semicommons concept through the apparently inefficient but surprisingly durable medieval open-field system. Under this regime, land was held and farmed privately most of the time, but at certain times the private right to exclude was suspended to allow for grazing by the village’s collective herd across all parcels. . . . [H]ybrid regimes benefit from regulation, whether formal or informal, to prevent individuals from exploiting hybridity to their benefit but to the community’s detriment.”).

405. Foster & Iaione, *supra* note 222, at 319. There is a danger that this doctrine can be used in a way that enables property owners to “act solely in their self-interest, without any democratic check, and in ways that are not clearly in the public interest or even for the benefit of the particular public space.” *Id.* at 319–20.

economically optimal but also when it fulfills political imperatives.”⁴⁰⁶ If the political imperative in outer space is to develop some form of property regime that meets the needs of public and private investors in space while providing access for non-space faring nations and their citizens, then maybe some form of hybridity that allows for overlapping forms of property or governance should be used rather than exclusive zones where one form of property is allowed and another is not allowed.⁴⁰⁷ There may be political support for “such a spatial compromise” where the hybrid regime preserves and strengthens “existing informal governance mechanisms in open-access areas.”⁴⁰⁸ Further, these hybrid regimes, because of the role of local—even community-based—government, may avoid some of the back-channel dealings that disfavor entities, in this case disempowered countries and their citizens.⁴⁰⁹ But where there is “jurisdictional complexity”—i.e., the involvement of many jurisdictions in the affected area—it may be more difficult to work out the arrangements among those jurisdictions to achieve any form of hybridity, overlapping or spatial.⁴¹⁰

The problem with establishing a spatially hybrid property regime (or any property regime) in outer space is the lack of definable boundaries where one type of approach might be possible in one area, and another in a different area, or even overlapping regimes in the same area.⁴¹¹ But the idea of co-locating disparate property regimes in a single area that overlap either temporally or spatially may reduce the need to have separate defined areas where one property regime is based on private property precepts and the other on common ownership. Regardless of which approach is adopted—common property, private property, or some form of hybrid property—“efficient privatization does not inevitably triumph in property law and [] ultimately no single regime may triumph.”⁴¹² If anything, the rational tilt may be towards preserving public access to CPRs and to “push privatization further elsewhere rather than bringing

406. Arnold, *supra* note 237, at 1247.

407. *See id.* at 1248.

408. *Id.*

409. *See id.*

410. *See id.* at 1248 n.201 (“The jurisdictional complexity of the Chesapeake, which is split between two states, may also have complicated negotiation toward a grand bargain along the lines of Connecticut’s 1881 reforms, and the state’s political structure may have also conspired against compromise.”).

411. *But see* Arnold, *supra* note 237, at 1248 (“[F]ederal and state policymakers are increasingly embracing marine spatial planning, in which sub-areas of the ocean are defined and subjected to different property rules (for example, rules that allow or forbid private leasing for energy production) as a politically and economically expedient alternative to traditional, more spatially uniform maritime regulation.”).

412. *Id.* at 1247 (drawing from research on oystering in Connecticut’s waters).

all areas under a regime that embodies both open access and private property features.”⁴¹³

Another property model is stewardship.⁴¹⁴ Most scholars assume that “the classic property ownership concept is associated with traditional rights of alienability, title, and exclusion; and, it tends to overlook the possibility of non-owners exercising custodial duties over tangible and intangible goods in the absence of title and possession.”⁴¹⁵ The “stewardship” model of property assumes that those who actually possess the property may not be its “ultimate owners.”⁴¹⁶

At the core of the stewardship model is the idea that “mankind is a steward of natural resources, especially [of] globally important [ones].”⁴¹⁷ It “embodies a notion of mutual trusteeship.”⁴¹⁸ The model permits title, possession, and exclusion to be disaggregated from each other.⁴¹⁹ This enables the refiguring of “the rights of possession, use, and production among non-owners as well as owners.”⁴²⁰ Complete control of something is neither required nor does it guarantee possession of that thing.⁴²¹ The fact that ownership of property is not necessary makes it attractive from the standpoint of international law. However, there are no rights implicit in stewardship and only duties with respect to the property.⁴²² This makes it less attractive to those who want some return for their investment in space development.⁴²³ Thus, it offers less of an incentive to explore outer space, as well as no assurance about any equitable distribution of any benefits from development.⁴²⁴

But, regardless of the type of property regime, how property will be managed in outer space is still to be determined. Various management approaches are discussed below in Part V.

413. *Id.* at 1248.

414. Hirschprung, *supra* note 226, at 149.

415. *Id.*

416. *Id.*

417. *See* Coulter, *supra* note 385, at 1995 (“Effective environmental legislation embodies the notion that mankind is a steward of natural resources, especially globally important resources like the Pacific Ocean. Small policies can encourage widespread acceptance of the environmental moral imperative . . .”).

418. Hirschprung, *supra* note 226, at 149–50.

419. *Id.* at 150.

420. *Id.*

421. *Id.* at 151.

422. Hirschprung notes that some who favor stewardship as a way to define ownership emphasize its “potential” to reform copyright law “by emphasizing the duties to the public that correlate with ownership rights.” *See id.* at 150.

423. *See* Reinstein, *supra* note 1, at 72 (suggesting that a degree of certainty is necessary to encourage investment and that for space development to be possible, investors must receive an early return on their investment).

424. *See id.*

V. HOW TO MANAGE PROPERTY IN OUTER SPACE

*[W]e must accord the highest priority to efforts to solve or avoid the tragedy of the commons, the free rider problem, and the harmful impacts of side effects as they arise in connection with human/environment relations. For the most part, success in this endeavor will depend on our ability both to understand the sources of perverse incentives and to devise systems of rights and rules or, in other words, governance systems capable of altering incentives sufficiently to alleviate problems of this sort.*⁴²⁵

The lack of property lines or boundaries in outer space make it difficult to delineate an individual claim to ownership, which could lead to overlapping and conflicting claims of development rights. Assertion of ownership rights over space and its resources conflicts with the ban on appropriation of outer space in the governing treaties and could lead to rivalrous conditions, perhaps even to war. Without a management system that assures equitable access to and sharing of celestial resources, any form of property regime runs the risk of violating the equitable principles that animate the OST and Moon Treaty—that space should be developed for the benefit of all mankind.⁴²⁶

The Article, to this point, has established that outer space is closer to a global commons than it is to private property. Yet, treating space as a global commons, as noted previously, poses a unique management problem: how to design a management approach that protects open access commons resources from overconsumption or damage while still incentivizing the development of those resources. Hardin believed that privatization of property was the best way to achieve efficiency and sustainability, Ellickson argued that informal norms were the best way to achieve “sustainable equilibrium,” and Ostrom promoted “a range of management techniques specific to that community in order to redirect the march towards total exhaustion.”⁴²⁷ While these ideas do not work in isolation for space, they each contribute in some way to a solution.

425. See Young, *supra* note 216, at 16.

426. See Reinstein, *supra* note 1, at 72.

427. Pearl, *supra* note 243, at 1047; see also Foster & Iaione, *supra* note 222, at 288 (“Hardin famously postulated that threats of degradation and destruction of the commons give rise to either a system of centralized public regulation or the imposition of private property rights in order to avoid the ‘tragedy.’ Ostrom’s groundbreaking work, on the other hand, demonstrated that there are options for commons management that are neither exclusively public nor exclusively private. Ostrom identified groups of users who were able to cooperate to create and enforce rules for using and managing natural resources—such as grazing land, fisheries, forests and irrigation waters—using ‘rich mixtures of public and private instrumentalities.’”). But see Pearl, *supra* note 243, at 1061 (“Ostrom’s model [of self-management] works under certain conditions—typically small CPRs—but the Ogallala is not among them.”).

This Part identifies some management approaches designed to achieve those goals from the right of first possession rule to the application of norms, and evaluates each one for its suitability and ability to meet the dual goals of equitably and sustainably allowing the profitable development of outer space resources, as well as for its efficiency, fairness, cost effectiveness, and ease of implementation and enforcement. One conundrum is that

not only does one size not fit all, but also there are apt to be multiple approaches to the development of solutions. To take a single example, any effort to avoid or alleviate the tragedy of the commons must include the creation of some sort of exclusion mechanism or system for rationing available supplies of the relevant good(s) or service(s) among prospective users. But it turns out that there are distinctive ways to meet this condition under structures of private property, common property, or public property.⁴²⁸

This Part also shows that there are a number of solutions whose effects are comparable in terms of conservation, but are significantly different when criteria like “efficiency, equity, or robustness” are examined.⁴²⁹

A. Hybrid Governance

Hybrid forms of governance are a way of managing property.⁴³⁰ An example of a hybrid *governance* regime is a “nested governance system,” in which one form of governance, self- or local governance, is nested in a larger, “centralized governance regime.”⁴³¹ In this management scenario, the public authority, which acts as a designer and mediator of these co-designed systems, becomes a “collaborative institutional ecosystem [of] manager[s]” enabling “the networks, actions and reactions of others in the ecosystem [to be] independent and free [while] nested

428. Young, *supra* note 216, at 16.

429. *Id.*

430. Arnold, *supra* note 237, at 1217.

431. Foster & Iaione, *supra* note 222, at 324–25 (internal footnotes omitted) (“In user-managed scenarios, individuals exist in an interdependent relationship with each other and with the resource, and are strongly motivated to overcome collective action problems, collaboratively manage the resource, and enhance their productivity over time. In many of these cases, users are able to enforce and monitor their rules only with the help of external state agencies on whom they rely in instituting a complex, ‘nested’ governance system to regulate the resource but without subsuming these institutions into a centralized governance regime. . . . Both formal and non-formal groups alike rely to some extent on the local government to facilitate or enable their activities in managing and governing the commons. In this sense, they are ‘nested’ governance regimes that ‘claim’ the urban resource as an open-access common resource, allowing some class of users to work cooperatively and collaboratively to care for and manage it.”).

within the local government, consistent with a polycentric system.”⁴³² Elected officials “assist, collaborate, and provide technical guidance (data, legal advice, communication strategy, design strategies, sustainability models, etc.) to enable themselves to manage, mediate, and coordinate the ecosystem.”⁴³³ The public official becomes a manager who enables and supports “parts of the ecosystem to allow it to ‘nest’ within the larger policy of the city.”⁴³⁴ Arnold calls this nested system of governance a “spatially hybrid property regime.”⁴³⁵ Given the different levels of government that might be involved in outer space—international, national, and even local—nested hybridity might become a reality.

Another hybrid form of governing property, particularly commons, which contains separate, yet overlapping power centers is called “subsidiarity.”⁴³⁶ “Subsidiarity is the idea that power should be shared with ‘the lowest practicable tier of social organization, public or private.’”⁴³⁷ It is based on the impression that “governments look for allies at different hierarchical levels to facilitate the initiatives of proactive citizens who, individually or in groups, are willing to take direct care of the commons.”⁴³⁸ Space-faring nations could involve subunits of government in the actual management of space, like states, provinces, and towns, as well as special interest groups that might benefit from the development of space, like universities or space development enterprises.⁴³⁹ Foster and Iaione use horizontal subsidiarity as a means of

432. *Id.* at 336. “The challenge of networked governance may be that its structure resembles a loosely coupled system, subject to fraying at the margins and not glued together enough to be organizationally coherent.” *Id.* at 335.

433. *Id.* at 336.

434. *Id.*

435. Arnold, *supra* note 237, at 1246; *see also* Pearl, *supra* note 243, at 1035 (“In the Liberal Commons, Heller and Dagan seek to demonstrate the benefits of ‘synthesizing features of existing [property] types, private and commons, to create vigorous hybrids including the liberal commons.’”).

436. Foster & Iaione, *supra* note 222, at 288–89 (“In this article, we tease[d] out . . . a set of democratic design principles that can be replicated to manage or govern a range of shared urban goods and resources. These principles—horizontal subsidiarity, collaboration, and polycentrism—reorient public authorities away from a monopoly position over the use and management of common assets and toward a shared, collaborative governance approach. In other words, the Leviathan state gradually becomes what we call the facilitator, or enabling, state.”).

437. *Id.* at 325–26. “The governance regime for shared urban resources becomes one without a dominant center but instead one in which all actors who have a stake in the commons are part of an autonomous center of decision making as co-partners, or co-collaborators, coordinated and enabled by the public authority.” *Id.* at 289. However, Foster and Iaione warn that “although loosely coupled systems may be adaptive, they can lose consistency and predictability if repeatedly confronted with abrupt and unpredictable change.” *Id.* at 335.

438. *Id.* at 327.

439. *See* Foster & Iaione, *supra* note 222, at 326–27. “Horizontal subsidiarity thus prompts

engaging an active urban citizenry in maintaining the city for the collective welfare of its citizens.⁴⁴⁰ However, there is no reason to limit the principle's application to the urban environment. Indeed, the goal of reorienting "public authorities away from the central state to an active citizenry willing to cooperatively govern common resources" seems equally useful in outer space where there are similar sub-governing units.⁴⁴¹ Indeed, to the extent this approach breaks the tie between the space development industry and government and the industry's push to realize the principle of first possession, subsidiarity as a management principle may hold some merit, if adjusted to meet the physical circumstances of outer space.⁴⁴² And a nested system of governance or subsidiarity could involve interested parties in governance providing for more local resolution of conflicts, if and when there are regulations to apply.

B. Application of the Right of First Possession Property Rule

As noted previously, the space industry favors allowing ownership of property in outer space because it enables them to profit from their investment in the development of space resources and counter balances the risks of each venture they undertake.⁴⁴³ They argue that "[o]wnership

governments to look for, and accept, allies to facilitate the initiatives of proactive citizens who, individually or in groups, are willing to take direct care of the common assets of the city. In a sense, the government is looking to share the responsibility of caring for common goods with an active citizenry. This 'sharing' implies that citizens are willing to act for the general interest—to be a *city-maker* rather than just a *city-user*." *Id.* at 327 (emphasis added).

440. *See id.* at 326.

441. *Id.* at 328. Foster and Iaione also recommend a "polycentric system of governance," which reduces the state to providing these subgroups with the "necessary tools (including appropriate public policies packaged as collaborative devices), connecting the several networks of actors, and helping the so-called 'collaborative class' to enlarge the boundaries of innovation. In this kind of system, 'many elements are capable of making mutual adjustments for ordering their relationships with one another within a general systems of rules where each element acts with interdependence of other elements.'" *Id.* at 333. But, polycentric governance appears too chaotic and indeterminate to be an appropriate form of governance for outer space, and reduces the power of a central authority too low to effectively regulate and enforce activities in outer space. The scale of managing outer space compared to managing activities in an urban environment is too disproportionate to apply its lessons to outer space.

442. *Cf.* Foster & Iaione, *supra* note 222, at 313 ("The reigning account of the politics of urban land use decisions, the 'growth machine' account, situates land use officials as acting in concert with an elite coalition of developers and real estate interests primarily concerned with economic growth.").

443. Brehm, *supra* note 1, at 374–75 ("By creating a system in which private entities can establish real property rights in their space objects and a surrounding safety zone, the proposal incentivizes private investment of large sums into space exploration programs. Provisions which authorize the right to exclude, the right to be free from interference, the exclusive right to appropriate resources within an established safety zone, and the right to sell real property further encourage private space exploration and create strong associated incentives."); *see*

rights would also provide incentives for expeditions to make the initial treks to the moon⁴⁴⁴ and “would allow a free market to develop in property rights” on celestial bodies like asteroids or the moon.⁴⁴⁵ Critical to protecting those investments is the right of first possession.⁴⁴⁶ But, as also discussed earlier, “full ownership” of property in outer space, like the surface of an asteroid or the moon, violates Article II of the Outer Space Treaty, making any implementing rule a nullity.⁴⁴⁷

One approach around the ban, allowing application of the principle, might be to create “a real property rights system based on jurisdictional sovereignty” distinguishing “between absolute territorial sovereignty and functional or jurisdictional sovereignty.”⁴⁴⁸ An essential part of this proposal is to permit “private entities to occupy locations on a first-come, first-served basis so long as the occupation does not interfere with the activities of other entities.”⁴⁴⁹ The proposal “would permit private property rights in outer space once a private entity made effective use of the property for a period of one year, and continued to use the property in a peaceful way that allowed for free and open use of outer space.”⁴⁵⁰ The genesis of this proposal, according to Andrew Brehm, are the Homestead Acts, “which similarly encouraged private exploration and settlement in new frontiers.”⁴⁵¹ The key elements of this proposal are the non-interference requirement and the diligence requirement.⁴⁵² But, eventually, the land transferred to the homesteader, which was the incentive for undertaking the hard work in the first place.⁴⁵³

Other scholars have advocated using the General Mining Law of 1872 (GML).⁴⁵⁴ The GML not only gave the first discoverer of a valuable mineral the exclusive right to develop it, but also to the land around the discovery.⁴⁵⁵ Ownership of the land remained in the United States until

also Coffey, *supra* note 29, at 139 (“[T]he clearest, most efficient solution to the space resources question would simply be to allow comprehensive property rights, including real estate ownership, in space.”).

444. Coffey, *supra* note 29, at 140.

445. *Id.* at 141.

446. *See id.*

447. *Id.* “While the OST allows a constrained claim to space resources, it does not allow the right to exclude under [A]rticle I’s guarantee of free access to all areas of celestial bodies.” *Id.* at 139.

448. Brehm, *supra* note 1, at 366.

449. *Id.* at 367–68.

450. *Id.* at 368.

451. *Id.* at 369.

452. *See id.* at 368.

453. *See* Brehm, *supra* note 1, at 369.

454. MacWhorter, *supra* note 42, at 667.

455. *Id.*

the discovering entity perfected its claim, at which point the land transferred to the miner.⁴⁵⁶ At that point, the proposal runs afoul of the OST ban, just like using the Homestead Act as a model.⁴⁵⁷ Another reason the models will not work in outer space is that the United States originally owned the land before it was transferred to a private entity.⁴⁵⁸ As no sovereign owns land in outer space, there is no sovereign to transfer anything to anybody.⁴⁵⁹ Therefore, the right of first possession rule under any approach cannot get over the non-appropriation hurdle of the international space treaties, regardless of any other attributes they may have, and is unworkable.

C. Establish Exclusive Economic Zones (EEZ) Like Those Under UNCLOS

One approach that has captured the attention of some space law scholars is the idea of establishing development or enterprise zones on celestial bodies.⁴⁶⁰ Under this approach, existing organizations could allocate areas on celestial bodies for the construction of installations by different countries “with the understanding that a certain exclusive economic zone would radiate from that location.”⁴⁶¹ Nations could then allow activities to occur in those zones and regulate them.⁴⁶² “Alternatively, an international organization could divide celestial bodies into shares for each country to presently or eventually exploit, as opposed to a system of arising economic zones.”⁴⁶³

The EEZ proposal is not that different from traditional Euclidian zoning to the extent it “separates incompatible land uses and excludes harmful ones to avoid negative spillovers” from the co-location of conflicting uses.⁴⁶⁴ Zoning can also be used to “control the kind of users allowed to consume the commons by excluding those who are likely to take out more than what might be considered their fair share of the commons and leave everyone worse off, at least fiscally.”⁴⁶⁵

456. *See id.* at 668, 670.

457. *See id.* at 668.

458. *See id.*

459. MacWhorter, *supra* note 42, at 668 (“The situation in space—where no sovereign may lay claim—is far different from the effort to exploit the American West.”).

460. *See* DiMaria *supra* note 28, at 433 (“Some scholars have argued that the successful middle ground [between *res communis* and *res nullius*] lies in exclusive zones for States to encourage industry but avoid giving spacefarers free reign.”).

461. *Id.* at 436.

462. *See id.*

463. *Id.* at 436–37.

464. Foster & Iaione, *supra* note 222, at 310.

465. *Id.*

Separating incompatible land uses and excluding those who might over-consume the commons might be a useful approach in outer space, if the obstacles to creating it can be overcome, which they cannot. The fact that the proposal assures development rights for countries creates several problems. First, creating an exclusive zone from which some entities are excluded in all likelihood would “directly interfere with the free exploration and use principles in Article I of the Outer Space Treaty.”⁴⁶⁶ Second, the proposal’s administration requires the presence of an international organization, with its attendant problems.⁴⁶⁷ Third, given the difficulty tracking asteroids, monitoring and enforcing what happens within these zones may be very difficult.⁴⁶⁸ Fourth, depending on the perceived *fairness* of the zones and the allocation process, the proposal could lead to “discord” among various countries causing the possible dissolution of whatever civility norms had been established among spacefaring nations.⁴⁶⁹

The zoning proposals to date have focused on single uses, principally mining.⁴⁷⁰ It is possible, however, that as conditions on the moon, for example, become more useful for other uses, such as a place from which to launch ventures into deeper outer space or for extracting water for use in situ or elsewhere, there may be more than one activity occurring in a single zone. One way to avoid one activity interfering with the use by another is the use of “performance zoning,” an idea Lee Anne Fennell proposed to allow for the agglomeration of beneficial uses to produce positive impacts within the zone as well as beneficial spillover impacts.⁴⁷¹ Another is to adopt the idea of “poolism,” the “co-production of goods” and adoption of “sharing practices” in a single space, like in a city.⁴⁷² For such an idea to work, there would have to be a system of

466. DiMaria, *supra* note 28, at 437.

467. *Id.* at 436–37 (discussing these problems).

468. *Id.* at 437; *see also* Abrams, *supra* note 57, at 813 (“One key characteristic of asteroids is that they are more difficult to track than planets or real estate on Earth. This makes an asteroid seem more like a chattel, which may be lost.”).

469. *Cf.* Saunders, *supra* note 241, at 1384 (discussing the establishment of zones with specific restrictions which fractured existing community norms).

470. *See, e.g.*, MacWhorter, *supra* note 42, at 667.

471. Foster & Iaione, *supra* note 222, at 312 (internal footnote omitted) (“Because we cannot rely upon markets to assemble urban participants optimally or to maximize the positive agglomeration benefits of urban common space, [Fennell] floats the idea of using ‘performance zoning’ as a means of favoring land uses that will produce positive impacts or spillovers to a particular neighborhood or to the City.”). The concept of performance outcome zoning as advocated by Foster and Iaione might also be transferrable to outer space. *See id.* at 313–14 (“Zoning permits would be based not on a particular type of land use but rather on the basis of particular targeted outcomes using performance metrics by which the positive impacts of that land use on communities can be assessed.”).

472. *Id.* at 340–41.

assembling uses in a single area of a celestial body, perhaps through performance zoning, and then occupants of that zone would have to be willing and able to collaborate.⁴⁷³ Assuming those obstacles can be surmounted, it is not clear how either of these approaches will overcome the exclusion problems associated with any proposal that excludes some users.

D. Lotteries or Tradable Credits

Having a lottery or an auction of “ownership rights,” or establishing a system of tradable credits like under the Clean Air Act’s acid rain provision,⁴⁷⁴ or under the prior appropriation doctrine for allocating use rights to a quantity of water, might be ways to lessen the equitable problems with the prior proposals, none of which is sensitive to the interests of non-developed countries.⁴⁷⁵ While an auction theoretically would open up the market in development rights to others than the large spacefaring nations, in practice one would expect that only they would be able to effectively bid on and then secure those rights.⁴⁷⁶ However, the idea of tradable credits might work.⁴⁷⁷

Under an outer space trading system, participant nations, “regardless of [their] space-faring capacity, would be allocated a certain number of lunar mining credits. The credits would allow the holder to mine a certain tonnage of natural resources on the moon during a given period.”⁴⁷⁸ The credits could apply to the amount of the resource a participant was allowed to mine, regardless of location, or could be tied to a particular plot of land on a celestial body.⁴⁷⁹ Participants could buy and sell their credits to other participants.⁴⁸⁰ The openness of the process would create an incentive for all countries, regardless of their “spacefaring

473. *See id.* at 342.

474. 42 U.S.C. §§ 7651a–7651o (2012).

475. *See Coffey, supra* note 29, at 137; DiMaria, *supra* note 28, at 434; Reinstein, *supra* note 1, at 90.

476. *Cf. Reinstein, supra* note 1, at 92 (“The auction occupies the middle ground between laissez faire privatization of space development and a belief that space is the equal birthright of all humanity.”).

477. *See Taylor, supra* note 31, at 279 (“Tradable allowances are more cost-effective, generate more innovation and facilitate greater global participation than any other resource management strategy. Thus, tradable allowances offer the most promising solution to the tragedy of the space commons.”).

478. Coffey, *supra* note 29, at 138.

479. *Id.*; *see also* Edwin W. Paxson, III, *Sharing the Benefits of Outer Space Exploration: Space Law and Economic Development*, 14 MICH. J. INT’L L.J. 487, 514 (1993) (“[E]ach country would be allocated a certain amount of lunar mining credits, which would allow the holder of the credits to engage in mining certain tonnage of natural resources on the [m]oon for a given period.”).

480. Coffey, *supra* note 29, at 138.

capacities.”⁴⁸¹ Two additional features make this an appealing approach. The first of these, “tonnage limits,” will encourage countries to “make careful choices in where and what to mine,” assuring that valuable resources will still be there for countries that begin mining later, like developing nations.⁴⁸² The other, a sunset provision, should prevent hoarding and speculative purchases.⁴⁸³

The approach “would allow developing nations to benefit from space exploration and exploitation fairly, without giving them control over an international regime.”⁴⁸⁴ Another advantage, other than determining the amount of allocable credits, is that there would be no need for an international central authority, because participants will run the market.⁴⁸⁵ Coffey proposes linking the concept of tradable permits to an exclusive economic zone so that “[w]hen a nation exercises its credits on land, that land will become the exclusive economic zone of that nation,” but would allow others to pass through the zone “as long as they do not disturb it or take resources from it.”⁴⁸⁶ However, her approach comes close to conflicting with the prohibition against appropriating celestial resources.

Yet, there are potential problems even with this promising approach. For example, there is still a need for some international organization to allocate mining credits and to determine the methodology for any allocation, especially how to assure that non-spacefaring nations benefit in some way.⁴⁸⁷ Some form of international oversight will be needed to “ensure that nations adhere to the rules and do not exceed their allotted tonnage.”⁴⁸⁸ There is an unresolved question whether commercial mining enterprises would be able to buy credits not only from their own country, but from other countries.⁴⁸⁹ Then, there is the question of whether space resources may legally be considered personal property, requiring a new international agreement to clarify that “celestial resources may legally belong to those who extract them.”⁴⁹⁰ Tradable credits would also need to be anchored by a permit, again raising the need for an administering

481. *Id.* The worry is that these countries might try and develop a profit distribution system for resources they neither undertook the risk or cost of developing that benefits them. *Id.*

482. *Id.*

483. *Id.* The sunset provision might also help to control how much actual mining activity occurs at during any given time period. Coffey, *supra* note 29, at 138.

484. *Id.*

485. *Id.*

486. *Id.* at 145.

487. *Id.*

488. Coffey, *supra* note 29, at 139.

489. *Id.* at 138 (“Since credits would be bought and sold among nations, it is unclear what role private actors such as corporations would play.”).

490. *Id.* at 139.

agency.⁴⁹¹ To prevent over-consumption of permitted resources, a “time-limited” permit based on something like the prior appropriation doctrine giving the first appropriator superior rights over any later appropriator might be a way to curb over-consumption, but might disadvantage non-spacefaring countries who would come later to the market.⁴⁹²

Therefore, tradable development credits—absent Coffey’s modification—is largely consistent with international law, and could assure equitable distribution of the benefits of space development as well as provide sufficient incentives for development of these resources. However, the approach may be too administratively encumbered and difficult to enforce to be worth adopting.

*E. Norms as a Management Approach*⁴⁹³

Norms are social rules that are promulgated and enforced by the community to which they apply.⁴⁹⁴ They come from communities and not from an outside organization or governmental entity.⁴⁹⁵ They provide “social meaning” for individuals in specific communities and thus provide the framework or understandings that guide personal behavior.⁴⁹⁶

491. *Id.* at 138.

492. DiMaria, *supra* note 28, at 434. Noting the similarity to water law, DiMaria says that valuable celestial resources

May eventually become unsustainable without imposing any equitable principles over a longer period of time. Without sustainable regulations in place as early as possible, space could eventually become saturated, excluding future parties from use and exploration by allowing exclusionary rights to prior appropriators. Although it may seem farfetched to prepare a legal regime with such a distant future in mind, a lack of similarly forward thinking led to the present dilemma by leaving outer space property rights vague while the technology to obtain such rights ripened.

Id. at 439 (internal footnote omitted).

493. The descriptive portions of the text in this Section about norms and some of the supporting footnotes are drawn from my article. See Hope M. Babcock, *Assuming Personal Responsibility for Improving the Environment: Moving Toward a New Environmental Norm*, 33 HARV. ENVTL. L. REV. 117, 134–42 (2009).

494. See Robert D. Cooter, *Three Effects of Social Norms on Law: Expression, Deterrence, and Internalization*, 79 OR. L. REV. 1, 5 (2000) (“[A] social norm is an obligation backed by a social sanction. . . . [An] ‘obligation’ . . . [is] a statement about what people ought to do, such as pay taxes and clean up after their dogs. . . . [A] social sanction . . . [is a] punishment imposed, not by state officials, but by ordinary people, such as shunning a litigious lawyer or refusing to deal with a law firm that organizes hostile takeovers.”); Richard A. Posner & Eric B. Rasmusen, *Creating and Enforcing Norms, with Special Reference to Sanctions*, 19 INT’L REV. L. & ECON. 369, 369 (1999) (“A norm is a social rule that does not depend on government for either promulgation or enforcement.”).

495. Pearl, *supra* note 243, at 1039.

496. Michael P. Vandenberg, *The Social Meaning of Environmental Command and Control*, 20 VA. ENVTL. L.J. 191, 200 (2001).

They function as

nonlegal rules or obligations that certain individuals feel compelled to follow despite the lack of formal legal sanctions, whether because defiance would subject them to sanctions from others (typically in the form of disapproval, lowered esteem, or even ostracism) or because they would feel guilty for failing to conform to the norm (a so-called internalized norm).⁴⁹⁷

Concern about esteem is especially important in close-knit groups, which makes norms unlikely to have any effect on the disparate entities that might engage in developing outer space.⁴⁹⁸ However, if conditions were appropriate for the activation of norms in outer space, it is conceivable that a norm favoring an equitable distribution of space resources could arise.

Ellickson's study of Shasta County, California, demonstrates how norms that originate within a close-knit community can efficiently manage a CPR.⁴⁹⁹ His theory revolves around the baseline rule that "property rights—be they communal or individual—should be clear and well-known among community members."⁵⁰⁰ Besides the absence of any close-knit community in outer space, the fact that property rules in outer space are neither clear nor well known would seem to undercut the application of norms as a management tool in that environment.⁵⁰¹

Thus, norms work as a means of controlling individual behavior when individuals see themselves as part of a particular group.⁵⁰² When

497. Ann E. Carlson, *Recycling Norms*, 89 CAL. L. REV. 1231, 1238 (2001); see also Alex Geisinger, *A Group Identity Theory of Social Norms and Its Implications*, 78 TUL. L. REV. 605, 608 (2004) ("The sanctions can be based on shame or some other type of social ostracism."). "In rational actor terms, violating a social norm imposes a cost on the violator that can tip the cost-benefit balance in favor of conformity with the norm." Carlson, *supra*, at 1239.

498. David R. Karp, *The New Debate About Shame in Criminal Justice: An Interactionist Account*, 21 JUST. SYS. J. 301, 313 (2000) ("Repeated interactions give rise to habits. They are perceived by the actors and become expectations in the sense of predictions or anticipations of behavior . . . [E]ach actor feels constrained to live up to the expectation, partly out of a feeling that the other will be irritated, offended, or disappointed if the expectation is not fulfilled."); Michael P. Vandenberg, *Order Without Social Norms: How Personal Norm Activation Can Protect the Environment*, 99 NW. U.L. REV. 1101, 1105 (2005) ("Social sanctions will not change the individual payoff because the individual will either act in isolation or in a setting with insufficient iterative relationships or information exchange to enable social norm sanctioning to occur. . . . [S]ituations in which the individual's actions are not observable by others and situations in which the actions are observable but occur in non-close-knit groups as loose-knit group situations.").

499. Pearl, *supra* note 243, at 1039.

500. *Id.*

501. *Cf. id.*

502. Geisinger, *supra* note 497, at 632.

this happens, individuals identify with and assimilate the group norm, replacing individual behavior with “group-guided behavior.”⁵⁰³ To the extent that “[i]nformal norms and private ordering seek to identify circumstances that combine the benefits of the unmanaged commons—freedom—with the benefits of privatization—efficiency,” they offer “an appealing degree of autonomy, efficiency, and freedom.”⁵⁰⁴ But, as in the case of the users of Pearl’s “Ogallala Aquifer,” there is no “close-knit group” of actors in outer space, “no shared workday affairs[,] . . . and the population of users is too large to enable each to sanction the other.”⁵⁰⁵ Hence, norms as a management approach in outer space, while consistent with international law, inexpensive to administer, implement, and enforce, and capable of responding to inequitable situations, seem unlikely to take hold in that environment.

*F. The Public Trust Doctrine (PTD) as a Gap Filling, Place-Holding Management Approach*⁵⁰⁶

The PTD offers both an approach for managing an open access commons and a gap-filling tool until a regulatory regime is adopted.⁵⁰⁷ The doctrine is based on the idea that the “sovereign holds certain common properties in trust in perpetuity for the free and unimpeded use of the general public.”⁵⁰⁸ The public’s right to access and use trust resources is never lost, and neither the government nor private individuals can alienate or otherwise adversely affect those resources unless for a comparable public purpose.⁵⁰⁹ The resources the doctrine protects “have

503. *Id.*

504. Pearl, *supra* note 243, at 1039.

505. *See id.* at 1061.

506. Parts of the descriptive portions of this Section about the PTD and some footnotes are drawn from articles I have written on the doctrine. *See generally* Hope M. Babcock, *Is Using the Public Trust Doctrine to Protect Public Parkland from Visual Pollution Justifiable Doctrinal Creep?*, 42 *ECOLOGY L.Q.* 1 (2015); Hope M. Babcock, *Grotius, Ocean Fish Ranching, and the Public Trust Doctrine: Ride ‘Em Charlie Tuna*, 26 *STAN. ENVTL. L.J.* 3 (2007); Hope M. Babcock, *The Public Trust in Public Art: Property Law’s Case Against the Private Hoarding of “Pubic Art,”* 50 *CONN. L. REV.* (forthcoming 2019) (on file with author); Babcock, *supra* note 11.

507. *See, e.g.,* Babcock, *supra* note 11, at 664–75 (advocating the use of the doctrine to protect migrating wildlife, discussing inadequacies of current federal and private law, and the capacity of the doctrine to adapt to changing societal needs); Joseph L. Sax, *The Public Trust Doctrine in Natural Resources Law: Effective Judicial Intervention*, 68 *MICH. L. REV.* 471, 556 (1970) (arguing the PTD could achieve environmental goals until the legislation caught up.).

508. Babcock, *supra* note 11, at 674.

509. *See* Hope M. Babcock, *Should Lucas v. South Carolina Coastal Council Protect Where the Wild Things Are? Of Beavers, Bob-o-Links, and Other Things that Go Bump in the Night*, 85 *IOWA L. REV.* 849, 889–98 (2000) (summarizing salient aspects of the PTD).

long been part of a ‘taxonomy of property’ [that recognizes] the division of natural wealth into private and public property.”⁵¹⁰

“The doctrine places on governments ‘an affirmative, ongoing duty to safeguard the long-term preservation of those resources for the benefit of the general public,’”⁵¹¹ thus limiting the sovereign’s power on behalf of both present and future individuals.⁵¹² It directs the government to manage trust resources for public benefit, not private gain.⁵¹³ It applies to private as well as public resources and is used to preserve the public’s access to CPRs.⁵¹⁴ Government agencies have the non-rescindable power to revoke uses of trust resources that are inconsistent with the doctrine.⁵¹⁵ This effectively places a permanent easement over trust resources that burdens their ownership with an overriding public interest in the preservation of those resources.⁵¹⁶ However, trust resources can be alienated in favor of private ownership, if the alienation will still serve the public’s interest in those resources and not interfere with trust uses of the remaining land.⁵¹⁷ The PTD, therefore, protects the “people’s common heritage,”⁵¹⁸ just as Article 11 of the Moon Treaty protects outer space as part of the common heritage of mankind.⁵¹⁹

510. Michael C. Blumm & Mary Christina Wood, “*No Ordinary Lawsuit*”: *Climate Change, Due Process, and the Public Trust Doctrine*, 67 AM. U.L. REV. 1, 44 (2017).

511. Babcock, *supra* note 11, at 675; *see also* J. Peter Byrne, *The Public Trust Doctrine, Legislation, and Green Property: A Future Convergence?*, 45 U.C. DAVIS L. REV. 915, 918 (2012) (“Public trust rights are understood to precede and constrain legislative action to a larger extent than do private property rights.”).

512. Babcock, *supra* note 11, at 675–76.

513. *Id.* at 676.

514. Lloyd R. Cohen, *The Public Trust Doctrine: An Economic Perspective*, 29 CAL. W.L. REV. 239, 275 (1992) (“Any body of law will be fuzzy around the edges; that [cannot] be helped. But the notion of an evolving unbounded set of communal rights—whether they are constitutional or common law, procedural or substantive, in all public and private property strips clarity, certainty, and predictability from the very core of the [PTD].”).

515. Babcock, *supra* note 509, at 892.

516. *See id.* at 893 (“One cannot construct a common law canon more offensive to the notion of absolute private rights in property than the [PTD].”); *see also* Ill. Cent. R.R. Co. v. Illinois, 146 U.S. 387, 453 (1892) (“The State can no more abdicate its trust over property in which the whole people are interested . . . so as to leave them entirely under the use and control of private parties . . . than it can abdicate its police powers in the administration of government and the preservation of the peace.”).

517. Michael C. Blumm & Aurora Paulsen Moses, *The Public Trust as an Antimonopoly Doctrine*, 44 B.C. ENVTL. AFF. L. REV. 1, 17 (2017).

518. Nat’l Audubon Soc’y v. Superior Court of Alpine Cty., 658 P.2d 709, 724 (Cal. 1983) (“The public trust is more than an affirmation of state power to use public property for public purposes. It is an affirmation of the duty of the state to protect the people’s common heritage[.] . . . surrendering that right . . . only in rare cases when the abandonment of that right is consistent with the purposes of the trust.”); Christopher C. Miller, Note, *To the Moon & Beyond: The United States and the Future of International Space Law*, 35 SUFFOLK TRANSNAT’L L. REV. 121, 132 (2012).

519. Moon Treaty, *supra* note 120, art. 11.

The doctrine also appears to be infinitely malleable. Original uses of the doctrine were restricted to only that “aspect of the public domain below the low-water mark on the margin of the sea and the great lakes, the waters over those lands, and the waters within rivers and streams of any consequence,”⁵²⁰ and covered only traditional uses of those lands, like fishing and navigation.⁵²¹ Over time, the scope and application of the doctrine broadened to protect more public resources and different uses.⁵²² Thus, the doctrine expanded to protect new trust resources, such as dry sand beaches, inland lakes, groundwater, dry riverbeds, and wildlife,⁵²³ and passive uses of those resources, like scientific study.⁵²⁴ The original link to navigable water and tidelands disappeared.⁵²⁵ Supporters of the

520. Sax, *supra* note 507.

521. Babcock, *supra* note 11, at 678–79.

522. *Id.*

523. *Id.*; see also Blumm & Moses, *supra* note 517, at 20 (“[T]he PTD has grown in several somewhat surprising ways, extending antimonopoly protection beyond tidelands and beyond traditional public uses while reinforcing the principle of non-alienation of natural resources.”).

524. See, e.g., Marks v. Whitney, 491 P.2d 374, 380 (Cal. 1971) (holding that the PTD protects environmental and ecological values); Lamprey v. State, 53 N.W. 1139, 1143 (Minn. 1893) (recognizing public recreation rights as being within the scope of the PTD, being the first state to do so); Borough of Neptune City v. Borough of Avon-by-the-Sea, 294 A.2d 47, 54 (N.J. 1972) (“We have no difficulty in finding that, in this latter half of the twentieth century, the public rights in tidal lands are not limited to the ancient prerogatives of navigation and fishing, but extend . . . to recreational uses, including bathing, swimming and other shore activities. The [PTD], like all common law principles, should not be considered fixed or static, but should be molded and extended to meet changing conditions and needs of the public it was created to benefit.”); Raritan Baykeeper Inc. v. City of New York, 984 N.Y.S.2d 634, 634 (N.Y. Sup. Ct. Kings Cnty. 2013) (first citing 795 Fifth Ave. Corp. v. City of New York, 205 N.E.2d 850 (N.Y. 1965); and then citing Williams v. Gallatin, 128 N.E. 121 (N.Y. 1920)) (holding that the use of a municipal park for leaf composting was inconsistent with the aesthetics or activities typically associated with recreation and, therefore, alienated park resources in violation of the PTD, and finding the activity could only be authorized by the Legislature exercising “properly conferred” authority, and enjoining the facility’s operation until acted upon by the Legislature).

525. See, e.g., Save the Welwood Murray Mem’l Library Comm. v. City Council, 263 Cal. Rptr. 896, 904 (Cal. Ct. App. 1989) (invoking the PTD to block conversion of a public library to improve public access to nearby commercial areas); Big Sur Props. v. Mott, 132 Cal. Rptr. 835, 837 (Cal. Ct. App. 1976) (revoking permit to cross public parkland to access private property); Paepcke v. Pub. Bldg. Comm’n of Chi., 263 N.E.2d 11, 14–15, 19 (Ill. 1970) (allowing conveyance of one percent of Washington Park for a middle school and recreational facilities leased to the Chicago Park District only after showing that public rights in remaining parkland protected and use was for public purpose); Williams, 128 N.E. at 121–23 (invalidating a ten-year lease of part of Central Park for a museum for impermissibly diverting park resources without the state legislature’s approval); Brooklyn Park Comm’rs v. Armstrong, 45 N.Y. 234, 243 (N.Y. 1871) (disallowing a sale of parkland due to the city’s trust obligations); Ellington Constr. v. Zoning Bd. of Appeals, 549 N.Y.S.2d 405, 414 (N.Y. App. Div. 1989) (prohibiting the re-conveyance of parkland for redevelopment); Ackerman v. Steisel, 480 N.Y.S.2d 556, 558 (N.Y. App. Div. 1984) (ordering removal of city sanitation equipment from a park); Hoffman v. Pittsburgh, 75 A.2d 649, 654–55 (Pa. 1950) (upholding an injunction against the sale of a public square for development based on the PTD); *In re* Conveyance

doctrine successfully advocated that it be applied to “wildlife, parks, cemeteries, and even works of fine art,”⁵²⁶ while arguing more recently its application to the atmosphere.⁵²⁷

A doctrine that imposes a perpetual duty on the sovereign to preserve trust resources, prevents their alienation for private benefit, assures public access to them, and can be invoked by anyone seems particularly useful as a management tool in outer space.⁵²⁸ The fact that public access to trust resources is so central to the doctrine makes it reflective, not contradictory, of international space law’s bar against appropriation of outer space and of the principle of space being the “province of all mankind.”⁵²⁹ It avoids the problems of alienation and exclusion associated with any of the management approaches associated with some form of private property and requires neither the creation of a new administrative authority nor the presence of a close-knit group of like-minded people.⁵³⁰ Members of the public, both rich and poor, can invoke and enforce the doctrine as easily as the sovereign.⁵³¹ It is cost effective to the extent that no separate apparatus is required to implement it, and the doctrine has shown itself to be highly adaptable and innovative as different needs arise.⁵³² It could also fill the gap in international law with respect to managing celestial property. Therefore, of all the management approaches studied here, the PTD seems the most suited to keep order in space until a regulatory regime is imposed.

However, the doctrine provides no incentives for development of trust resources; rather, it might be used to limit or curtail that development, making it an imperfect, perhaps even counter-productive solution by itself to the extent that such development might be

of 1.2 Acres of Bangor Mem’l Park to Bangor Area Sch. Dist., 567 A.2d 750, 751–53 (Pa. Commw. Ct. 1989) (blocking attempted transfer of parklands for construction of an elementary school).

526. Erin Ryan, Comment, Public Trust and Distrust: The Theoretical Implications of the Public Trust Doctrine for Natural Resource Management, 31 *Envtl. L.* 477, 480 (2001) (“Scholars and practitioners have responded to Sax’s call and have advocated extending public trust protection to [cultural assets].”).

527. See Blumm & Wood, *supra* note 510, at 23 (“The basic [Atmospheric Trust Litigation] case applies public trust principles to the atmosphere . . .”).

528. See Babcock, *supra* note 509, at 891; Babcock, *supra* note 11.

529. See Babcock, *supra* note 509, at 892 (internal footnote omitted) (“Since property containing trust lands is conveyed subject to the doctrine, absolute private dominion over property impressed with the public trust can never be granted unless it is in the public interest to do so.”); see also *Ill. Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 453 (1892).

530. See *Cal. Co. v. Price*, 74 So. 2d 1, 21 (La. 1954) (citing *N.Y., New Haven & Hartford R.R. Co. v. Armstrong*, 102 A. 791, 794 (Conn. 1918)).

531. See Babcock, *supra* note 11, at 676–77.

532. See *id.* at 674–75, 678.

beneficial.⁵³³ Modifying the doctrine to allow limited use of private property management approaches, like tradable development claims, might buffer that effect—a form of overlapping hybridity between one type of property, a commons, and a management regime from another, private property, enabled by application of the PTD.

CONCLUSION

*“Only a legal system that accommodates both the human need for resources and the necessary preservation of mankind’s common heritage can fulfill these criteria.”*⁵³⁴

The future is now with regard to the development of outer space and its resources—it is no longer a question of whether humans will engage in these activities, but how soon they will. Technically advanced countries and private commercial enterprises are probing outer space and preparing for landing on an asteroid or the moon to extract their resources.⁵³⁵ Speculators are selling deeds to the moon’s surface and preparing to exploit the tourism potential that space offers.⁵³⁶ But, the legal framework for managing these initiatives is almost nonexistent.⁵³⁷ International treaties came into being before all this activity began in earnest and national laws that might apply are stunted by jurisdictional quandaries like the absence of national boundaries in outer space.⁵³⁸ Thus, there is an urgency to figure out how to control what happens in outer space before its resources are irreparably damaged or permanently monopolized by powerful countries and individuals.

In the absence of regulation, much of the current debate centers on what property regime should be applied in outer space.⁵³⁹ The assumption is that by only allowing private property rights in space, countries and commercial enterprises will undertake the risks and costs of space development.⁵⁴⁰ However, unless international space law changes, it may prevent this from happening. If it changes, strong management controls will be necessary to prevent destruction or over-consumption of celestial resources, as well as monopolization and competitive behavior by participants, which could lead to hostilities and inequities.

533. *See id.* at 697–700 (discussing modifications to the doctrine to lessen any controversy associated with its application).

534. Widgerow, *supra* note 22, at 518.

535. *See* Brehm, *supra* note 1; Reinstein, *supra* note 1; Ross, *supra* note 1.

536. *See* Reinstein, *supra* note 1; Wasser & Jobes, *supra* note 98.

537. *See* Reinstein, *supra* note 1 at 62–63.

538. *See id.* at 72.

539. *See, e.g.,* Brehm *supra* note 1, at 374; Reinstein, *supra* note 1, at 72.

540. *See* DiMaria, *supra* note 28.

This Article examines various private property regimes, including those of less than full fee ownership, to see if any would avoid the conflict with the international prohibition on appropriation of outer space and its resources. It concludes that none will because each retains the right to exclude and each is insensitive to the treaties' equity concerns. In contrast, considering outer space to be common is consistent with international space law in both respects.

Hypothesizing that private property in outer space may yet prevail, this Article investigates different private property management approaches, such as the right of first possession, lotteries, and tradable development rights, to see if any would be cost effective, easy to implement and equitable, and would also prevent over-consumption, monopolization or the slide into rivalrous behavior. The Article concludes that each comes up short in some respect. Social norms as a management tool for property held in common, although compliant with international law, are also not up to the task. Instead, although ancient, the PTD, with its malleability, easy and cost-effective implementation and enforcement, non-consumption principle, and consistency with the goals that animate international space treaties, seems best suited to the task of protecting the public's interests in the global commons that is outer space as it has done for centuries in Earth-bound commons.

But, as its principal terrestrial use has been to protect trust resources from development, the doctrine needs some modification to encourage development of celestial resources. Hence, this Article suggests that modifying the PTD to allow the application of private property management tools, like tradable development rights, will not only allow development, but also will assure that when it happens, it will not be just profitable for a few, but will also be sustainable and equitable.