

WASTE IN SPACE: REMEDIATING SPACE DEBRIS THROUGH THE DOCTRINE OF ABANDONMENT AND THE LAW OF CAPTURE

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With the growing commercialization of outer space, the threat of damage to satellites from detritus hurtling through space could prevent the continued installation of satellites. The cure for this issue cannot simply come from mitigation efforts; governments and organizations involved in spacefaring activities must participate in active remediation measures. International space agency guidelines and U.S. statutes and regulations are productive preventative measures against further accumulation of debris. In addition, a number of organizations are working on new technology to actively reduce orbital debris. These active processes for culling debris from orbit are essential for the reduction of debris buildup.

One possible barrier to the organizations looking to clean up outer space is property ownership rights. Enforcement of ownership rights rests with domestic law, which would accordingly need to be applied extraterritorially to satellites in space to uphold ownership interests. Though the U.S. Supreme Court has set forth a presumption against extraterritorial application of domestic laws, U.S. domestic laws apply in the narrow instance of suits arising when actions in international areas do not invoke international law or create a conflict of laws problem. With this the case, remediators should look to the doctrine of

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abandonment as a way to easily facilitate the capture of debris and defunct satellites. Under this doctrine, an owner has abandoned the property if he unilaterally relinquished “all title, possession, or claim to or of [the property].”

Applying the abandonment doctrine to post-mission satellites can help determine the legal ramifications of trying to clean up post-mission satellites and how those actions might impact ownership rights. Owners generally take one of two actions as regards post-mission satellites: (1) leaving the satellite in its mission orbit or (2) moving the satellite from its mission orbit to its disposal orbit. When owners fail to move post-mission satellites into a disposal orbit, the satellites qualify as abandoned property and can therefore be captured. A more nuanced, case-by-case analysis must apply when owners take the prescribed steps to move post-mission satellites to a disposal orbit. While post-mission satellites can be analyzed through the doctrine of abandonment, orbital debris does not easily fit into the analysis and cannot be reduced through the avenue of abandonment and capture.

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INTRODUCTION

Space is littered with junk, and we cannot simply call in the garbage collectors to clear it all up. The rapid increase of companies and nations installing satellites in orbit—amounting to “[m]ore than 5000 launches since the start of the space age”—has resulted in a ring of space objects around the Earth.¹ An unhealthy production of orbital debris² has developed from failures to successfully remove defunct satellites from orbit, collisions of objects in space, and installations of new satellites.³ For instance, in 2007, the Chinese government intentionally destroyed a weather satellite during an anti-satellite missile test, producing approximately 2500 pieces of orbital debris.⁴ Experts consider this “the most prolific and serious fragmentation” in

1. Hugh Lewis, *Trouble in Orbit: The Growing Problem of Space Junk*, BBC NEWS (Aug. 5, 2015), <http://www.bbc.com/news/science-environment-33782943>. Space objects are defined as “anything created, fabricated, or launched in any manner from Earth that enters outer space.” SPACE POLICY INST. ET AL., A GUIDE TO SPACE LAW TERMS 122 (Henry R. Hertzfeld ed., 2012) [hereinafter SPACE LAW TERMS], https://swfound.org/media/99172/guide_to_space_law_terms.pdf.

2. Orbital debris is defined as “[a]rtificial objects, including derelict spacecraft and spent launch vehicle orbital stages, left in orbit which no longer serve a useful purpose.” NASA, HANDBOOK FOR LIMITING ORBITAL DEBRIS 21 (2008) [hereinafter NASA HANDBOOK], https://explorers.larc.nasa.gov/APMIDEX2016/MIDEX/pdf_files/NHBK871914.pdf. Orbital debris includes (1) operational debris; (2) inactive payload; (3) microparticulate debris; and (4) fragmentation debris. Meghan R. Plantz, Note, *Orbital Debris: Out of Space*, 40 GA. J. INT’L & COMP. L. 585, 592 (2012).

3. See Plantz, *supra* note 2, at 586 (discussing some of the problems caused by orbital debris in space); see also Jillian Scudder, *How Do We Clean up All that Space Debris?*, FORBES (Jan. 6, 2016, 7:18 PM), <http://www.forbes.com/sites/jillianscudder/2016/01/06/astroquizzical-space-debris/#4fe8076b3ec6> (detailing two incidents, an explosion and collision, that significantly increased the amount of orbital debris). One of the top priorities for the international community is space sustainability, yet a unified plan is nonexistent and the objective remains largely unfunded. Marlon E. Sorge et al., *Space Debris Mitigation Policy*, CROSSLINK, Fall 2015, at 52, 56, http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/crosslink/Crosslink_Fall_2015.pdf.

4. See Becky Iannotta & Tariq Malik, *U.S. Satellite Destroyed in Space Collision*, SPACE.COM (Feb. 11, 2009, 6:00 PM), <http://www.space.com/5542-satellite-destroyed-space-collision.html>; see also Nola Taylor Redd, *Space Junk: Tracking & Removing Orbital Debris*, SPACE.COM (Mar. 8, 2013, 5:00 PM), <https://www.space.com/16518-space-junk.html> (discussing sources of debris currently in orbit).

space exploration history.⁵ Similarly, in 2009, a non-functional Russian satellite crashed into a functioning American communications satellite.⁶ This disaster was the first instance of two intact satellites accidentally running into each other,⁷ and the collision caused upwards of 2000 pieces of orbital debris.⁸ Orbital debris is not only an environmental concern, but it also poses a danger to current and future missions in outer space.⁹

5. Leonard David, *China's Anti-Satellite Test: Worrisome Debris Cloud Circles Earth*, SPACE.COM (Feb. 2, 2007, 3:39 PM), <http://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html>. Prior to this Chinese test, the United States and Soviet Union conducted anti-satellite weapon testing during the 1960s–1980s with the last test conducted in 1985. LORETTA HALL, *THE HISTORY OF SPACE DEBRIS* 4–5 (2014), <http://commons.erau.edu/cgi/viewcontent.cgi?article=1000&context=stm>. The twelve tests conducted during this period produced, in total, around 700 pieces of orbital debris. *Space Debris from Anti-Satellite Weapons*, UNION CONCERNED SCIENTISTS (Apr. 2008), <http://www.ucsusa.org/sites/default/files/legacy/assets/documents/nwgs/debris-in-brief-factsheet.pdf> [hereinafter *Space Debris from Anti-Satellite Weapons*]; see U.S. OFFICE OF TECH. ASSESSMENT, *OTA-BP-ISC-72, ORBITING DEBRIS: A SPACE ENVIRONMENTAL PROBLEM BACKGROUND PAPER 12* (1990) (noting that while the twelve tests were significant, they were only responsible for seven percent of the total space debris in 1990). In comparison, the Chinese satellite destruction more than tripled the amount of orbital debris produced from anti-satellite weapon testing. *Space Debris from Anti-Satellite Weapons*, *supra*.

6. See William J. Broad, *Debris Speus into Space After Satellites Collide*, N.Y. TIMES (Feb. 11, 2009), http://www.nytimes.com/2009/02/12/science/space/12satellite.html?_r=0.

7. See Iannotta & Malik, *supra* note 4 (describing the collision as “the worst space debris event” since the Chinese satellite destruction). Prior breakups of satellites generally resulted from individual satellites exploding due to propellant left on board, not from collisions. Joseph Stromberg, *Space Garbage: The Dark Cloud Above*, SMITHSONIAN.COM (Jan. 26, 2012), <http://www.smithsonianmag.com/science-nature/space-garbage-the-dark-cloud-above-80279582>.

8. See *10 Breakups Account for 1/3 of Catalogued Space Debris*, SPACE NEWS MAG. (Apr. 2016), <http://www.spacemag.com/feature/10-breakups-account-for-13-of-catalogued-debris>. Due to the large size of these two satellites, the amount of resulting orbital debris was astronomical in comparison to prior collisions of small objects. Ted Muelhaupt, *The Collision of Iridium 33 and Cosmos 2251*, *CROSSLINK*, Fall 2015, at 26, http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/crosslink/Crosslink_Fall_2015.pdf.

9. See Lewis, *supra* note 1 (“In 2014, the International Space Station had to move three times to avoid lethal chunks of space debris.”); Scudder, *supra* note 3 (noting that even paint-flake debris can cause serious damage to spacecrafts). Not only should spacefaring nations be concerned about their missions, but nations without objects currently in space should worry as well. See Ram Jakhu, *Legal Issues Relating to the Global Public Interest in Outer Space*, 32 J. SPACE L. 31, 97 (2006). Latecomer nations seeking to initially place objects in space now bear greater risks of collisions between debris and active satellites due to the growing presence of space debris and a lack of ideal location for new satellites. *Id.*

Recognizing this growing concern, domestic and international agencies have created guidelines and parameters to mitigate the increase in orbital debris.¹⁰ Yet the even bigger challenge remains remediation, or cleaning up debris that already exists.¹¹ Companies and nations are now turning to Active Debris Removal (“ADR”) to address existing orbital debris and its rapid reproduction.¹² ADR “involves changing the orbit of a debris object via the actions of another system.”¹³ This system may take different forms, and a number of interested parties have developed ADR systems to remedy the growing space debris problem.¹⁴ Some companies suggest utilizing a laser cannon,¹⁵ while others suggest using a net¹⁶ or adhesive on the side of a spacecraft that sticks to debris and drags it out of harm’s way.¹⁷

Although strategists are advancing many possible approaches for addressing orbital debris, the lack of a cohesive and comprehensive

10. See generally *infra* Part III (describing the parameters for boosting a post-mission satellite out of the GEO region into a graveyard orbit and the 25-year rule for post-mission reentry for satellites in the LEO region). Debris mitigation guidelines codify the most efficient way to control debris production based on scientific observations and analysis about debris origins, as well as technical capabilities and cost constraints. Sorge et al., *supra* note 3, at 53.

11. See Redd, *supra* note 4 (reporting that the amount of debris in orbit will likely only increase, thus making cleanup more difficult).

12. See Marlon Sorge & Glenn Peterson, *How to Clean Space: Disposal and Active Debris Removal*, CROSSLINK, Fall 2015, at 46, 50, http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/crosslink/Crosslink_Fall_2015.pdf (distinguishing ADR from other mitigation efforts). ADR takes a proactive role in removing existing orbital debris whereas mitigation involves implementing procedures and policies to prevent the creation of more orbital debris.

13. Marlon Sorge, *Legal Issues for Active Debris Removal*, CROSSLINK, Fall 2015, at 50, http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/crosslink/Crosslink_Fall_2015.pdf.

14. See Debra Werner, *NASA’s Interest in Removal of Orbital Debris Limited to Tech Demos*, SPACENEWS (June 22, 2015), <http://spacenews.com/nasas-interest-in-removal-of-orbital-debris-limited-to-tech-demos> (discussing the plans developed by Tethers Unlimited, Busek Co., and MMA Design, which aim to reduce the amount of space debris).

15. Danielle Venton, *The Mad Plan to Clean up Space Junk with a Laser Cannon*, WIRED (May 12, 2015, 8:00 AM), <http://www.wired.com/2015/05/laser-cannon-space-debris>.

16. See Leonard David, *Space Junk Menace: How to Deal with Orbital Debris*, SPACE.COM (Jan. 25, 2013, 12:03 PM), www.space.com/19445-space-junk-threat-orbital-debris-cleanup.html (noting that several possible solutions to the space debris problem have been suggested, including fishing nets).

17. Andrew McKirdy, *Company Aiming to Clear Space Junk Wins Funding*, JAPAN TIMES (Mar. 1, 2016), <http://www.japantimes.co.jp/news/2016/03/01/national/science-health/company-aiming-clear-space-junk-wins-funding/#.V6frMZODGko>.

legal framework frustrates these efforts.¹⁸ As companies and nations seek to take possession of or destroy orbital satellites and debris, the question of property and ownership rights lingers. While remediation efforts generally have broad support, private companies and countries still may not have the legal right to destroy objects in orbit due to a lack of ownership.¹⁹ There is the option for companies to undergo an ownership transfer process, but doing so could be oppressively expensive, remarkably inconvenient, or exceedingly time consuming.²⁰ Consequently, property law could make remediation efforts impractical and hinder cleanup efforts if a company must seek to transfer ownership of every satellite and piece of debris before taking remediation action.²¹

This Comment addresses the legal issues surrounding space satellite and debris removal by exploring the opportunities and limits property law imposes on companies seeking to conduct ADR. This Comment also describes the specific remediation actions companies can take in

18. See Jakhu, *supra* note 9, at 97 (suggesting that nations are unwilling to adopt a comprehensive set of legal rules pertaining to space as the rules might restrict their freedom to act); see also Nina Tannenwald, *Law Versus Power on the High Frontier: The Case for a Rule-Based Regime for Outer Space*, 29 YALE J. INT'L L. 363, 363–64 (2004) (discussing the “fragmented” space law regime and finding it insufficient to address the challenges arising from an increased use of space).

19. See Sorge & Peterson, *supra* note 12, at 50 (opining that difficulties related to ownership and the use of ADR are compounded by debris that is too small to identify an owner).

20. While the transfer of ownership in satellites is becoming more commonplace, buyers and sellers can run into problems that hinder the ease of the transfer. Michael Chatzipanagiotis, *Registration of Space Objects and Transfer of Ownership in Orbit*, 56 GERMAN J. AIR & SPACE L. 229, 229 (2007). Even though ownership may transfer, the country from which the satellite is launched still retains liability from any damage the satellite causes. 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, 89 (2005). Due to this fact, some countries may block the sale or put restrictions on the transfer of ownership. See *id.* at 90 (detailing how governments want to hold new owners accountable to the same rules as original owners for reimbursement of damages from claims involving the satellite). Further, satellites can reach exorbitant prices, which limits who can purchase and participate in the satellite marketplace. Compare Christie Smythe, *Judge OKs Dish's \$1.4B Buy of Bankrupt TerreStar*, LAW360 (July 7, 2011, 5:10 PM), <https://www.law360.com/articles/256494/judge-oks-dish-s-1-4b-buy-of-bankrupt-terrestar> (reporting a bankruptcy judge's decision to allow Dish Network Corp. to purchase TerreStar-1 satellite for almost \$1.4 billion contingent on the Federal Communications Commission approving the sale), with Ki Mae Heussner, *Satellite for Sale: Buy It, Bring Web to the Developing World*, ABC NEWS (Dec. 3, 2010), <http://abcnews.go.com/Technology/buy-satellite-bring-web-access-developing-world/story?id=12298086> (describing non-profit ahumanright.org's campaign to raise \$150,000 to purchase TerreStar-1 so the satellite could be used to bring Internet to developing areas).

21. See Sorge & Peterson, *supra* note 12, at 50–51.

accordance with property law's doctrine of abandonment. These available actions are critical knowledge because, on the one hand, investors want to know the hurdles facing remediation companies so that they can understand how a company may conduct remediation legally and profitably.²² On the other hand, companies that own satellites in orbit need assurance that these remediation organizations cannot arbitrarily take possession of their property. These companies want safeguards to protect their property. Clarification of property rights for objects in orbit is thus critical to easing the way for successful remediation.

Part I of this Comment details the current practices in post-mission satellites.²³ It explains and addresses both Geosynchronous Earth Orbit and Low Earth Orbit, which are two regions in space where satellites are common. Section I.A begins with an overview of procedures that agencies, both domestic and international, advise owners to take once satellites complete their missions. Section I.B details U.S. statutes and regulations that require post-mission orbital debris procedures.

Part II examines the current law that governs property in outer space, assessing the international conventions currently in place and evaluating whether courts could apply U.S. domestic law in outer space.²⁴ Part II also discusses when satellites qualify as abandoned for the purposes of ADR by establishing the elements of abandoned property and applying the abandonment analysis to satellites and orbital debris in four common post-mission scenarios.²⁵

Part III concludes that because of the lack of a well-developed legal regime pertaining to outer space, companies can, in certain circumstances, strategically use the doctrine of abandonment to capture or destroy post-mission satellites and orbital debris.²⁶ When owners fail to move post-mission satellites into a disposal orbit, the satellites qualify as abandoned property and can therefore be captured. However, when owners take the prescribed steps to move post-mission satellites to a disposal orbit, those seeking to capture the satellites would need to perform case-by-case abandonment analysis

22. See DAVE BAIOCCHI & WILLIAM WELSER IV, *CONFRONTING SPACE DEBRIS: STRATEGIES AND WARNINGS FROM COMPARABLE EXAMPLES INCLUDING DEEPWATER HORIZON* 62–63 (2010) (suggesting that the lack of investment in debris remediation results from the current investor view that debris is an acceptable risk, with the cost of remediation being greater than shareholder value received from less debris).

23. See *infra* Part I.

24. See *infra* Part II.

25. See *infra* Part II.

26. See *infra* Part III.

before attempting any remediation action because owners likely have not abandoned the satellites. While post-mission satellites can be analyzed through the doctrine of abandonment, orbital debris does not easily fit into the abandonment analysis and cannot be reduced through abandonment and capture.

I. CURRENT PRACTICE REGARDING POST-MISSION SATELLITES

In 1995, the National Aeronautics and Space Administration (NASA) was the first space agency to produce a comprehensive set of guidelines addressing post-mission satellites and orbital debris mitigation.²⁷ Orbital debris mitigation involves “[a]ll legal, regulatory, technical, and other efforts to reduce debris in space and to make space activities more sustainable.”²⁸ Following NASA’s lead, the Inter-Agency Space Debris Coordination Committee (IADC) created its own technical post-mission guidelines dedicated to slowing the growth of orbital debris.²⁹ Drafters of the IADC guidelines presented their recommendations to the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) Scientific & Technical Subcommittee where the guidelines became the basis for the Space Debris Mitigation Guidelines, which the United Nations (UN) endorsed.³⁰ Together, the NASA and IADC guidelines include the procedures satellite owners should follow to prevent orbital debris before, during, and after a mission.³¹

27. NASA HANDBOOK, *supra* note 2, at 155; *see also* Int’l Ass’n for Advancement of Space Safety & Int’l Space Safety Found., *Space Debris Mitigation*, SPACE SAFETY MAG. (2014), <http://www.spacesafetymagazine.com/space-debris/mitigation> [hereinafter IAASS] (noting that after NASA introduced its guidelines, other countries followed suit and issued their own guidelines).

28. SPACE LAW TERMS, *supra* note 1, at 116.

29. *See* IAASS, *supra* note 27. *See generally* INTER-AGENCY SPACE DEBRIS COORDINATION COMM., IADC SPACE DEBRIS MITIGATION GUIDELINES 4 (2007) [hereinafter IADC GUIDELINES], http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf (stating that the common principles behind the Guidelines are the prevention of break-ups in orbit, the recovery of post-mission equipment, and the limitation of objects satellites release during normal operation). The IADC is an international forum where governmental organizations come together to coordinate activities related to space debris; for example, NASA is a member of the IADC. *Id.*

30. *See* IAASS, *supra* note 27; U.N. OFFICE FOR OUTER SPACE AFFAIRS, SPACE DEBRIS MITIGATION GUIDELINES OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE 1–2 (2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf (acknowledging that the IADC submitted their guidelines to the UNCOPUOS).

31. *See* discussion *infra* Sections I.A.1–2.

In the United States, President Obama further sought to mitigate orbital debris through the National Space Policy he introduced in 2010.³² The policy advocated for the United States to incorporate industry and international standards and guidelines into U.S. efforts to mitigate orbital debris from post-mission satellites.³³ Accordingly, Congress promulgated statutes incorporating the NASA and IADC post-mission procedures into domestic law.³⁴

A. *Post-Mission Satellite Guidelines*

Satellites reside in two primary orbital regions: the Geosynchronous Earth Orbit (GEO) and the Low Earth Orbit (LEO).³⁵ These two regions are oriented at different distances from the Earth—the GEO is the farther region and the LEO is the closer region to Earth.³⁶ The distance differential determines the speed at which satellites orbit the Earth.³⁷ A satellite's purpose and the speed at which it needs to orbit the Earth determines which region, GEO or LEO, it will occupy.³⁸

Because both the GEO and LEO are important for carrying out space activities, both the NASA Handbook for Limiting Orbital Debris and the IADC Space Debris Mitigation Guidelines qualify the areas as

32. See EXEC. OFFICE OF THE PRESIDENT, NATIONAL SPACE POL'Y OF THE UNITED STATES 7–8 (2010), https://www.faa.gov/about/office_org/headquarters_offices/ast/national_space_policy/media/national_space_policy.pdf.

33. *Id.* (emphasizing that the U.S. should promote the use, maintenance, and defense of outer space).

34. See *infra* Section I.B.

35. Elizabeth Howell, *What Is a Geosynchronous Orbit?*, SPACE.COM (Apr. 24, 2015, 7:31 PM), <http://www.space.com/29222-geosynchronous-orbit.html>. Satellites also occupy a third orbital region: the Medium Earth Orbit (MEO). Holli Riebeek, *Catalog of Earth Satellite Orbits*, EARTH OBSERVATORY (Sept. 4, 2009), <http://earthobservatory.nasa.gov/Features/OrbitsCatalog>. The MEO primarily houses satellites used for navigation purposes, like the U.S. Global Positioning System (GPS) satellites and satellites to facilitate communications in the far northern and southern regions of the Earth. *Id.* Because the MEO is such a large region, it is not as crowded as the GEO or LEO and therefore warrants fewer concerns about the production of orbital debris. Peter B. de Selding, *Overcrowding Not a Problem in Vast Medium Earth Orbit*, SPACENEWS.COM (Oct. 11, 2010), <http://spacenews.com/overcrowding-not-problem-vast-medium-earth-orbit>. For this reason, this Comment will not include further analysis of the MEO region.

36. Riebeek, *supra* note 35 (stating that the GEO distance from Earth is greater than 35,780 kilometers and the LEO distance is between 180 and 2000 kilometers).

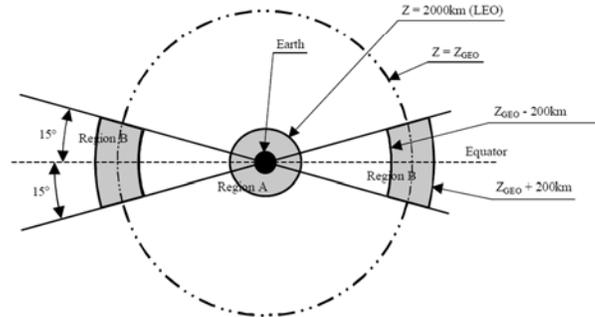
37. *Id.*

38. See *id.* (discussing how a satellite's speed is determined by how far the satellite is from the Earth); discussion *infra* Sections II.A.1–2.

protected regions.³⁹ As such, each region has its own set of proposed special protective measures pertaining to the generation of orbital debris.⁴⁰ The diagram below shows the parameters for both the GEO and LEO regions.

*Figure 1: GEO and LEO Region Parameters*⁴¹

- (1) Region A, **Low Earth Orbit** (or LEO) Region – spherical region that extends from the Earth's surface up to an altitude (Z) of 2,000 km
- (2) Region B, the **Geosynchronous Region** - a segment of the spherical shell defined by the following:
- lower altitude = geostationary altitude minus 200 km
 - upper altitude = geostationary altitude plus 200 km
 - 15 degrees \leq latitude \leq +15 degrees
 - geostationary altitude (Z_{GEO}) = 35,786 km (the altitude of the geostationary Earth orbit)



1. Geosynchronous Earth Orbit⁴²

The GEO is a high earth orbit allowing satellites to match the Earth's rotation.⁴³ Satellites in this region orbit at the same speed as the Earth, allowing the satellite to stay in place.⁴⁴ The GEO primarily houses

39. See, e.g., IADC GUIDELINES, *supra* note 29, at 6 (noting that “[t]hese regions should be protected regions with regard to the generation of space debris”); NASA HANDBOOK, *supra* note 8, at 24–25 (tracing the history of U.S. presidents recognizing the need to mitigate orbital debris).

40. *Id.*

41. *Id.*

42. The technical definition of the GEO is “[a]n orbit with a period equal to the sidereal day. A circular GEO with 0° inclination is a geostationary orbit; i.e., the nadir point is fixed on the Earth's surface. The normal altitude of a circular GEO is 35,786 km and the inclination is normally ± 15 degrees latitude.” NASA HANDBOOK, *supra* note 2, at 20.

43. See *supra* notes 35–36 and accompanying text (describing the differences between the GEO and LEO).

44. See *Three Classes of Orbit*, EARTH OBSERVATORY, <http://earthobservatory.nasa.gov/Features/OrbitsCatalog/page2.php> (last visited

weather, surveillance, and communications satellites.⁴⁵ Once satellites in the GEO have terminated their mission, they should maneuver into an orbit outside of the GEO region so as not to interfere with active satellites.⁴⁶

The IADC guidelines created a formula for determining a specific location to place post-mission satellites.⁴⁷ This formula concluded that post-mission satellites should boost themselves approximately 300 kilometers above or below the GEO protected region.⁴⁸ U.S. agencies have adopted this formula and have integrated it into their own guidelines and recommendations.⁴⁹

2. *Low Earth Orbit*⁵⁰

Satellites in the LEO region orbit Earth multiple times each day, seeing different regions of Earth at different times.⁵¹ Satellites in this region are generally scientific or weather satellites, including the International Space Station, the Hubble Space Telescope, and the Tropical Rainfall Measuring Mission satellite.⁵²

Balancing the need for extensive use of the LEO region with the growing concern about orbital debris buildup in that region, agencies began promulgating instructions for removal of nonfunctioning satellites to decrease debris production. In its 1995 guidelines, NASA provided the initial procedures for post-mission satellites in the LEO

Aug. 30, 2017) [hereinafter EARTH OBSERVATORY] (stating that since the satellite stays in place, it is always over the same place on Earth's surface).

45. See *id.*; Luke Punnakanta, Note, *Space Torts: Applying Nuisance and Negligence to Orbital Debris*, 86 S. CALIF. L. REV. 163, 168 (2012).

46. IADC GUIDELINES, *supra* note 29, at 9.

47. *Id.*

48. *Id.* The IADC formula includes two conditions: (1) the area on the satellite closest to earth should increase its altitude a minimum of $235 \text{ km} + (1000 \cdot C_R \cdot A/m)$, and (2) the eccentricity should be less than or equal to 0.003. *Id.*

49. The Federal Communications Commission (FCC) now requires that all satellites seeking an FCC license comply with the IADC formula and disposal recommendations. *Mitigation of Orbital Debris*, 19 FCC Rcd. 11,567, 11,595 (2004). NASA guidelines follow this same determination and suggest that post-mission satellites be placed 300 kilometers above the GEO region. NASA HANDBOOK, *supra* note 2, at 152.

50. The technical definition of LEO is “[a]n orbit with a mean altitude less than or equal to 2000 km, or equivalently, an orbit with a period less than or equal to 127 minutes.” NASA HANDBOOK, *supra* note 2, at 21.

51. See Howell, *supra* note 35. During a twenty-four-hour period, satellites in this region observe most of the Earth both in daylight and darkness. EARTH OBSERVATORY, *supra* note 44.

52. *Id.* But see Punnakanta, *supra* note 45, at 168 (submitting that the LEO is increasingly being used for cell phone and other telecommunication satellites).

region.⁵³ NASA set out three options to ensure removal of satellites from the LEO region within twenty-five years after their mission: (1) controlled or uncontrolled atmospheric reentry; (2) transfer to a disposal orbit; or (3) retrieval.⁵⁴ Differing slightly, the IADC established that a spacecraft in the LEO region should immediately reenter upon completion of its mission or should remain in an orbit where the atmospheric drag will cause the object to reenter earth's atmosphere after twenty-five years.⁵⁵ As with the IADC's guidance for the GEO region, some U.S. agencies have adopted the IADC guidelines for their own use.⁵⁶

Within the LEO region, post-mission guidelines focus on reentry, or de-orbiting,⁵⁷ which is a satellite or space object's exit from the LEO region and return to earth.⁵⁸ Minimizing the amount of nonfunctional satellites and pieces of debris left in the LEO region is critical to controlling the continuous growth of orbital debris.⁵⁹ Most often, the pieces of orbital debris that reenter burn up in the atmosphere before

53. See NASA HANDBOOK, *supra* note 2, at 151 (adopting these rules because they limit the time objects spend in the LEO and the risk of object collision or explosion). Since objects launched before implementation of this rule were grandfathered in, this rule now applies to only fifteen percent of the objects currently in the LEO with lifespans longer than twenty-five years because that is the percentage of objects in the LEO launched after 1995. *Id.*

54. See NICHOLAS L. JOHNSON, THE DISPOSAL OF SPACECRAFT AND LAUNCH VEHICLE STAGES IN LOW EARTH ORBIT 3 (2007), <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070021588.pdf>; NASA HANDBOOK, *supra* note 2, at 154.

55. IADC GUIDELINES, *supra* note 29, at 9–10. Both organizations suggest satellites reenter twenty-five years post-mission based on scientific studies looking at the effect of different time limits on the growth in orbital debris accumulation and collision rate. *Id.* at 9.

56. The FCC has adopted the IADC guidelines and will look at license applications on a case-by-case basis to make sure satellites will perform one of the two post-mission options. *Mitigation of Orbital Debris*, 19 FCC Rcd. 11,567, 11,602–03 (2004).

57. See Sorge et al., *supra* note 3, at 56; see also JOHNSON, *supra* note 54, at 3 (finding that of the three removal options, compliance is generally performed through uncontrolled atmospheric reentry of a satellite).

58. See R. JANOVSky ET AL., END-OF-LIFE DE-ORBITING STRATEGIES FOR SATELLITES 2–3 (2002), <http://www.dlr.de/Portaldata/55/Resources/dokumente/sart/dglr-2002-028.pdf> (identifying different methods for de-orbiting a satellite).

59. See Sorge et al., *supra* note 3, at 53. NASA experts conducted a study in 2006 and found that even if no more satellites were launched, the amount of orbital debris would continue to increase because of collisions between existing objects in space. Stefan Lovgren, *Space Junk Cleanup Needed, NASA Experts Warn*, NAT'L GEOGRAPHIC (Jan. 19, 2006), http://news.nationalgeographic.com/news/2006/01/0119_060119_space_junk.html.

reaching Earth's surface.⁶⁰ Nonetheless, the amount of orbital debris is increasing. Functioning satellites and small pieces of debris are colliding, causing fragmentation or explosions.⁶¹ Both U.S. and international agencies have focused remediation efforts on successful reentry to remove bits of space objects from orbit, lessening collisions, reducing debris creation, and improving the safety of future space missions.⁶²

B. U.S. Space Debris Remediation and Mitigation Requirements

Congress embraced both the NASA and IADC guidelines for orbital debris mitigation by integrating parts of each into statutes and regulations that control domestic activities in outer space.⁶³ Within these laws, Congress dictates procedures for disposing of post-mission satellites. Additionally, Congress requires companies to outline the actions they will take to prevent post-mission orbital debris creation before companies can receive licenses to boost satellites into orbit.⁶⁴ While laws surrounding remediation and mitigation are still in development, Congress's initial foray to support these efforts establishes previously suggested guidelines as law and sets out an adequate, preliminary means of addressing orbital debris.

1. Statutes

Two statutes guide post-mission procedures and orbital debris remediation.⁶⁵ Within Title 51, which governs national and commercial space programs, § 31501 gives general authorization to the

60. See Redd, *supra* note 4 (comparing smaller pieces of debris that generally completely disappear upon reentry with larger pieces of debris, around four inches, that often remain intact in some form and reach the Earth's surface). Any pieces that reach the Earth's surface regularly land harmlessly in unpopulated areas, such as Siberia, the Australian Outback, or the oceans. NASA HANDBOOK, *supra* note 2, at 160.

61. See David, *supra* note 5 (recounting the views of Marshall Kaplan, founder of Launchspace, on the origins of the rising amount of space debris).

62. See Sorge et al., *supra* note 3, at 53; see also NASA HANDBOOK, *supra* note 2, at 160 (noting the balance between encouraging reentry and protecting people on the ground from the risk to life and property from falling debris). Although one piece of debris a day has reentered Earth's atmosphere over the last forty years, averaging around 200,000 pounds of space debris returning to Earth each year, only one person has been struck by falling space debris, and no deaths or serious injuries have occurred because of falling debris. *Id.*

63. See discussion *infra* Sections I.B.1-2.

64. See discussion *infra* Sections I.B.1-2.

65. See 51 U.S.C. § 31501 (2012); 42 U.S.C. § 18441(a); see also 156 CONG. REC. 17,1334 (2010) (statement of Rep. Lee) (expressing support for the reauthorization of NASA so the agency can carry out its statutory duties, help achieve the goals of the National Science Policy, and make the U.S. space program more sustainable).

NASA Administrator for development or acquisition of technologies that will assist in the decrease of orbital debris risks.⁶⁶ However, the emphasis on the words “develop” and “acquire” within the statute limits its usefulness because the statute does not provide for further testing or use once NASA develops or acquires the technology.⁶⁷

The second statute, 42 U.S.C. § 18441, recognizes the need for both a national and international effort to develop an approach to orbital debris remediation.⁶⁸ The statute also recognizes the IADC guidelines as the general agreement of ten national space agencies—including NASA—on the need to halt orbital debris creation and on the best measures to mitigate further debris.⁶⁹ Congress also directs NASA to continue its robust participation in the IADC and asks NASA to urge other domestic agencies to cooperate with international counterparts to conform to these guidelines, showing the United States’ commitment to orbital debris mitigation.⁷⁰

2. *Regulations and policies*

In light of congressional efforts to remedy orbital debris, federal agencies have created regulations that require satellite operators to mitigate post-mission orbital debris and perform end-of-life satellite disposal.⁷¹ For example, the Federal Communications Commission

66. 51 U.S.C. § 31501.

67. See Werner, *supra* note 14 (examining the impact of NASA’s policy supporting the development of technology that removes orbital debris but failing to provide further funding for in-flight demonstrations). With only a directive and no additional funding, NASA does not want to be identified as a “space garbage collector,” which would require it taking on a large responsibility without the necessary budget to support such activities. *Id.*

68. 42 U.S.C. § 18441(a)(1). The Senate Committee drafting this section directed the Office of Science and Technology Policy to work with the National Security Council to prepare a strategy and recommendation for international collaboration on orbital debris prevention and mitigation. See S. REP. NO. 111-278, at 20 (2010). These recommendations would subsequently be presented to the President for review. *Id.*; see also § 18441(b)(2) (codifying this requirement).

69. § 18441(a)(2).

70. *Id.* Congress recommends three key approaches that agencies can use to show commitment to orbital debris mitigation, including (1) the development of debris prevention agreements; (2) the establishment of a Space Situational Awareness network that identifies potential collisions and provides information to enable avoidance maneuvers; and (3) the enactment of an interagency proposal, for Presidential review, presenting possible international collaboration efforts. § 18441(a)(3).

71. See 47 C.F.R. § 25.114 (2016) (discussing the requirements for debris mitigation as part of space station authorization applications); see also Howard A. Baker, *Space Debris: Law and Policy in the United States*, 60 U. COLO. L. REV. 55, 73 (1989)

(FCC) established a set of regulations that all applicants must follow to receive a license for a communications satellite.⁷² Applicants must provide the designs and strategies they will use to prevent any post-mission orbital debris from their satellite.⁷³ The regulations also articulate certain satellite disclosure requirements specific to the GEO and LEO regions.⁷⁴ For applicants with satellites in the GEO, the FCC sets out a formula for determining the orbit where post-mission satellites can reside.⁷⁵ Similarly, the Federal Aviation Administration (FAA) requires operators to submit written launch plans that include a flight safety plan detailing end-of-life debris dispersion data.⁷⁶

While some agencies have not proposed any formal regulations, they have developed internal policies governing the creation of orbital debris. For instance, the Department of Defense (DoD) published Directive 3100.10 requiring the DoD to follow the U.S. Orbital Debris

(explaining NASA's emphasis for other national agencies, such as the Department of State and the Department of Transportation, to share information with other nations and to cooperate to resolve the space debris problem).

72. *Id.* (detailing what an application must include before the FCC will authorize a communication satellite for use in space).

73. § 25.114(d)(14)(i)–(iv). The regulations require four different statements pertaining to post-mission plans. *Id.* First, there must be a statement that the operator has limited the satellite's potential to be a source of debris from collisions with small debris or meteoroids. § 25.114(d)(14)(i). Second, there must be a statement and demonstration that, post-mission, the satellite will not accidentally explode because of retained fuel on the spacecraft. § 25.114(d)(14)(ii). Third, there must be a statement that the operator has limited the possibility of the satellite colliding with large debris or other satellites post-mission. § 25.114(d)(14)(iii). Fourth, there must be a statement detailing the specific post-mission disposal plans for the satellite at the end of its life. § 25.114(d)(14)(iv).

74. § 25.114(d)(14)(iii)–(iv). For satellites in the GEO, the statement must specifically lay out the altitude selected for the post-mission disposal orbit, clarifying the calculations used to arrive at this altitude. § 25.114(d)(14)(iv). For satellites in the LEO, the statement must include the anticipated evolution of the post-mission orbit as the satellite is gradually pulled into the Earth's atmosphere. § 25.114(d)(14)(iii). If the plan involves atmospheric reentry, the post-mission plan must present the operator's casualty risk assessment that provides an estimate of which portions of the satellite might survive re-entry to reach the Earth's surface and what the resulting human casualty rate could be. § 25.114(d)(14)(iv).

75. § 25.283(a) ("Unless otherwise explicitly specified in an authorization, a space station authorized to operate in the geostationary satellite orbit under this part shall be relocated, at the end of its useful life . . . to an orbit with a perigee with an altitude of no less than: $36,021 \text{ km} + (1000 \cdot C_{R-A}/m)$.").

76. 14 C.F.R. § 417.111(b)(4) (2017); *see also* § 417.129 (requiring no debris be generated from energy conversion at the end of a launch and all remaining stored energy be depleted, which prevents possible explosion of the launch vehicle).

Mitigation Standard Practices.⁷⁷ In addition, the National Environmental Satellite, Data, and Information Service (NESDIS) Office of Satellite and Product Operations—which the National Oceanic and Atmospheric Administration (NOAA) created to oversee the operation of environmental satellites—published a policy for the decommissioning and disposal of NOAA satellites.⁷⁸ Under this policy, NESDIS states that NOAA satellites should be decommissioned and disposed of in accordance with NASA’s Procedural Requirement for Limiting Orbital Debris.⁷⁹

II. CURRENT LAW GOVERNING PROPERTY IN SPACE

Determining which laws apply and govern objects in space is the first step to establishing whether owners have abandoned satellites. Generally, space law includes both international and domestic systems of regulation that address activities in outer space.⁸⁰ Section II.A discusses how formalized treaties define the international consensus about the scope of State-participants’ conduct in space.⁸¹ Since property laws are inherently domestic, Section II.B examines whether U.S. law is applicable to activities in outer space. Because a limited number of U.S. cases deal with outer space issues, domestic courts have yet to establish sufficient precedent concerning application of U.S. laws in outer space.⁸² So, U.S. law may apply if the law applies extraterritorially.⁸³ In the narrow instance of the United States

77. Dep’t of Def. Directive 3100.10, Space Policy (2012), http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodd/310010_dodd_2012.pdf; U.S. Government Orbital Debris Mitigation Standard Practices, NASA, https://www.orbitaldebris.jsc.nasa.gov/library/usg_od_standard_practices.pdf (last visited Aug. 30, 2017).

78. NAT’L ENVTL. SATELLITE, DATA, & INFO. SERV., SATELLITE DECOMMISSIONING AND DISPOSAL POLICY (June 2013), https://www.nesdis.noaa.gov/sites/default/files/asset/document/completed_wdf_13-031300_nesdis_satellite_decommissioning_and_disposal_policy.pdf.

79. *Id.* at 6–7, 9; NASA, NASA PROCEDURAL REQUIREMENTS FOR LIMITING ORBITAL DEBRIS (May 14, 2009), https://www.orbitaldebris.jsc.nasa.gov/library/npr_8715_006a.pdf.

80. *Space Law: Did You Know?*, U.N. OFFICE FOR OUTER SPACE AFFAIRS, <http://www.unoosa.org/oosa/en/informationfor/faqs.html> (last visited Aug. 30, 2017).

81. *See infra* Section II.A.

82. Brian Abrams, Note, *First Contact: Establishing Jurisdiction over Activities in Outer Space*, 42 GA. J. INT’L & COMP. L. 797, 808 (2014) (expressing that there have not been many lawsuits because the commercialization of outer space activities is still in its infancy).

83. Franklin A. Gevurtz, *Determining Extraterritoriality*, 56 WM. & MARY L. REV. 341, 347–50 (2014) (providing a history of the principle of extraterritoriality in U.S. case law). Extraterritorially is enforcing domestic law beyond a nation’s borders. *E.g.*, Jeffrey A. Meyer, *Dual Illegality and Geoambiguous Law: A New Rule for Extraterritorial*

applying domestic laws to its own citizens outside of its borders, U.S. law governs if no other nation's or individual's rights are infringed.⁸⁴ Finally, Section II.C explores the elements of one specific set of U.S. laws—the doctrine of abandoned property.

A. *International Law on Jurisdiction and Property in Outer Space*

International law pertains to how sovereign nations or multinational private entities interact with one another and reflects the laws, treaties, and customs that many legal entities worldwide recognize and follow.⁸⁵ Additionally, international law addresses concerns regarding security, exploration, war, and peace.⁸⁶

The international legal framework pertaining to activities in outer space consists primarily of four international agreements: (1) the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty);⁸⁷ (2) the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Treaty);⁸⁸ (3) the Convention on the Registration of Objects Launched into Outer Space (Registration Convention);⁸⁹ and (4) the Convention on International Liability for Damage Caused by Space Objects (Liability Convention).⁹⁰ The Registration Convention and the Outer Space Treaty provide the most guidance on satellite ownership.⁹¹

Application of U.S. Law, 95 MINN. L. REV. 110, 111–12 (2010) (discussing the United States' struggle to exert jurisdiction over other States while simultaneously avoiding extraterritorial jurisdiction being exerted over it).

84. See *infra* Section III.B.

85. See Harlan Grant Cohen, *Finding International Law: Rethinking the Doctrine of Sources*, 93 IOWA L. REV. 65, 69 (2007) (discussing the traditional sources of international law); KELLY VINOPAL, RESEARCHING PUBLIC INTERNATIONAL LAW 3–4 (2015) (defining international law “as the law between sovereign nation-states”).

86. VINOPAL, *supra* note 85, at 3.

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

88. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 21 [hereinafter Moon Treaty].

89. Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

90. Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

91. These two treaties directly address jurisdiction, control, and ownership over objects in outer space. See JOYEETA CHATTERJEE, LEGAL ISSUES RELATING TO UNAUTHORISED SPACE DEBRIS REMEDIATION 6–7 (2014). The Moon Treaty, on the other hand, does not address ownership or property rights in satellites but addresses activities dealing with the Moon and other natural celestial bodies, which are outside

Pursuant to the Registration Convention, each spacefaring nation must maintain a registry of the objects it launches into outer space, and all objects a nation or company launches into outer space must appear on one of these national registries.⁹² Individual States must report to the UN on “the nature, conduct, locations[,] and results of [outer space] activities.”⁹³ As changes occur in the status or orbit of a space object, the Convention encourages, but does not require, nations to report those changes to the UN;⁹⁴ however, nations must update the UN if a previously reported space object is no longer in orbit.⁹⁵

Even though a satellite appears on a State’s registry, the private owner retains his property rights in the satellite.⁹⁶ 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.”⁹⁷ Jurisdiction and control function together

the scope of this comment. *See generally* Moon Treaty, *supra* note 88. Additionally, the international community does not widely accept the Moon Treaty, so its influence is limited. *See* David Johnson, Comment, *Limits on the Giant Leap for Mankind: Legal Ambiguities of Extraterrestrial Resource Extraction*, 26 AM. U. INT’L L. REV. 1477, 1487 (2011) (noting that the Moon Treaty “has failed to receive much support, so it is not considered a binding element of international space law”). Similarly, the Liability Convention presupposes actors involved know the ownership and jurisdiction that space objects fall under and thus provides guidance on remedies for when disputes arise. *See generally* Liability Convention, *supra* note 90.

92. Registration Convention, *supra* note 89, art. II. As ventures become more internationally collaborative, the idea that the launching State is the State of registry begins to break down as entities pick and choose preferred registries for the purposes of jurisdiction and control. *See* CHATTERJEE, *supra* note 91, at 7 (setting out that a State whose citizen owns a satellite has a greater interest in jurisdiction and control and will want to be the registry State, as opposed to the State who simply governs the area from which the launch occurs). For instance, the Orion-1 satellite appears on the United Kingdom (U.K.) Registry but was launched from Cape Canaveral in the United States. *Registry of Space Objects*, GIBRALTAR REG. AUTHORITY, <http://www.gra.gi/satellite/registry-of-space-objects> (last visited Aug. 30, 2017) [hereinafter U.K. Space Object Registry].

93. Outer Space Treaty, *supra* note 87, art. XI. Under the Registration Convention, this information includes: “(a) name of launching State or States; (b) an appropriate designator of the space object or its registration number; (c) date and territory or location of launch; (d) basic orbital parameters . . . ; (e) general function of the space object.” Registration Convention, *supra* note 89, art. IV.1. As these reporting requirements apply to all space objects on a State’s registry, the State must report on both government-owned and private-owned satellites. *Id.*

94. *See id.* art. IV.2.

95. *Id.* art. IV.3.

96. *See* CHATTERJEE, *supra* note 91, at 8.

97. Outer Space Treaty, *supra* note 87, art. VIII.

and fall under a singular definition.⁹⁸ Furthermore, the Treaty establishes that the mere fact that an individual launches an object into space does not impact his ownership.⁹⁹ For example, Planet, a firm based in San Francisco, has the greatest number of privately owned satellites with sixty, and each satellite individually appears on a nation's registry.¹⁰⁰ Yet the satellite's location in outer space and its appearance on national registries does not change Planet's status as owner of the satellites.

B. Extension of U.S. Jurisdiction and Property Law to Outer Space

Space is a global commons.¹⁰¹ Because of this, choice of law challenges surface when nations try to apply ideas of sovereignty to objects in space.¹⁰² Because property rights are essentially expressions of sovereignty, questions arise as to whether governments can extend their property laws to objects in outer space.¹⁰³

98. See CHATTERJEE, *supra* note 91, at 7 (evaluating the argument that "jurisdiction and control" be given two separate definitions and finding that international space law uniformly considers the concepts together). The argument stems from jurisdiction being a passive action and control being an active action. See BESS C.M. REIJNEN, *THE UNITED NATIONS SPACE TREATIES ANALYSED* 118–19 (1992). However, taken together, the terms, as applied, mean the right of a State to control the conduct of natural and juridical individuals pursuant to defined rights, duties, and obligations, taking into account the rights of other States and responsibilities under international relations. See CHATTERJEE, *supra* note 91, at 7.

99. See Outer Space Treaty, *supra* note 87, art. VIII ("Ownership of objects launched into outer space, . . . and of their component parts, is not affected by their presence in outer space . . ."). Since the phrase about jurisdiction and control is separate from the phrase about ownership within the Article, these two concepts do not equate to one another. In other words, ownership is not jurisdiction and control, and jurisdiction and control is not ownership. See REIJNEN, *supra* note 98, at 120. The treaties provide no further clarification of ownership over satellites in outer space.

100. See Calla Cofield, *Rocket Lab Aims to Win Cubesat-Launching Race*, SPACE.COM (Oct. 13, 2016, 7:00 AM), <http://www.space.com/34364-rocket-lab-small-satellite-launch-race.html> (reporting that Planet hopes to maintain up to 150 satellites in orbit).

101. Jill Stuart, *Unbundling Sovereignty, Territory and the State in Outer Space: Two Approaches*, in *SECURING OUTER SPACE* 8, 10 (Natalie Bormann & Michael Sheehan eds., 2009) (defining global commons as areas that are transterritorial in which global citizens have a set amount of rights to the area). Other global commons include the high seas, air space, and Antarctica. *Id.*

102. See *id.* at 11; Bo Min Kim, *Governance of the Global Commons: The Deep Seabed, the Antarctic, Outer Space*, *WORLD ECON. UPDATE*, Aug. 22, 2014, at 1 (finding that because global commons are domains over which no nation exerts sovereignty, the lack of ability to establish exclusive property rights could lead to international conflicts).

103. *E.g.*, Charles A. Reich, *The New Property*, 73 *YALE L.J.* 733, 778 (1964) (explaining that property rights trace back to grants of title from sovereigns to individuals). While traditional property grants dealt with real property, personal property rights also originated from the government. *Id.* Since the law creates and

While not absolute, the Supreme Court has set forth a “presumption that Acts of Congress do not ordinarily apply outside [U.S.] borders.”¹⁰⁴ As a policy and political matter, this presumption against extraterritorial application of domestic law protects against international discord by preventing conflict of laws between the United States and other recognized sovereigns.¹⁰⁵ That being said, domestic law can apply to claims arising beyond U.S. territorial limits if the guiding statute unambiguously allows for application extraterritorially.¹⁰⁶ In that case, the extraterritorial application of U.S. law generally arises in either of two situations: when the conduct at issue occurred within the borders of another nation or when the conduct at issue caused damage to a foreign national.¹⁰⁷

However, the Supreme Court takes a different approach when dealing with acts performed in the global commons that do not infringe the rights of other nationals. For example, in *American Banana Co. v. United Fruit Co.*,¹⁰⁸ the Court held that in areas not subject to any nation’s law, nations may hold their own citizens accountable to their

sustains personal property, ownership then comes from rights fulfilling the requirements of the law. *Id.*

104. *Sale v. Haitian Ctrs. Council, Inc.*, 509 U.S. 155, 173 (1993) (applying the presumption against extraterritoriality to prevent application of the Immigration and Nationality Act to actions on the high seas); *see Smith v. United States*, 507 U.S. 197, 204 (1993) (holding that the presumption prevented application of the Federal Tort Claims Act to a claim arising in Antarctica); *Hughes Aircraft Co. v. United States*, 29 Fed. Cl. 197, 230 (1993) (recognizing that Congress did not extend patent infringement laws to apply extraterritorially). *But see Smith*, 507 U.S. at 205 (Stevens, J., dissenting) (comparing a potential tort claim from negligence in space to cases the Court decided regarding negligence on the “sovereignless high seas”).

105. *See Kiobel v. Royal Dutch Petroleum Co.*, 569 U.S. 108, 115 (2013) (cautioning courts from interfering with foreign policy, which is the proper role of the legislative and executive branches).

106. *Id.* at 118 (quoting *Morrison v. Nat’l Austl. Bank Ltd.*, 561 U.S. 247, 265 (2010)) (noting that such an interpretation would require a “clear indication of extraterritoriality”); *Morrison*, 561 U.S. at 255 (“When a statute gives no clear indication of an extraterritorial application, it has none.”); *see, e.g.*, 18 U.S.C. § 112 (2012) (“If the victim of [the criminal] offense . . . is an internationally protected person *outside the United States*, the United States may exercise jurisdiction over the offense if (1) the victim is a representative, officer, employee, or agent of the United States, (2) an offender is a national of the United States, or (3) an offender is afterwards found in the United States.” (emphasis added)).

107. *See e.g.*, *Sosa v. Alvarez-Machain*, 542 U.S. 692, 698 (2004) (arising from the kidnapping and transportation of a foreign national into the United States); *Cuba R.R. Co. v. Crosby*, 222 U.S. 473, 477 (1912) (arising due to an injury sustained by a U.S. citizen in Cuba).

108. 213 U.S. 347 (1909).

own domestic laws.¹⁰⁹ The Court further narrowed this holding in *Skiriotos v. Florida*,¹¹⁰ choosing to apply U.S. law on the high seas because the conduct at issue could not have damaged the rights of any other nation or any other nation's citizens.¹¹¹ Thus, domestic law governs the actions of U.S. citizens and controls any suits that may arise when actions in international areas do not invoke international law or create a conflict of laws problem between nations.¹¹²

C. *The Law of Abandonment of Property*

A very limited amount of legal writing focuses on abandoned property.¹¹³ However, available scholarship presents a simple definition on which to build a legal analysis.¹¹⁴ At the baseline, abandonment of property is the "unilateral" transfer of ownership.¹¹⁵ Generally, courts consider property abandoned when an owner has thrown away or

109. *Id.* at 355–56 (recognizing that the local laws of the foreign jurisdiction where the actions occurred were controlling). The Court affirmed the case dismissal and concluded that while the conspiracy was contrived in the United States and illegal under U.S. law, the actions were carried out in a foreign jurisdiction under whose local laws the actions were permitted. *Id.* at 359.

110. 313 U.S. 69 (1941).

111. *See id.* at 72–73 (finding, under these circumstances, that international law does not bar the United States from governing the conduct of its citizens). This case addressed a diver illegally collecting sponges on the high seas in violation of Florida statutory law. *Id.* at 69–70. Since his activities did not damage foreign nationals or impact the rights of foreign nations, no question of international law or the extent to which the United States could apply domestic law to the territory of other nations arose, so United States domestic law controlled. *Id.* at 72–73.

112. *But cf.* *Kiobel v. Royal Dutch Petroleum Co.*, 133 S. Ct. 1659, 1667 (2013) (noting that the court has repeatedly treated the high seas like foreign soil when addressing the presumption against extraterritorial application of U.S. domestic law).

113. *See* Lior Jacob Strahilevitz, *The Right to Abandon*, 158 U. PA. L. REV. 355, 358 (2010) (noting that writings investigating abandoned property focus on specific issues, such as shipwrecks, oil and gas interests, and rail lines). Additionally, leading property law casebooks fail to meaningfully address the topic of abandoned property. *See id.* at 358 n.9 (identifying property law casebooks that provide limited treatment of the topic or ignore the topic altogether).

114. *See id.* at 360; *see also* Eduardo M. Peñalver, *The Illusory Right to Abandon*, 109 MICH. L. REV. 191, 196 (2010) (discussing the deceptively simple hornbook definition).

115. *E.g.*, Strahilevitz, *supra* note 113, at 360 (deriving this definition of abandonment from what it does not include: the transfer of property to a third party who assumes ownership, such as a gift, sale, bequest, forfeiture, or foreclosure); *see also* *Bright v. Gineste*, 284 P.2d 839, 842 (Cal. Dist. Ct. App. 1955) (holding that abandonment cannot be directed at a particular individual, a transfer of property from one individual to another cannot happen through abandonment, and a relinquishment of property by one person to another is not abandonment).

voluntarily forsaken possession of an item.¹¹⁶ Abandoned property then “returns to the commons.”¹¹⁷ In other words, the original owner has no lingering responsibility toward the property, and the property is available for a first finder to capture and possess it.¹¹⁸

Because the Supreme Court has not granted certiorari to a case about abandonment of property that specifically articulates an appropriate test, legal scholars consider the New York Court of Appeal’s decision in *Foulke v. New York Consolidated Railroad*¹¹⁹ as the leading case for defining and distinguishing abandoned property.¹²⁰ *Foulke* defines abandonment of property as the unilateral “relinquishing of all title, possession, or claim to or of [the property].”¹²¹ Building on this established definition, case law sets out certain criteria owners must meet before property is abandoned. To abandon property, an owner must (1) perform a manifest act that (2) shows his or her intent to forsake the property, and (3) the action and intent must occur concurrently.¹²² These elements are conjunctive, meaning each individual element is necessary but not sufficient to prove abandonment on its own.¹²³

The first element of the abandoned property doctrine is that an owner must execute a manifest act. A “manifest act” is a physical act

116. See *Friedman v. Farmer*, 788 F.3d 862, 868 (8th Cir. 2015); see also *Bright*, 284 P.2d at 842 (“[T]o constitute an abandonment in the strict legal sense there must be a parting with title that is unilateral, the owner must leave the property free to the acquisition of whoever wishes to claim it, and indifferent as to what may become of it.”).

117. Peñalver, *supra* note 109, at 196.

118. *Id.*; see 1 AM. JUR. 2D *Abandoned, Lost, and Unclaimed Property to Adjoining Landowners* § 6 (2016) [hereinafter *Property Jurisprudence*] (clarifying that the abandoner has no interest in who takes over possession and ownership of the property).

119. 127 N.E. 237 (N.Y. 1920).

120. See R.H. Helmholz, *Equitable Division and the Law of Finders*, 52 FORDHAM L. REV. 313, 314 n.7 (1983); see also Comment, *Lost, Mislaid, and Abandoned Property*, 8 FORDHAM L. REV. 222, 233, 236 (1939) (using *Foulke* for an in-depth analysis of abandoned and mislaid property). *Foulke* distinguishes “abandoned property” from “lost property,” property whose owner involuntarily parted with possession of, and “mislaid property,” property whose owner thoughtfully and voluntarily placed in a specific location and subsequently forgotten. *Foulke*, 127 N.E. at 238.

121. *Foulke*, 127 N.E. at 238. This definition has also been accepted by the Second Circuit Court, see *United States v. Cowan*, 396 F.2d 83, 87 (2d Cir. 1968), and the Eighth Circuit Court, see *Friedman*, 788 F.3d at 868.

122. See *Lost, Mislaid, and Abandoned Property*, *supra* note 120, at 235; see also *Friedman*, 788 F.3d at 868 (applying these elements to determine ownership of equipment left exposed on business property).

123. See *Shammel v. Vogl*, 396 P.2d 103, 106 (Mont. 1964).

evidencing clear intent to relinquish property interests.¹²⁴ While courts may evince abandonment from singular acts or from a series of acts,¹²⁵ mere contemplation, discussion, or preliminary planning is insufficient to meet the manifest act standard.¹²⁶ For example, in *Botkin v. Kickapoo, Inc.*,¹²⁷ Kickapoo sold equipment to Botkin at a discounted price under the agreement that Botkin would remove the equipment from Kickapoo's warehouse within six months.¹²⁸ Three years after the purchase, Botkin still had not removed all the equipment from the warehouse.¹²⁹ During this three-year time, Botkin unsuccessfully attempted to sell the equipment, left the equipment open to vandals at the unlocked warehouse, allowed the equipment to deteriorate, and failed to remove equipment from property in a timely manner.¹³⁰ The Kansas Supreme Court held these deeds to be manifest actions satisfying the first element of abandonment.¹³¹

In performing a manifest act, the owner must also be aware of the effect of that action. In the case of *Prue v. Royer*,¹³² the Prues entered into a contract with Royer for the sale of a bar.¹³³ During an inspection from a state liquor inspector, the Prues were unable to produce the original contract with Royer, so the inspector informed the Prues they would have to stop operating the bar.¹³⁴ The Prues closed the bar, tendered their liquor license, and removed equipment from the premise under the assumption that the state inspector would shut down the bar imminently.¹³⁵ Additionally, the Prues were under the

124. See *Idaho v. Or. Short Line R.R. Co.*, 617 F. Supp. 213, 217 (D. Idaho 1985) (finding that discontinued use is not a manifest act evidencing abandonment); Property Jurisprudence, *supra* note 118, § 8; cf. *Hunt v. DePuy Orthopaedics, Inc.*, 729 F. Supp. 2d 231, 233 (D.D.C. 2010) (allowing the omission or failure to act as an acceptable reflection of the intent to abandon); *Prue v. Royer*, 67 A.3d 895, 908–10 (Vt. 2013) (upholding a determination that failure to pay did not equate to an act of abandonment).

125. E.g., *UMG Recordings, Inc. v. Augusto*, 558 F. Supp. 2d 1055, 1064 (C.D. Cal. 2008), *aff'd*, 628 F.3d 1175 (9th Cir. 2011).

126. See *Or. Short Line R.R. Co.*, 617 F. Supp. at 217 (determining that discussion and preliminary planning to abandon property are not manifest acts).

127. 505 P.2d 749 (Kan. 1973).

128. *Id.* at 751.

129. *Id.* at 751–52.

130. *Id.* at 753.

131. *Id.*

132. 67 A.3d 895 (Vt. 2013).

133. *Id.* at 899.

134. *Id.* at 901.

135. *Id.*; see also *Bennett v. Galindo*, No. 94-1101-PFK, 1994 WL 613429, at *7 (D. Kan. Oct. 24, 1994) (explaining that misunderstanding a written demand notice for failure to pay and surrendering keys to the premises do not amount to voluntary

impression that Royer would evict them due to their nonpayment and lack of required liability insurance.¹³⁶ The Supreme Court of Vermont found that the Prues did not comprehend “what the effect of leaving the property would be on their equitable interest.”¹³⁷ Since the Prues did not understand the effect of their actions, the Court found they had not abandoned their interest in the property.¹³⁸

To satisfy the second element of the abandoned property doctrine, an owner must intend a total desertion.¹³⁹ The owner’s intent to abandon must arise voluntarily without influence by “any necessity, duty, or utility.”¹⁴⁰ A court can infer this voluntary intent from “words spoken, acts done, and other objective facts.”¹⁴¹ For instance, in *Katsaris v. United States*,¹⁴² the Eleventh Circuit would not classify money seized during a drug raid as abandoned property just because the arrested suspects disclaimed ownership.¹⁴³ Because the suspects would want to separate themselves further from any incriminating evidence, the court did not consider their denial of ownership voluntary, without coercion, or without pressure.¹⁴⁴ Beyond this, an owner’s mere non-use of property or failure to maintain upkeep of property is not sufficient to prove an intent to abandon property.¹⁴⁵

abandonment because the recipients did not understand the consequences of their actions).

136. 67 A.3d at 901 (missing payments because of financial difficulties was not enough to show abandonment because the buyers had missed payments in the past without consequence).

137. *Id.* at 910.

138. *Id.*

139. *See Katsaris v. United States*, 684 F.2d 758, 762 (11th Cir. 1982) (explaining that the owner must simply no longer desire to possess the thing and willingly forsake it to whoever wishes to possess it); BARLOW BURKE, PERSONAL PROPERTY IN A NUTSHELL 151 (3d ed. 2003) (reasoning that abandoning property means an owner essentially throws away the item).

140. *Katsaris*, 684 F.2d at 762; *see Peñalver, supra* note 114, at 196 (finding voluntariness of abandonment a crucial element such that any evidence that an owner was defrauded or tricked will defeat a claim of abandonment); *see also Jackson v. United States*, 526 F.3d 394, 397 (8th Cir. 2008) (holding that property seized from an owner is not abandoned).

141. *United States v. Colbert*, 474 F.2d 174, 176 (5th Cir. 1973); *see also Peñalver, supra* note 114, at 196 (noting that generally observable acts expressing the owner’s desire to sever ownership accompany the intent to abandon).

142. 684 F.2d 758 (11th Cir. 1982).

143. *Id.* at 763.

144. *Id.* at 762.

145. *See Property Jurisprudence, supra* note 118, § 59 (explaining that while “nonuse or lapse of time does not, in itself, constitute abandonment,” great weight is given to non-use or time lapse to show intent to abandon when weighed against other facts); *see also King v. Bankerd*, 465 A.2d 1181, 1184 (Md. Ct. Spec. App. 1983) (finding the

Because intent is an essential element of abandonment, an owner must know of the existence of property to effectuate an abandonment.¹⁴⁶ The Eighth Circuit case, *Linscomb v. Goodyear Tire & Rubber Co.*,¹⁴⁷ clarifies this principle. Goodyear suffered a fire at its rented facility and salvaged as many tires as appeared merchantable.¹⁴⁸ Linscomb subsequently purchased the facility and found additional merchantable tires in the debris that Goodyear then claimed it still owned.¹⁴⁹ Upon review, the court found that Goodyear owned the tires and had not abandoned them—even though it had left the tires in the facility.¹⁵⁰ Goodyear did not have the “conscious purpose” to abandon the property because it did not know of the property’s existence.¹⁵¹

To satisfy the third element of abandonment, the voluntary act and intent must happen concurrently. Neither element alone is sufficient, and courts consider a number of factors when evaluating this final requirement.¹⁵² Waiting for a certain interval of time may be necessary to determine if the act and intent occurred concurrently.¹⁵³ In addition, a first finder’s offer of proof to support abandonment must be direct, affirmative, or reasonably lead one to believe that an owner has thrown away the property.¹⁵⁴ The individual alleging abandonment has

time lapse of four years without communication did not rise to the intent to abandon property interests), *aff’d*, 492 A.2d 608 (Md. 1985); *Shammel v. Vogl*, 396 P.2d 103, 106 (Mont. 1964) (finding that the nonuse of a water ditch over an extended period of time was insufficient for intent to abandon).

146. See *Linscomb v. Goodyear Tire & Rubber Co.*, 199 F.2d 431, 436 (8th Cir. 1952).

147. 199 F.2d 431 (8th Cir. 1952).

148. *Id.* at 434.

149. *Id.*

150. *Id.* at 436.

151. *Id.*

152. *E.g.*, *Johnson v. Smithsonian Inst.*, 189 F.3d 180, 187 (2d Cir. 1999). See generally Property Jurisprudence, *supra* note 118, § 11 (discussing concurrence and providing supporting case law).

153. See *United States v. Lee*, 916 F.2d 814, 818 (2d Cir. 1990) (concluding that checked luggage, which is left for a short period of time in the custody of an airline, is presumed to be stored and not abandoned); *Nunley v. M/V Dauntless Colocotronis*, 863 F.2d 1190, 1198–99 (5th Cir. 1989) (finding failure to act within thirty days to recover a sunken vessel does not constitute legal abandonment of the property, but an interval of three years is sufficient to conclude abandonment); *Sharkiewicz v. Lepone*, 96 A.2d 796, 797 (Conn. 1953) (holding failure to move a car within eight days of the request was not a sufficient interval of time to show plaintiff’s intent to abandon the property).

154. See *Foulke v. N.Y. Consol. R.R.*, 127 N.E. 237, 238 (N.Y. 1920); see also BURKE, *supra* note 139, at 151 (instructing that an inference that property has been voluntarily forsaken by the owner must directly stem from the circumstances surrounding the finding of the property).

the burden of proof,¹⁵⁵ and a court's evaluation of whether abandonment has occurred involves a review of the totality of the circumstances.¹⁵⁶

III. ABANDONMENT OF SPACE SATELLITES

Applying the elements of abandonment to post-mission satellites listed on the U.S. Registry of Objects Launched into Outer Space (U.S. Registry) can help determine the legal ramifications of ownership that arise when trying to clean up post-mission satellites.¹⁵⁷ The absence of a substantive legal regime surrounding activities in space subjects companies to potential liability when they pursue orbital debris remediation.¹⁵⁸ For example, one risk involved is a company's capture of a post-mission satellite because there is such uncertainty regarding ownership:¹⁵⁹ the original owners believe this property still belongs to them; however, the party in possession believes the satellite is abandoned property.¹⁶⁰

Pursuant to Article VIII of the Outer Space Treaty, objects launched into space fall under the jurisdiction and control of the country whose register lists the object.¹⁶¹ Thus, objects listed on the U.S. Registry—whether the objects are publicly, privately, domestically, or

155. *Hoelzer v. City of Stamford*, 933 F.2d 1131, 1138 (2d Cir. 1991). *See generally* Property Jurisprudence, *supra* note 118, § 56 (presenting the general presumption against abandonment as a reasonable person is unlikely to abandon property of value).

156. *E.g.*, *Prue v. Royer*, 67 A.3d 895, 908–10 (Vt. 2013) (reaffirming that deliberations about abandonment take into consideration all relevant facts, including the conduct of the parties before and immediately after the action occurs).

157. Space debris remediation will eventually need international coordination to sustain the efforts, but the United States can allow companies to begin the process by permitting removal of debris and satellites that are under the United States' jurisdiction. *See Werner, supra* note 14.

158. *See 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, 81 (2005).

159. *See CHATTERJEE, supra* note 91, at 1 (explaining that under current international space law, interception of space objects must be authorized by the State of Registry, otherwise capture constitutes an internationally wrongful act).

160. Article VIII of the Outer Space Treaty allows jurisdiction and control over space objects so long as they remain in space, but at the same time it seems to grant ownership rights in perpetuity. *See CHATTERJEE, supra* note 91, at 8; Outer Space Treaty, *supra* note 87, art. VIII (stating that ownership rights are not affected by objects being in space, therefore ownership remains the same on Earth's surface or in space). Even though the treaty allows ownership rights in perpetuity, the language in the treaty does not require that entities retain ownership rights at all times. Individuals can relinquish their ownership of a satellite if they perform the necessary actions to meet the established legal criteria.

161. Outer Space Treaty, *supra* note 87, art. VIII.

internationally owned—fall under U.S. jurisdiction and control.¹⁶² To that extent, any U.S. company remedying orbital debris from satellites on the U.S. Registry would not violate the rights of any nation or foreign national.¹⁶³ Such conduct would fall within the jurisdiction of the United States, so U.S. domestic law would apply to all legal issues that implicate ownership of these objects.¹⁶⁴

A. *Abandonment of Satellites in the GEO Region*

Because U.S. domestic law applies in outer space where no damage is done to another nation or foreign national, U.S. property laws and the laws of abandonment can apply to post-mission satellites in these areas.¹⁶⁵ To facilitate debris and satellite remediation efforts, companies may want to simply capture abandoned satellites without going through the formal ownership transfer process. However, for a company to capture a post-mission satellite, the satellite must qualify as abandoned by satisfying the necessary elements of the abandonment doctrine.¹⁶⁶ The following scenarios are two common instances in which companies seeking to take remediation actions need to conduct an abandonment analysis before taking possession of satellites: (1) when a post-mission satellite is boosted into its graveyard orbit and (2) when a post-mission satellite remains in its GEO position.

1. *A post-mission satellite boosted from its GEO position into its graveyard orbit*

A company cannot capture a post-mission satellite boosted from its GEO position into its graveyard orbit because, under property law, the owner has not abandoned the satellite. Satellites in this position only meet two of the three elements of abandonment, so owners retain control over these satellites. Because the voluntary intent element is missing from this scenario, companies seeking to conduct remediation

162. See Chatzipanagiotis, *supra* note 20 (explaining that the state on whose register the space object is listed has “the right to exercise jurisdiction and control over the space object”).

163. So long as the remediation efforts do not accidentally or negligently cause harm to another nation’s or national’s satellite or object in space, the remediating company’s actions fall with the *Skiriotis* legal regime allowing U.S. domestic law to govern these actions. See *supra* notes 108–12 and accompanying text.

164. See CHATTERJEE, *supra* note 91, at 2, 6–7.

165. See *supra* Section II.B (discussing how U.S. property law may be extended to outer space).

166. See *supra* Section III.A (analyzing how satellites may be abandoned in the GEO region).

efforts cannot take possession of these satellites under the laws of abandonment and capture.

Once a satellite in the GEO has completed its mission, it will generally use its remaining reserved propellant to boost out of the GEO into a graveyard orbit.¹⁶⁷ This action satisfies the necessary manifest act standard for abandonment.¹⁶⁸ However, a prospective captor would then need to evaluate the intent of the owner by looking at the totality of the circumstances as set forth in *Prue*.¹⁶⁹ First, the owner's forethought in ensuring enough propellant remained for the boost demonstrates the owner's intent that the satellite remain in space, though no longer under the owner's control.¹⁷⁰ Second, boosting the satellite and knowing enough fuel remains to move the satellite into a graveyard orbit demonstrates a concurrence of intention and action.¹⁷¹

However, if the owner conducts these actions pursuant to current practices for satellites in the GEO region, guidelines set out by domestic or international agencies, or the satellite's licensing application, then the owner has not *voluntarily* intended to abandon the satellite.¹⁷² Similar to the suspects in *Katsaris*—who disclaimed an amount of money to separate themselves from incriminating evidence, thereby not voluntarily abandoning ownership—the owner of the satellite would be under pressure to comply with these norms.¹⁷³ Therefore, a remediation company could not possess a satellite falling

167. See *supra* Section I.A.1 (describing the GEO region and how satellites behave therein).

168. See *supra* notes 124–31 and accompanying text.

169. See *Prue v. Royer*, 67 A.3d 895, 908–10 (Vt. 2013) (finding that an evaluation of owner intent includes an investigation of all actions taken by the owner).

170. Allowing the satellite to remain floating in space without making an effort to retrieve it equates to an owner willingly forsaking the satellite to whoever wishes to capture and possess it. Cf. *Katsaris v. United States*, 684 F.2d 758, 762 (11th Cir. 1982) (explaining that intent to abandon can be presumed from evidence of the owner's inaction or desertion).

171. See *supra* note 153 and accompanying text (explaining that the passing of an interval of time may evince that an act and intent occurred).

172. In this instance, the owner would not have boosted the satellite into a graveyard orbit of his own volition, but would have done so in compliance with laws and/or customs. Cf., e.g., *Johnson v. Smithsonian Inst.*, 189 F.3d 180, 187 (2d Cir. 1999). If the owner is unaware and uninfluenced by any of these guidelines, one might argue that the owner has abandoned the satellite. His actions in boosting the satellite into a graveyard orbit with the intent to never again exert control over the satellite are voluntary, and therefore fulfill the third element of voluntary intent necessary to accomplish abandonment.

173. See *Katsaris v. United States*, 684 F.2d 758, 762 (11th Cir. 1982).

into this category under the laws of capture because the owner has not abandoned the satellite.

2. *A post-mission satellite remaining in its GEO position*

Under the abandonment doctrine, an owner has likely abandoned a post-mission satellite by leaving it to remain in its GEO position. It is free for the first finder to capture it for remediation or recalibration efforts because such satellites satisfy all three elements of abandonment. Owners, therefore, have relinquished ownership and property rights over these satellites.

While the owner took no overt manifest action, an omission or failure to act occurred when the owner did not interact further with the satellite once it completed its mission.¹⁷⁴ By failing to act, the owner met the first element of abandonment.¹⁷⁵ Next, a company would need to determine the owner's intent by looking at the owner's actions, inactions, or words.¹⁷⁶ Considering the totality of the circumstances, remediation companies would look to a number of different actions that could represent the owner's intent.¹⁷⁷ First, entities could investigate the U.S. Registry to see if the owner changed the entry from active to post-mission.¹⁷⁸ Second, the remediation company could examine the UN Space Object Index, checking whether the owner reported the changed status or monitored the

174. Since the owner would likely be aware of the day the satellite completes its mission, failure to interact further with the satellite represents a desire to abandon the property. *Cf.* *Hunt v. DePuy Orthopaedics, Inc.*, 729 F. Supp. 2d 231, 233 (D.D.C. 2010) (stating that allowing a person to knowingly take possession of medical components without opposition or requests for safekeeping from the original owner for four years constituted abandonment).

175. *See id.* (upholding a failure to act as an acceptable reflection of the intent to abandon).

176. *See* *United States v. Colbert*, 474 F.2d 174, 176 (5th Cir. 1973) (establishing that a court should consider all circumstances in existence at the time of the abandonment including acts, spoken words, or any other facts).

177. *See* *Prue v. Royer*, 67 A.3d 895, 908–10 (Vt. 2013) (evaluating an owner's intent includes investigation of all actions taken by the owner).

178. The Office of Space and Advanced Technology within the U.S. State Department's Bureau of Oceans and International Environmental and Scientific Affairs (OES/SAT) maintains the U.S. Registry and can be contacted regarding the status of any satellites currently in orbit. *Space and Advanced Technology*, U.S. DEP'T OF STATE <https://www.state.gov/e/oes/sat/index.htm> (last visited Aug. 30, 2017) [hereinafter OES/SAT]. By investigating the U.S. Registry, an entity can learn whether the life span of the satellite is complete, whether the owner made the effort to keep the Registry updated (showing control over the satellite), and whether any post-mission actions were planned, just not yet actualized. *Id.* The U.S. Registry also includes the length of time the satellite was in orbit, during and post-mission. *Id.*

satellite.¹⁷⁹ Third, a company could check the FCC License database to see if the owner submitted a license application for the satellite and to determine what post-mission procedures the application included.¹⁸⁰ Fourth, a company could simply reach out to the owner of the satellite and inquire about his intentions for the satellite. Through this process, a company could determine the owner's intent toward leaving the satellite in orbit post-mission.

Whether the omission to act and unilateral intent to give up possession of the satellite happened concurrently would likely come to light during such an investigation.¹⁸¹ The inquiry into the owner's intent would examine the duration the satellite has remained in orbit post-mission and the timeline between any owner reporting. These two factors will reveal if sufficient time has passed to clearly indicate the owner's abandonment.¹⁸² In light of these factors, a remediation company has a legally well-founded basis to assume that an owner has abandoned the satellite. Because a satellite in this position would satisfy all three elements of abandoned property, the owner has relinquished the rights to the satellite.

B. Abandonment of Satellites and Orbital Debris in the LEO Region

Similar to satellites in the GEO region, property laws and the laws of abandonment apply to post-mission satellites and orbital debris in the LEO region.¹⁸³ To promote remediation efforts, companies are searching for ways to capture abandoned satellites and pieces of debris without the tedious process of transferring ownership.¹⁸⁴ However, for a company to capture a post-mission satellite or space debris, an owner must have abandoned the satellite or debris by taking, or failing to take, the necessary actions to prevent that abandonment.¹⁸⁵ The following scenarios investigate two common instances in which

179. *UN Online Index of Objects Launched into Outer Space*, U.N. OFF. FOR OUTER SPACE AFF., http://www.unoosa.org/oosa/osoindex/search-ng.jsp?lf_id= (last visited Aug. 30, 2017) [hereinafter *UN Space Object Registry*].

180. *Universal Licensing System*, FCC, <http://licensing.fcc.gov/myibfs> (last visited Aug. 30, 2017).

181. See *supra* note 113 and accompanying text.

182. See *Nunley v. M/V Dauntless Colocotronis*, 863 F.2d 1190, 1198–99 (5th Cir. 1989) (finding lack of action within thirty days does not constitute legal abandonment of the property but lack of action after three years as sufficient evidence of abandonment).

183. See *supra* Section II.B.

184. See *infra* Section II.B.

185. See *supra* Section III.A.

companies will need to make a determination about abandonment before taking remediation action.

1. A satellite that fails to reenter after twenty-five years post-mission

Satellites that fail to reenter after twenty-five years post-mission break down into two separate groups: (1) satellites an owner placed in a disposal orbit where the atmospheric drag should have pulled the satellites into Earth's atmosphere within twenty-five years, but it failed to do so; and (2) satellites an owner left in the LEO region and did not place in a disposal orbit.¹⁸⁶ In both of these categories, there is a high likelihood that the owner has abandoned the post-mission satellite.

In the case of the former situation, it appears an owner has likely abandoned the satellite. By moving the satellite to a disposal orbit, one can infer that the owner intended the satellite's destruction, essentially throwing it away by placing it in a position to be destroyed after twenty-five years.¹⁸⁷ This seemingly meets the standard laid out in *Foulke*.¹⁸⁸ However, while an owner did take an overt step in placing the satellite in a disposal orbit, if the satellite is still intact after twenty-five years, then the owner has not properly disposed of the satellite.¹⁸⁹ Recognizing this reentry failure, the owner may attempt to ameliorate the problem or may continue to forsake ownership.¹⁹⁰ So, a firm looking to capture these orbiting satellites might investigate whether the owner is considering retrieval or other reentry options, or whether the owner is calculating why the satellite failed to reenter and if it will reenter given more time.¹⁹¹ Second, the remediation firm could also look at what updates the owner has provided to the U.S. Registry and

186. Johnson, *supra* note 54, at 2–4.

187. See *Friedman v. Farmer*, 788 F.3d 862, 868 (8th Cir. 2015) (concluding an indicator of abandonment is an owner throwing property away).

188. See *Foulke v. N.Y. Consol. R.R.*, 127 N.E. 237, 238 (N.Y. 1920) (discussing the standard that abandonment of property is the relinquishing of title, claim, or virtually throwing it away).

189. See *supra* notes 124–31 and accompanying text (discussing the manifest act requirement to abandon property).

190. As a starting point, an owner who has invested millions into a satellite likely tracks the satellite at every juncture. This means, the owner is likely aware when and if a satellite reenters the Earth's atmosphere or is aware that the satellite did not complete the expected disposal objective.

191. If an owner is taking these steps, likely the owner is still expressing control over the satellite and is not intending that the satellite be abandoned. The owner is taking the necessary steps to make sure the satellite completes its disposal trajectory and reenters Earth's atmosphere. See *United States v. Colbert*, 474 F.2d 174, 176 (5th Cir. 1973) (discussing how intent to abandon and ownership may be inferred by actions taken).

the UN Space Object Index.¹⁹² Such conduct would manifest the owner's continuing intent to exert possession and ownership over the satellite.¹⁹³ If the owner ignores the satellite, simply allowing it to orbit and failing to do any of the actions listed above, then a company could appropriately conclude that the owner abandoned the satellite.¹⁹⁴

An owner has also likely abandoned a satellite left in the LEO region and not placed in a disposal orbit. Satellites in this position meet all three elements of abandonment. This situation is similar to owners leaving satellites in the GEO region.¹⁹⁵ While the owner took no overt or manifest action toward the satellite, the owner's failure to act reaches the necessary standard to satisfy the first element of abandonment.¹⁹⁶ The owner simply had no further interaction with the satellite and left it to continue in its orbital position.

Next, the owner's intent is displayed by looking at the owner's actions, inactions, or words.¹⁹⁷ Taking into account the totality of the circumstances, remediating companies would look to a number of different actions that could represent the owner's intent.¹⁹⁸ First, companies encountering this type of satellite could check the U.S. Registry to see if the owner changed the entry from active to post-mission.¹⁹⁹ Second, the remediation company could also look at the UN Space Object Index to check if the owner changed the satellite's status or tracked the satellite within the index.²⁰⁰ Third, a company could simply interact with the owner, inquiring about the owner's intentions toward the satellite. By taking these steps, a company can determine the intent toward a deserted satellite.

Furthermore, such an investigation would also likely reveal whether the owner's failure to act and unilateral intent to forgo possession of the satellite happened concurrently.²⁰¹ Considering the time frame set

192. See *UN Space Objects Registry*, *supra* note 179.

193. The intent of the owner is expressed through the totality of the circumstances. See *Prue v. Royer*, 67 A.3d 895, 908–10 (2013). These circumstances must amount to an intent to completely desert the property. See *BURKE*, *supra* note 139, at 151.

194. See *Colbert*, 474 F.2d at 176. One contingency to this situation is a consideration of the financial restrictions of the owner. If an owner is financially restricted, he possibly wants to retain ownership or determine how to retrieve the satellite, but is not in a monetary situation to do so.

195. See *supra* notes 174–82 and accompanying text.

196. See *Hunt v. DePuy Orthopaedics, Inc.*, 729 F. Supp. 2d 231, 233 (D.D.C. 2010) (upholding a failure to act as an acceptable reflection of the intent to abandon).

197. See *Colbert*, 474 F.2d at 176.

198. See Peñalver, *supra* note 114, at 196.

199. OES/SAT, *supra* note 178.

200. *UN Space Objects Registry*, *supra* note 179.

201. See *supra* note 111 and accompanying text.

out in *Nunley*, looking at how long the satellite has remained in orbit post-mission and the timeline between any reporting the owner has completed would reveal whether sufficient time has passed to clearly indicate the owner's abandonment.²⁰² In light of these factors, a remediation company could make a legally well-founded assumption that the owner abandoned the satellite.

2. *Orbital debris in the LEO region*

Orbital debris in the LEO region is not abandoned property. Because debris in the LEO orbit includes everything from rocket fuel to paint chips to tools,²⁰³ applying the laws of property and abandonment becomes more complex.²⁰⁴ Within the four categories of space debris, certain microparticulate debris items—such as fuel—cannot readily be connected with an owner,²⁰⁵ whereas others—such as a microchip from a satellite or a rocket booster—could be linked back to the satellite and its owner.²⁰⁶ Within existing proposals for space debris remediation, the most common method of addressing small debris items is to redirect the objects toward Earth so they reenter more quickly and burn up in the atmosphere.²⁰⁷ However, this method poses a problem: a company that captures items of debris

202. See *Nunley v. M/V Dauntless Colocotronis*, 863 F.2d 1190, 1198–99 (5th Cir. 1989) (establishing that thirty days with no action is too short a time period for a court to find abandonment but three years with no action shows abandonment).

203. See Agatha Akers, *To Infinity and Beyond: Orbital Space Debris and How to Clean It Up*, 33 U. LA VERNE L. REV. 285, 288–90 (2012) (discussing what constitutes space debris).

204. See CHATTERJEE, *supra* note 91, at 8 (discussing pervasive concerns that property law and Article VIII of the Outer Space Treaty impede efforts to clean up space debris).

205. See Plantz, *supra* note 2, at 592 (noting the four categories of debris). This is contrary to the requirements for satellites, which must appear on a spacefaring nation's registry according to the Registration Convention. See Registration Convention, *supra* note 89, art. II (explaining that the amount of microparticulate matter polluting the LEO ranges from 10 billion to trillions of pieces); see also Christopher D. Williams, *Space: The Cluttered Frontier*, 60 J. AIR L. & COM. 1139, 1143 (1995).

206. See Plantz, *supra* note 2, at 593 (discussing that larger pieces of debris from fragmentation, collisions, or general launch operations are more easily tracked).

207. See Elizabeth Howell, *Space Junk Clean Up: 7 Wild Ways to Destroy Orbital Debris*, SPACE.COM (Mar. 3, 2014, 5:37 PM), <http://www.space.com/24895-space-junk-wild-clean-up-concepts.html>. Star Technology and Research, Inc. suggests using an electrified net to knock down satellites. *Id.* The Space Debris Elimination design would use bursts of air to move satellites closer to the Earth's atmosphere. *Id.* The Sling-Sat Space Sweeper will capture and sling pieces of debris toward Earth's atmosphere, using the momentum from the sling to move between pieces of debris. *Id.*

would need to sift through the items collected and identify the owner of each piece, to the extent possible, before destruction. This process would cause an overwhelming burden on the remediation company.²⁰⁸

Larger pieces of debris that are identifiable would require a full abandonment analysis. Types of debris in this category likely do not meet all three elements of abandonment, causing owners to therefore retain possession and property rights over this debris. Under the Outer Space Treaty, owners are required to report all objects sent into space and submit updated reports as the satellite's situation and progress changes.²⁰⁹ Thus, owners should include large debris items in the U.S. Registry and UN Space Object Index to meet the manifest act element of the abandonment doctrine.²¹⁰

Whether an owner has performed an overt act or omission to show abandonment of debris is not as clear-cut as with satellites.²¹¹ Because owners do not have direct control over pieces of debris, meaning an owner could perform no manifest action with the debris, a time lapse would need to be observed to recognize a failure to act.²¹² Next, a company would need to determine the owner's intent by looking at the owner's actions, inactions, or words.²¹³ Considering the totality of the circumstances, remediating companies would look to a number of different behaviors that could demonstrate the owner's intent.²¹⁴

To determine intent, a company could first check the creation date for the debris by looking at the U.S. Registry or the UN Space Objects Index.²¹⁵ Second, a firm could check with the owner to determine if it has any plans toward the debris items. If an owner reports the creation of debris and tracks it until it can address the debris issues, likely the owner wants to continue in possession of the debris. If the owner took no further steps other than to report the creation of the debris, the

208. See CHATTERJEE, *supra* note 91, at 8.

209. See *supra* Section II.A.

210. OES/SAT, *supra* note 178; *UN Space Objects Registry*, *supra* note 179.

211. The boosting or failure to boost satellites into debris orbits are easily identifiable overt acts. Orbital debris, in contrast, often does not have an independent fuel source it can use to maneuver, and owners have no control over the movement of the debris.

212. See *supra* notes 103, 153. An argument can be made that until there is sufficient, widespread technology and capability of conducting debris removal and remediation, no piece of space debris is abandoned because owners cannot yet take overt actions toward orbital debris and owners cannot omit or fail to act when no actions could be taken.

213. See *United States v. Colbert*, 474 F.2d 174, 176 (5th Cir. 1973).

214. See Peñalver, *supra* note 114, at 196 (discussing the standards for interpreting the intent of an abandoning party).

215. OES/SAT, *supra* note 178; *UN Space Objects Registry*, *supra* note 179.

owner has shown a lesser level of intent to retain ownership over it.²¹⁶ The amount of time from the creation of the debris until a remediation company completes its inquiry into the items would be sufficient to reflect the owner's failure to act and intention to abandon.²¹⁷ Because orbital debris does not have an independent fuel source owners can use to maneuver the debris into a disposal orbit and technology is not yet advanced enough to provide a method for collecting pieces of debris, likely the first element of the test for abandonment—an owner's manifest act—would remain unfulfilled. Because of this, large items of orbital debris are, in general, not abandoned.²¹⁸

Similarly, applying abandonment elements to small pieces of debris like fuel and paint chips does not proceed smoothly. Such debris likely does not meet all three elements of abandonment, and, therefore, owners retain ownership and property rights over this debris as well. Essential to the law of abandonment is an owner's knowledge of the existence of the property.²¹⁹ In the case of microparticles of debris, some owners may not be aware of the debris their satellites have produced. These items would more appropriately fall under the category of lost property, which requires a different analysis.²²⁰ If, however, an owner is aware of the small items of debris it owns, these items of debris could be subjected to the same analysis as large orbital debris objects.²²¹ Thus, qualification and quantification of debris contributes to an owner's overall intent to abandon property.

CONCLUSION

Because there is no well-developed, guiding legal regime, a company looking to conduct space debris and satellite remediation will need to make strategic decisions as it begins its remediation efforts.²²² Property law provides companies with a legal regime to justify its remediation

216. This assertion is predicated on whether or not the owner has actual knowledge of the creation of the pieces of debris.

217. See *supra* note 153.

218. This argument is predicated on owners knowing of the existence of the large pieces of debris. See *supra* note 146 and accompanying text.

219. An owner cannot unilaterally act with the intent to abandon an item he does not know he owns. See *Linscomb v. Goodyear Tire & Rubber Co.*, 199 F.2d 431, 436 (8th Cir. 1952); see also *Sorge & Peterson*, *supra* note 12, at 50 (presenting this situation as an added layer showing the legal difficulties of ADR efforts).

220. See *supra* note 120.

221. See *supra* notes 209–18 and accompanying text.

222. See *Hertzfeld*, *supra* note 158, at 81.

efforts and prevail over any challenges.²²³ Specifically, being able to identify and capture abandoned satellites circumvents the necessity of a company carrying out formal transfers of ownership for each post-mission satellite or small piece of space debris it wants to collect.²²⁴

As the United States continues space debris mitigation efforts, an ownership concern arises as to who can clean up space. International treaties touch on ownership of objects in space and discuss who has jurisdiction and control over those objects. As this Comment discusses, U.S. law can extend to activities in outer space. As long as the rights of other nations or the rights of citizens of other nations are not infringed by these remediation activities, neither international law nor the presumption against extraterritoriality is invoked.

Companies planning to conduct satellite and debris cleanup efforts may find it efficient to rely on abandonment and the law of capture to carry out these activities. By using abandonment and capture, companies can circumvent the necessity of going through ownership transference before remediation efforts take place. Companies can use these elements to evaluate whether post-mission satellites have been abandoned or remain the property of the original owner. When satellites are moved in accordance with current practices to graveyard or disposal orbits, it is likely that owners are intentionally acting but not with voluntary intent. Because domestic and international organizations tightly regulate and control access in space, a satellite functioning within this framework is not acting from its own volition—which is necessary for abandonment—but is acquiescing to requirements.

A different result arises when owners fail to take action according to these guidelines. The manifest act element of abandonment is also met through omission or failure to act. By failing to take further action toward a post-mission satellite, an owner provides a baseline assumption that he intends to abandon the satellite. Further, case-by-case investigation can better show the intent of the owner through the owner's own words and actions. Moreover, for orbital debris in the LEO region, objects again fall along two lines. Larger debris that is identified can be treated similarly to post-mission satellites left in their GEO or LEO position. Small unidentifiable debris does not fall within

223. *But see* CHATTERJEE, *supra* note 91, at 8 (discussing how property law hinders space debris remediation efforts more than it helps).

224. *See id.* (noting that even though international space law has not explicitly laid out procedures for transference of ownership, contemporary State practice regularly involves transferring satellite ownership as a way to get around any restrictions from the Ownership Clause of Article VIII of the Outer Space Treaty).

the scope of abandoned property because owners are often unaware of their possession of the microparticles of debris.

Despite the efficiency it could provide, companies aspiring to conduct space debris remediation should not rely solely on property law—specifically the law of abandonment and capture—to conduct these remediation actions. Because technology has not yet advanced to the point of being able to curtail the expansion of orbital debris, most owners have never had the option of retrieving a satellite or pieces of orbital debris. As such, owners can present a persuasive case that they should be given the opportunity to conduct remediation on their own satellites once those technologies are developed.²²⁵ Especially when specifically addressing small, unidentifiable debris objects, even though these objects are not considered abandoned, many owners are more interested in the safety and sustainability of outer space and would likely waive their rights to pieces of debris to facilitate remediation efforts.

225. See *supra* notes 14–17 (discussing advancements in orbital debris remediation technology).