

Caught in the Undertow: Seafaring Uncrewed Systems Test Maritime Law in the “Gray Zone”

December 2025

Laurel Baker
Research Associate

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

LLNL-MI-2013294

Caught in the Undertow: Seafaring Uncrewed Systems Test Maritime Law in the “Gray Zone”

Laurel Baker¹

Center for Global Security Research

Executive Summary

States and supranational bodies are struggling to govern uncrewed platforms’ distribution and use at pace with innovation. This piece assesses this phenomenon at sea for military strategists and policymakers; it hypothesizes that dual-use, mission-flexible uncrewed maritime vehicles (UMV) employed in the gray zone chafe against maritime law, and that friction may contribute to unpredictable escalation. Specifically, it finds that:

1. **UMV maturation will enable gray-zone activities:** Dual-use UMVs will become smaller, more technologically robust, more cost-effective, and stealthier. Their increasing accessibility and versatility suit the gray zone, augmenting maritime competition.
2. **Irregular UMV uses will expose gaps in their maritime legal interface:** Maritime law is one of several avenues for gray-zone preemption, intervention, and redress. However, the seas host unclear, inconsistent, or lagging legal authorities across maritime areas. These circumstances offer opportunities for perpetrators to irregularly employ UMVs to gain competitive advantages against their target(s) at little legal cost.
3. **These gaps hold implications for escalation:** National-security practitioners may find it difficult to anticipate escalation within the maritime gray zone—even more so when uncrewed systems enter the picture. If a perpetrator misjudges what tools an opponent is willing to wield when faced with low-to-medium-stakes aggression, interactions might unexpectedly ignite. The maritime legal regime is unlikely to consistently deter and rectify gray-zone UMV behavior on its own.

This interdisciplinary subject is growing in relevance as maritime incidents uncover an interplay between emerging disruptive technologies (EDTs), gray-zone operations, and international law. UMVs’ displays of force in the Black Sea by the Ukrainian and Russian Armed Forces and in the Red Sea by the Houthis encourage maritime threat assessments in multinational venues like NATO.² Gray-zone antagonism between PRC and various other crewed vessels in the South China Sea frequents headlines.³ Recent U.S. strikes on alleged drug-smuggling boats prompt questions about

¹ Laurel Baker was a Summer/Fall 2025 Research Associate at the Center for Global Security Research. She previously served as a National Nuclear Security Administration Graduate Fellow and conducted research at several think tanks. She received an MA in Russian, East European, and Eurasian Studies from Stanford University and a BA (Honors) in Russian from the University of Michigan.

² *Protecting Maritime Mobility: Defending Infrastructure and Supply Chains from Uncrewed Threats*, (CACI), 2.; Mykhailo Samus in *Defending Maritime Assets - Approaches to Critical Infrastructure Protection*, ed. George Scutaru and Murman Margvelashvili (Springer, 2025), 138.

³ Ethan Connell and Jonathan Walberg, “How the Philippines Can Counter China’s South China Sea Aggression,” *The Diplomat*, April 23, 2025, <https://thediplomat.com/2025/04/how-the-philippines-can-counter-chinas-south-china-sea-aggression/>; Aaron-Matthew Lariosa, “Chinese Maritime Safety Officers Beat Vietnamese Fishermen During South China

acceptable state conduct in international waters outside of formal war.⁴ While it is not a foregone conclusion that UMMVs will exacerbate these dynamics, the analysis below proposes so.

The following draws from dozens of academic publications, books, web pages, and journalistic pieces. With a broad national-security audience in mind, it qualitatively addresses state-level irregular UMMV activity through strategic- and operational-level legal analysis.⁵

Sea Interdiction, Say Officials,” *USNI News*, October 7, 2024, <https://news.usni.org/2024/10/07/chinese-maritime-safety-officers-beat-vietnamese-fishermen-during-south-china-sea-interdiction-say-officials>.

⁴ Charlie Savage and Helene Cooper, “Venezuelan Boat Suspected of Drug Smuggling Is Said to Have Turned before U.S. Strike,” *The New York Times*, September 10, 2025, <https://www.nytimes.com/2025/09/10/us/trump-drug-boat-venezuela-strike.html>.

⁵ The author is not a lawyer.

Introduction

The strategic weight of EDTs, such as uncrewed systems, continues to grow. One of their innumerable consequences is presenting increased means for rivals to compete in the so-called “gray zone”—the operational space between peace and armed conflict where actors compete underhandedly with rivals. This observation is well-represented in the last decade of discourse on great power competition and asymmetric conflict with non-state terrorist or proxy entities. It is also gaining attention in discourse around the global commons, which include (at minimum) outer space, the atmosphere, Antarctica, and the world’s seas. This paper will cover just one of the many interesting EDTs at sea: UUVs. **The central research question is: To what extent does UUVs’ potential for irregular use challenge the current legal paradigm at sea, and to what end(s)?**

Outline

This paper addresses each of the question’s components in turn. First, it investigates how UUVs’ activities might mature in the gray zone. UUVs go by several acronyms in their associated literature, but this report uses “uncrewed” to account for variable degrees of remote and autonomous operation, “maritime” to specify their domain and medium of transit (on or underwater), and “vehicles” to encompass the broadest array of seaborne mobile devices possible. Moreover, for the purposes of this paper, “irregular” activities or uses are a range of injurious and sometimes covert actions that inhabit an often-inscrutable space between standard—even bullish—diplomacy and formal warfare. These acts undermine a target’s perceived or actual economic, political, and/or military competitiveness and/or boost that of the perpetrator—either way, the latter gains competitive advantage.⁶ While ‘hybrid,’ ‘asymmetric,’ and ‘sharp,’ among other terms, describe similar activities, this author uses gray-zone and irregular as interchangeable umbrella labels. Irregular is simply an adjective to describe gray-zone activities.

The paper then provides an analysis of international legal mechanisms relevant to UUVs and how they might ignore or inadequately remediate those activities. Maritime (or “admiralty”) law lays out governance and jurisdiction—who has what privileges and where—including (but not limited to) commercial activities, labor, incident mitigation, and environmental resources.

Lastly, the piece posits that the fundamental problem between irregular activities UUVs perpetuate and their corresponding legal architecture concerns calculus: actors weigh competitive advantages against escalation risks. Interacting actors escalate circumstances by ratcheting up their stakes through dramatic or sustained social, political, economic, or military pressure. Legal deficiencies influence but do not *fully* account for these risks, and their heterogeneous and often ambiguous properties may yield provocation.

⁶ Javier Jordan, “International Competition Below the Threshold of War: Toward a Theory of Gray Zone Conflict,” *Journal of Strategic Security* 14, no. 1 (2021): 3-4, <https://doi.org/10.5038/1944-0472.14.1.1836>.

Assumptions

This paper emerged from the following observations-turned-assumptions:

State and non-state actors will gain greater access to UMVs: The literature on UMV proliferation and use cases is not as rich as that of their aerial counterparts, despite seaborne remotely operated or semi-autonomous vehicles having existed for some time. Their widely recognized general applications include shipping, scientific efforts, and military missions. UMVs will probably multiply due to their increasing commercial availability and operational desirability (e.g., decreasing costs, sometimes a low acoustic/visual profile, lower human risk).⁷

The seas are ripe for irregular activity: Actors increasingly employ EDTs to gain competitive advantages over their rivals in all domains. However, the maritime environment is rugged and vast, so actors can easily misrepresent or obscure gray-zone acts.

Actors may choose irregular operations over diplomacy or legally recognized armed conflict because they estimate these options provide unique, desirable effects at acceptable costs. If an actor operates in the gray zone with absorbable consequences, it is likely to continue such behavior as long as it vies for superiority against an adversary. Actors may cease irregular activities if they fulfilled limited objectives or if costs otherwise outweigh benefits. This situation begs questions around the resources available to deter or punish delinquency at sea.

As the primary supranational disciplinary *architecture* for maritime activity, the interstate *legal* topography deserves close analysis. The legal seascape is largely normative, ambiguous, and inconsistently governed across maritime areas. Many existing examinations of maritime law applicable to the gray zone relate to crewed vessel interactions and critical infrastructure incidents; these are instructive, though the aperture for further analysis is widening.

UMVs are well-suited to gray-zone activities: UMVs' multi-mission capabilities are poised to complicate behavior at sea and the structures that attempt to manage it. They can execute dull, dirty, and dangerous tasks ill-suited to people, boasting human and financial cost-effectiveness and stealth.⁸

Escalation dynamics in the gray zone may lack a predictable structure: Theories and practices for managing escalation in the gray zone—by legal and other means—are emerging. This is in part because gray-zone activities are by definition tied to escalation, thought to avoid what actors legally recognize as armed conflict. Appendix B deconstructs this idea.

While legal frameworks help delimit (in theory) what the interstate community agrees is acceptable behavior outside of war, there are two immediate problems concerning UMV operations in the gray zone. First, it is not clear that the interstate community agrees on what constitutes acceptable peacetime behavior at sea, much less meaningful prevention, intervention, and redress for unacceptable acts.⁹ Second, legal ambiguities that arise from the first problem can make

⁷ Henri van Soest et al., *Evolving threats to critical undersea infrastructure: Implications for European security and resilience* (RAND Europe, 2025), 13.

⁸ Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, under Drones: Legality, Morality, and Utility of Unmanned Combat Systems* (Naval Institute Press, 2018), 77.

⁹ The interstate community constitutes those states with vested interests and representation in international institutions.

escalatory trajectories at sea difficult to predict. This is undesirable; more players, more assets, and more geopolitical tensions could spell escalatory trouble on the horizon.

Irregular UMV uses do not incontrovertibly herald escalation within the gray zone, nor up to conventional or even nuclear levels. Escalation prospects are dependent on inconstant variables, such as information ecosystems, domestic conditions, and relationship(s) with the perpetrator(s). This is a problem for all theories of escalation, gray-zone or otherwise.

Scope of Research

Existing literature speaks to U MVs' strategic utility in the gray zone, interstate legal challenges inherent to uncrewed operations, and their potential manipulation of escalation dynamics. This paper synthesizes these themes.

It is also important to note what this paper does not address. In lieu of a comprehensive assessment of U MVs' potential to commit, defend against, and suffer aggression, it only surveys antagonistic uses.¹⁰ Moreover, it functions as a high-level investigation of legal problems posed by irregular U MV activities but does not prescribe solutions. It does not broach complex export control architectures that affect U MV accessibility domestically and abroad, particularly among non-state actors. Similarly, it focuses on states willing to operate in the gray zone, rather than active non-state actors like the Houthis.¹¹ The paper does not comment on expected commercial or research U MV uses, nor wartime uses under the Law of Armed Conflict (LOAC)—rather, the comparatively less-explored gray zone.¹² It does not entertain the ongoing moral and ethical debate on whether it is *right* to employ U MVs at all. It does not explore in detail how escalation might unfold, rather it observes how categories of events and their legal contexts might trigger chain reactions in the first place. Finally, it does not generalize its conclusion to all global commons.

Far from tangential, articulating the U MV 'problem' through a legal lens illustrates the need to anticipate and counter irregular behavior through state and interstate mechanisms, ideally easing tensions. While refraining from specific policy recommendations, it helps frame how policymakers and military strategists might consider deterring and interdicting U MV activities at the tactical and operational levels vs. responding at the strategic level. Strategies for credible litigation and regulation suggest how to stymie threats—preemptively or responsively; domestically or internationally; and in what proportion and manifestation.

¹⁰ Soest et al., *Evolving threats to critical undersea infrastructure: Implications for European security and resilience*, 22.

¹¹ Suat Cubukcu and Evan Jordan, "The Houthi Drone Supply Chain," Orion Policy Institute, July 26, 2025, <https://orionpolicy.org/the-houthi-drone-supply-chain/>; Jon Gambrell, "Yemen's Houthi rebels launch drone boat that hits ship in Red Sea as missile strikes another," *AP News*, October 1, 2024, <https://apnews.com/article/yemen-houthi-rebels-red-sea-attacks-israel-hamas-war-2faa48176d4f773003b6a4a3ad5ca73d>.

¹² James Kraska and Raul Pedrozo, *Disruptive Technology and the Law of Naval Warfare* (New York: Oxford University Press, 2022), 76-77, 87.

UMVs: The State of Play

With the context settled, it is appropriate to establish why UMVs are worth dedicated attention, given the diversity of threats plaguing Earth's seas.

Who, What, Where, When, Why, and How

Common Uses

UMVs come in surface (USV) or underwater (UUV) varieties. UMVs are largely dual-use; many commercial, academic, and government-owned UMVs serve civilian functions that contribute to military situational awareness.¹⁴ Regardless of application, UMVs fundamentally enjoy the advantages of stealth, low human and financial costs, 'attritability',¹⁵ and often, diverse missions and swappable payloads.



Figure 1. A U.S. REMUS 600 multi-use UUV deploys during BALTOPS 2018.¹³

On the commercial and civilian fronts, UMVs mostly carry out scientific endeavors (e.g., environmental, hydrographic, oceanographic surveys), conduct offshore infrastructure inspections, and carry cargo.¹⁶ UMV designs sometimes incubate in academia and industry before defense sectors rapidly adopt them, as opposed to being conceived from scratch in a concealed military environment.¹⁷

Militarily, UMVs execute intelligence, surveillance, and reconnaissance (ISR), mine countermeasures, anti-submarine warfare (ASW), electronic warfare (EW), strikes, and miscellaneous supportive positions alongside crewed assets.¹⁸ LOAC governs their wartime uses,

¹³ Image credit to MCC America Henry/U.S. Navy, sourced from Megan Eckstein, "US Navy tests sub-launched drones while industry continues designing," *Defense News*, November 8, 2023, <https://www.defensenews.com/naval/2023/11/08/us-navy-tests-sub-launched-drones-while-industry-continues-designing/>.

¹⁴ Michael Mazarr, *Mastering the Gray Zone: Understanding a Changing Era of Conflict* (U.S. Army War College Press, 2015), 62.

¹⁵ 'Attritability' is an increasingly common term national-security practitioners use to describe when losing certain assets is acceptable, given a broader objective.

¹⁶ Luis Castano-Londono et al., "Evolution of Algorithms and Applications for Unmanned Surface Vehicles in the Context of Small Craft: A Systematic Review," *Applied Sciences* 14, 9693 (2024): 14, <https://doi.org/10.3390/app14219693>.

¹⁷ Michael Raska, "The sixth RMA wave: Disruption in Military Affairs?" *Journal of Strategic Studies* 44, no. 4 (2020): 458, 68, <https://doi.org/10.1080/01402390.2020.1848818>; Lauren Williams, "Naval drone startup HavocAI hopes to build 100-foot robot boat by year's end," *Defense One*, June 7, 2025, <https://www.defenseone.com/business/2025/06/naval-drone-startup-havocai-hopes-build-100-foot-robot-boat-years-end/405901/>.

¹⁸ John Keller, "Military researchers ask industry for uncrewed shipdefense autonomy and weapons to safeguard cargo vessels," *Military & Aerospace Electronics* (2025); Bryan Clark, Mark Gunzinger, and Jesse Sloman, *Winning in the Gray Zone Using Electromagnetic Warfare to Regain Escalation Dominance*, Center for Strategic and Budgetary Assessments

which permits actions such as blockades, targeting of major economic assets (like tankers), and ruses like “camouflage, decoys, mock operations, and misinformation.”¹⁹ Depending on size and mission/payload, military UMVs can cost from the thousands to tens (or even hundreds) of millions of dollars, with non-specialized, commercial UMVs trending cheaper.²⁰

Notable Actors

While not rigorously examining UMV ecosystems among major players, this section can offer a few bird’s-eye-view observations. Unsurprisingly, states with large militaries and technological innovation ecosystems are at the forefront of UMV development. Notably for this paper, the United States, the People’s Republic of China (PRC), and Russia all have already developed and deployed military UMVs, and the United States and the PRC, especially, host productive civilian UMV industries.²¹ Below are a few military-oriented cases.



Figure 2. A PRC experimental military USV docked in Guangzhou.²²

The U.S. Navy has devoted significant attention to integrating uncrewed assets with crewed counterparts—a “distributed fleet architecture.”²³ Beyond ancillary missions like ISR and logistical support, other potential objectives include forward-deploying UMVs in a hot conflict while massive, expensive, crewed vessels remain harder to reach.²⁴ For instance, the Defense Innovation Unit recently solicited companies for relatively small, submarine-launched kamikaze drones and expeditionary UUVs—potentially as a part of the Defense Department’s (DOD) Replicator Initiative.²⁵

(2017), 43-47.; David Letts and Raul Pedrozo in Natalie Klein et al., eds., *Maritime Autonomous Vehicles and International Law* (Routledge, 2024), 106, 120, 122.

¹⁹ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 21-22, 25. LOAC does provides guidelines for how neutral sates might interact with belligerents and vice versa, as well as permissions for military activities outside of the territorial sea.

²⁰ Arthur Michel in John Jackson, ed., *One Nation, Under Drones*, 62.

²¹ Gabriel Honrada, “Neither US nor China ready for a sea drone fight,” *Asia Times*, August 23, 2025, <https://asiatimes.com/2025/08/neither-us-nor-china-ready-for-a-sea-drone-fight/>.

²² Image credit to Alex Luck, “Chinese Experimental Aviation Platform And Combat USV Emerge In Detailed New Imagery,” *Naval News*, July 11, 2024, <https://www.navalnews.com/naval-news/2024/11/chinese-experimental-aviation-platform-and-combat-usv-emerge-in-detailed-new-imagery/>.

²³ Ronald O’Rourke, “Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress (Report No. R45757),” Congressional Research Service, <https://www.congress.gov/crs-product/R45757>.

²⁴ “Oceanography and Remote Monitoring,” May (2025): 47.; Sam Lagrone, “Navy Moving Away from ‘Optionally Manned’ Vessels as Service Mulls Unmanned Future,” *USNI News*, August 15, 2025, <https://news.usni.org/2025/08/15/navy-moving-away-from-optionally-manned-vessels-as-service-mulls-unmanned-future>.

²⁵ Jon Harper, “U.S. military is on the hunt for killer UUVs,” *Defense Scoop*, July 9, 2025, <https://defensescoop.com/2025/07/09/diu-navy-uuv-one-way-attack-submarine-launched/>; U.S. Defense Innovation Unit, “Replicator,” n.d., <https://www.diu.mil/replicator>.

After the United States, the PRC is most capable in UUV development and deployment.²⁶ The PRC seemingly pursues UUVs for maritime situational awareness and local power projection; to take just a couple examples, Beijing recently unveiled its new AJX002 minelaying extra-large UUV, consequential for operations in border seas and around Taiwan, and assets from Shanghai University's dual-use Jinghai survey USV series reportedly operate in peripheral and remote waters.²⁷ PRC UUVs frequently demonstrate autonomous navigation with sophisticated perception, planning, and control to up to thousands of kilometers, steadily achieving more complex operations.²⁸



Figure 3. Russian naval drone strikes target ship during 2025 July Storm exercise.²⁹

Reporting on Russia notes that UUV developments are less visible than their aerial counterparts, but much speculation concerns UUV seabed operations facilitated by the Russian military and Main Directorate for Deep Research.³⁰ Meanwhile, the war in Ukraine has accelerated Moscow's more obvious kinetic platform development.³¹ These patterns are not limited to major competitive powers; smaller states are also keen on UUVs for their supportive and destructive potential.³² For example, Ukraine, Israel, the United Kingdom, the Netherlands, and France, among others, have all developed or acquired UUVs.³³ These players' attitudes toward each other and toward behaving in the global commons will inform their UUV uses.

²⁶ Ian Bowers and Sarah Kirchberger, "Not so disruptive after all: The 4IR, navies and the search for sea control," *Journal of Strategic Studies* 44, no. 4 (2020): 632, <https://doi.org/10.1080/01402390.2020.1848819>.

²⁷ H.I. Sutton, "China's New Giant Underwater Drone Increases Naval Mine Threat Around Taiwan," *Naval News*, September 18, 2025, <https://www.navalnews.com/naval-news/2025/09/chinas-new-giant-underwater-drone-increases-naval-mine-threat-around-taiwan/>; Astrid Young, "Shanghai University's uncrewed vessels support China's maritime push," Australian Strategic Policy Institute, September 18, 2025, <https://www.aspistrategist.org.au/shanghai-universitys-uncrewed-vessels-support-chinas-maritime-push/>.

²⁸ Lou Jiankun et al., "Advances and frontiers of key technologies in intelligent navigation for unmanned surface vehicles," *Chinese Journal of Ship Research* 20, no. 1 (2025), <https://doi.org/10.19693/j.issn.1673-3185.04348>.

²⁹ Image credit to Russian Ministry of Defense, sourced from Jake Epstein, "Russia's sinking fake ships with exploding naval drones. The training likely isn't for war with Ukraine.," *Business Insider*, July 28, 2025, <https://www.businessinsider.com/russias-sinking-fake-ships-with-naval-drones-copying-ukraine-tactic-2025-7>.

³⁰ Sidharth Kaushal, "Stalking the Seabed: How Russia Targets Critical Undersea Infrastructure," Royal United Services Institute, May 25, 2023, <https://www.rusi.org/explore-our-research/publications/commentary/stalking-seabed-how-russia-targets-critical-undersea-infrastructure>.

³¹ Dmytro Shumlyanskyi, "Advancements in Russian Naval Drones and Their Role in the Armed Forces," *Black Sea News*, August 9, 2025, <https://www.blackseanews.net/en/read/233967>. A few high-profile OSINT researchers like H.I. Sutton periodically publish their findings on states' UUV ecosystems.; Kateryna Hodunova, "Russia-Ukraine naval drone arms race could 'usher in a new era of warfare'," *Kyiv Independent*, September 1, 2025, <https://kyivindependent.com/a-new-era-of-warfare-russia-reorganizes-in-black-sea-turning-to-drone-reinforcements/>.

³² Luke Hahn, "USVs and UUVs Can Empower Middle Powers Amid China-US Competition," *The Diplomat*, June 2, 2025, <https://thediplomat.com/2025/06/usvs-and-uuv-can-empower-middle-powers-amid-china-us-competition/>.

³³ Arthur Michel in John Jackson, ed., *One Nation, Under Drones*, 70.

Enabling Technologies and Maturation

This section outlines some technological features of UMVs insofar as they confine near-term realistic uses. UMVs are an assembly of disparate legacy and emerging technologies that, like their airborne or ground-based brethren, offer novel avenues for geopolitical competition.³⁴ Their main technical-support categories are propulsion, data management, communications, and navigation; these factors determine where, when, and how they can execute missions. Appendix A provides more information.

Table 1. Enabling technologies' effects on UMV missions.³⁵

| Enabling Technologies | Effects on UMV Missions |
|------------------------|---|
| Propulsion | <ul style="list-style-type: none"> How far a single sortie can extend without refueling/recharging How nimble vehicles are, especially important for labyrinthian coastal environments |
| Data Management | <ul style="list-style-type: none"> Bandwidth for real-time data integration, processing, and storage Cyber resilience of a system against hijacking, jamming, other manipulation affects energy consumption |
| Communications | <ul style="list-style-type: none"> Data availability to end user How vehicles coordinate with other assets |
| Navigation | <ul style="list-style-type: none"> Degree of autonomy and artificial-intelligence (AI) integration Confidence affects applicable mission sensitivity |

Any lack of robust supportive systems restricts UMV operations. That said, the developmental trajectory of these systems is hard to predict, given the sheer speed at which states, non-state actors, and private companies alike exploit cheap commercial technologies to produce effective UMVs. Reports indicate that some UMVs evolve from concept to testing within a year, with companies like Havoc AI designing and deploying USVs in DOD exercises in just months.³⁶

Uncrewed systems themselves may prove an impetus for general maritime and remote sensing innovation. After all, UMVs are often small or stealthy enough to escape radar, sonar, or the Automatic Identification System (AIS); defending against UMV attacks in and outside of war will inevitably require a proportionate technological reaction (e.g., novel sensors, cameras, etc.).³⁷ Over time, UMV manufacturers may aim to create minimalistic designs that not only promote interoperability with crewed vessels or within autonomous swarms, but also to reduce the amount of technology actors can steal or trace.³⁸

³⁴ Anna Petrig, "Autonomous offender ships and international maritime security law," in *Autonomous Ships and the Law*, ed. Henrik Ringbom, Erik Røsæg, and Trond Solvang (Routledge, 2021), 27.; Bowers and Kirchberger, "Not so disruptive after all: The 4IR, navies and the search for sea control," 616.

³⁵ Please refer to Appendix A for detailed sourcing.

³⁶ Gregory C. Allen, Kateryna Bondar, and Samuel Bendett, "The Russia-Ukraine Drone War: Innovation on the Frontlines and Beyond," 2025.; Petrig, "Autonomous offender ships and international maritime security law," 27.; Rand LeBouvier, *ASW and Unmanned Undersea Systems* (Sea Technology, 2014).; "Oceanography and Remote Monitoring," 52.; John Biggs, "Startup HavocAI Bets Big on Autonomous Naval Drones, Eyes 100-Foot Platform by Year's End," *Resilience Media*, June 13, 2025, <https://www.resiliencemedia.co/p/startup-havocai-bets-big-on-autonomous>.

³⁷ Rudy R. Negenborn et al., "Autonomous ships are on the horizon: here's what we need to know," *Nature* 615 (2023): 31.

³⁸ Shadi Abujoub, Johanna McPhee, and Rishad A. Irani, "Methodologies for landing autonomous aerial vehicles on maritime vessels," *Aerospace Science and Technology* 106, 106169 (2020): 1-2, <https://doi.org/10.1016/j.ast.2020.106169>.

UMVs in the Gray Zone

Since scholars began circulating the term, discussions of the ‘gray zone’ have expanded, contracted, shifted, and fatigued, making it worthwhile to briefly clarify its relevance to this paper. Definitions of the gray zone tend to highlight a few key features: acts are coercive or aggressive, often but not always covert, attempt to avoid conventional military conflict, and can propagate for cumulative effects.³⁹ The immense and often opaque maritime domain, its unsettled legal terrain, and its range of innocuous to hostile UMVs complement these gray-zone ingredients.

Naturally, one might wonder to what end an actor might choose gray-zone tactics over concerted diplomacy or even war. Within this paper’s scope, stealth, cost-efficiency, and human safety are all desirable traits of dual-use UMVs. These advantages bear high-value returns for actors interested in undermining opponents or unilaterally advancing their own interests in completely obscured or otherwise elusive ways. Perpetrators may repeatedly antagonize victims through limited or deniable acts in contested or protected spaces, made more feasible through UMVs’ endurance and low profiles. In effect, these vehicles do not merely amplify the risks posed to civilian, commercial, and military assets by tactics of “pirates, terrorists, and hostile navies,” but also offer a suite of self-sacrificial, infiltrative, persistent, automated, non-lethal, and other non-traditional, adaptive techniques.⁴⁰

Competitive advantages wrought from UMV uses in the gray zone might include enhanced situational awareness, signaling a willingness to threaten an opponent’s commercial or military interests (i.e., a deterrent tool), institutional and political unease from untraceable acts or insufficient instruments to respond to traced acts, narrow but noticeable cost imposition after spats, and scrutiny of defenses, among others.

Degrees of authoritative institutional oversight affect gray-zone advantages in various domains. Maritime law does not consistently account for UMVs, irregular actions, nor their effects; this is the focus of the next section.

³⁹ Hal Brands, *Paradoxes of the Gray Zone* (Foreign Policy Research Institute, 2016), <http://www.fpri.org/article/2016/02/paradoxes-gray-zone/>; Jordan, "International Competition Below the Threshold of War: Toward a Theory of Gray Zone Conflict," 1-4.; Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," *Texas National Security Review* 8, no. 3 (2025): 59. <https://dx.doi.org/10.1353/tns.00005>

⁴⁰ Keller, "Military researchers ask industry for uncrewed shipdefense autonomy and weapons to safeguard cargo vessels."; Fact Sheet: Department of Defense Strategy for Countering Unmanned Systems, (2024).

The Legal Seascape

After outlining UMVs functions and the significance of their dual uses, the following sections explore in detail the kinds of legally problematic behaviors UMVs might exhibit in the gray zone.

The Maritime Legal Architecture

All seafaring states, littoral or otherwise, have rights and obligations under maritime law. The graphic below breaks up the legal architecture by geographic area; the basic principle is that a coastal state has the greatest sovereignty and associated privileges in its territorial sea, which gradually subtract as an asset moves seaward. This regime pertains to state conduct in peacetime, war, and the gray zone, with some entitlements changing between the former two. Since the gray zone sits below the threshold of formal armed conflict, so far, peacetime laws seemingly apply.

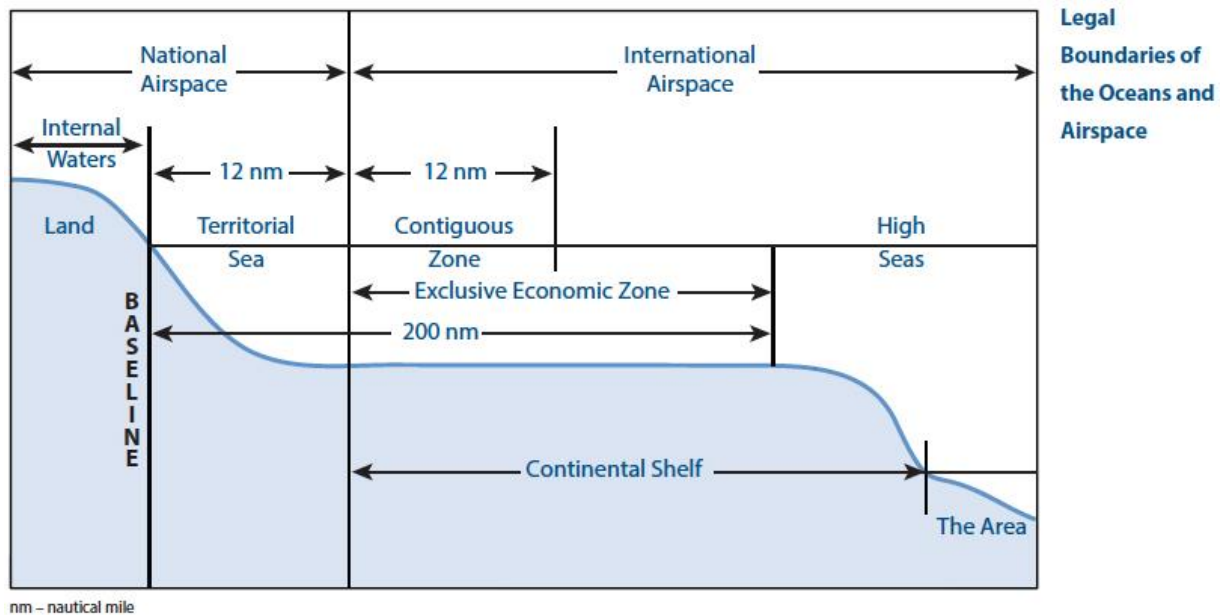


Figure 3. Maritime zones as defined by UNCLOS.⁴¹

A few concepts, entities, and materials are relevant to this paper's analysis of irregular UMV legal challenges by maritime area.⁴² Starting with important characteristics, the literature suggests that maritime law is:

- **Normative:** With few exceptions, states must accede to international accords to be legally bound by them. Many states have historically selectively ratified documents and often *nominally* abided by unratified documents. If states exhibit consistent practices, they may materialize as legal obligations (*opinio juris*), called customary law. Customary law is

⁴¹ Image credited to The Fletcher School of Law and Diplomacy, Tufts University; John Burgess, Lucia Foulkes, Philip Jones, et. al (eds.), *Law of the Sea: A Policy Primer*, "Chapter 2: Maritime Zones," <https://sites.tufts.edu/lawofthesea/chapter-two/>.

⁴² Jonathan Law and Elizabeth Martin, *A Dictionary of Law*, 10th ed. (Oxford: Oxford University Press, 2022).

binding for all but those states that consistently protested its installation— otherwise, they must adhere in good faith.

- **Heterogeneous:** The patchwork architecture consists of international, regional, and domestic agreements and regulations that reflect manifold interests and legal traditions. There is no single, universally binding enforcement body.
- **Ambiguous:** Law is by nature interpretable. It is subject to contradiction and gaps between treaty and customary law and often vague or antiquated language in the former. Interpretation and application of laws by maritime area evolve case-by-case.

Sample of Maritime Legal Principles

Sovereign Immunity: states cannot exercise jurisdiction over a foreign state’s government, non-commercial assets, potentially subject to asset status caveats

Innocent Passage: seafaring states’ right to benignly navigate through foreign territorial seas unobstructed, potentially subject to asset status caveats

Transit Passage: seafaring states’ right to benignly navigate through international straits and archipelagic waters unobstructed, potentially with asset status caveats

Freedom of Navigation: seafaring states’ right to benignly sail unobstructed in the high seas and exclusive economic zones (EEZ)

Hot Pursuit: a coastal state’s right to chase a law-violating foreign ship uninterrupted from the state’s internal waters, territorial sea, or contiguous zone through international waters

Table 2. Jurisdiction by maritime area.⁴³

| Maritime Areas | Distance from Littoral State’s Coast | Littoral State’s Jurisdiction |
|--|--|---|
| Territorial Sea | Up to 12 nautical miles (nm) | Full sovereignty over activities; Must allow innocent passage of foreign vessels (with exceptions) |
| EEZ and Continental Shelf | Contiguous Zone = 12-24 nm; EEZ = 12-200 nm; Continental Shelf = Up to 200 nm or to the farthest extent of the continental margin, usually up to 350 nm | Contiguous Zone = Disciplinary actions against customs, fiscal, immigration, and sanitary violations committed within territorial sea; EEZ = Sovereignty over natural resources and environment; Must allow freedom of navigation; Continental Shelf = Sovereignty over natural resources in seabed and subsoil, not the water column |
| Straits and Archipelagic Waters | Straits = Typically within territorial seas, sometimes patches of EEZs and high seas; Archipelagic Waters = Straight baselines drawn between outermost features of outermost archipelagic islands | Straits = States with overlapping territorial seas agree on median line or an alternative boundary, but no overlapping sovereign areas; Some preemptive regulation of security, safety, pollution; Must allow transit passage; Archipelagic Waters = Some preemptive regulation of security, safety, pollution; Must allow sea lane passage |
| High Seas | Beyond 200 nm | None against sovereign-immune vessels, very limited general exceptions (e.g., pirate assets, stateless, mutual consent); Flag state is primary authority |
| International Seabed (“The Area”) | Usually beyond 200 nm, though exceptions for extended continental shelf claims | None, governed by International Seabed Authority (ISA) |

⁴³ Please refer to citations from Table 5.

Sample of Regulatory Bodies

International Maritime Organization (IMO): United Nations entity, comprehensive standard-setter for the safety, security, and environmental protectiveness of ships

International Seabed Authority (ISA): mineral/resource-based regulatory body

International Law Commission: expert United Nations body that produces influential materials on maritime law

United Nations Commission on the Limits of the Continental Shelf: reviews and offers recommendations on shelf-limit submissions from coastal states

International Association of Classification Societies: creates technical benchmarks for constructing and operating various maritime platforms

Other international, state, and regional port control, environmental, and resource-based organizations: fisheries management, International Telecommunication Union, domestic entities with enforcement authority, etc.

Sample of Arbitration Bodies

International Court of Justice: adjudicates state disputes, binding to parties

International Tribunal for the Law of the Sea (UNCLOS Annex VI): unique permanent court that adjudicates disputes around UNCLOS' interpretation and enactment

Permanent Court of Arbitration: administrative, non-judicial body that supports maritime and non-maritime cases in arbitral tribunals

Arbitral Tribunals (UNCLOS Annex VII): temporary panels appointed by parties to arbitrate cases on ad-hoc basis, binding

Private, regional bodies: usually address commercial issues; London and Singapore Maritime Arbitrators Associations, for example

Sample of Prominent Maritime Legislation

International Convention on Civil Liability for Oil Pollution Damage (CLC): describes shipowners' liability for oil pollution

Convention on the International Regulations for Preventing Collisions at Sea (COLREG): navigation/collision safety criteria

Law of Armed Conflict: protects and regulates different classes of vessels during the conduct of naval warfare

London Dumping Convention (LDC) and London Protocol: offers standards to prevent dumping-based pollution

Convention on Limitation for Liability of Maritime Claims (LLMC): restricts shipowners' financial liability for injurious or fatal claims

International Convention on Load Lines: instructs safe carriage of cargo

International Convention on Maritime Search and Rescue (SAR Convention): establishes coordination guidance for emergencies at sea

International Convention for the Prevention of Pollution from Ships (MARPOL): comprehensive guidance for limiting a wide range of pollution, including after accidents or errors

International Convention for the Safety of Life at Sea (SOLAS): standardizes extensive safety parameters all elements of merchant ships

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW): sets training standards for mariners

Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation (SUA Convention): provides paths for action against maritime crime and aggression

United Nations Convention on the Law of the Sea (UNCLOS): wide-ranging, outlines maritime zones, rights, dispute resolution, etc.

The combination of voluntary participation and uncertainty in maritime law, inconsistent authorities across and within maritime zones, and theme-specific or regional legislation results in some areas being more thoroughly governed than others. Absent explicit uncrewed-system provisions, the above accords leave open questions about who or what is subject to regulations, in addition to how, where, and why. Moreover, while gray-zone operations are as old as maritime law, the listed entities lag behind state-of-the-art subversion tactics, even from more heavily litigated crewed vessels. Despite the maritime legal regime not being exclusively responsible for deterring and remedying states' irregular activities, the next section explores why it is ill-equipped to deny, interrupt, and respond to those from UUVs.⁴⁴

⁴⁴ Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," 55-72.

Implications: Where Irregular UMV Uses Meet Maritime Law

Many scholars highlight the multifariousness and frequent inadequacy of the maritime legal regime to solve territorial disputes, protect important civilian and military assets, steward marine environments, and systematically support interstate cooperation, along with other problems.⁴⁵ Uncrewed systems are another stressor on this already troubled architecture.

UMVs challenge countless legal minutia; this paper selects a few major problems and digests them from a strategic (as opposed to a scrupulous juridical) perspective. The rest of this section goes over why core themes of asset status, rights, and obligations according to maritime area apply to UMVs' irregular potential. In other words, the fundamental question of jurisdiction encapsulates all problems explored below—who may do what, where, when, why, and how.

Ship Classification and Operator Status: Much of the literature is preoccupied with what a UMV even *is*, legally. A vehicle's classification affects where, when, and how it can operate. Debates revolve around whether UMVs 1) can qualify as ships/vessels (interchangeable terms), 2) whether they can further don a belligerent status as warships, and 3) whether they are relegated to craft, vehicle, device, "sensor and system suite," or weapon status.⁴⁶ Each status has unique implications.

To the first point, flag states' domestic law, multinational classification societies, international accords, and customary law shape UMVs' legal identities.⁴⁷ Most of these entities and informed authors appear to be currently coalescing around the idea that an asset's crewed vs. uncrewed status is not what dictates whether it is a vessel or something else—rather, capability-based criteria might better suit this changing technological landscape.⁴⁸ As Simon McKenzie observes, UNCLOS treats the definition of "ship"/"vessel" with a light touch, outlining in Article 94 features a

⁴⁵ Philipp Peter Nickels, "Book Review: Regime Interaction in Ocean Governance: Problems, Theories and Methods, edited by Seline Trevisanut, Nikolaos Giannopoulos and Rozemarijn Roland Holst," *The International Journal of Marine and Coastal Law* 36 (2021), <https://doi.org/10.1163/15718085-bja10058>; Nilüfer Oral in *Regime Interaction in Ocean Governance: Problems, Theories and Methods*, ed. Seline Trevisanut, Nikolaos Giannopoulos and Rozemarijn Roland Holst (Brill Nijhoff: Leiden, 2020).

⁴⁶ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 91.; Natalie Klein, James Kraska, and Rob McLaughlin in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 6, 12, 82, 145.; Sanjeet Ruhel, "The evolving seascape of naval warfare: unmanned underwater vehicles and the challenges for international law," *Journal of Conflict & Security Law* 29 (2024): 349, 71, <https://doi.org/10.1093/jcsl/krae011>.; Malgorzata Materna, "Adjusting the Aperture: The International Law Case for Qualifying Unmanned Vessels as Warships," *International Law Studies* 100, no. 452 (2023): 480.; Simon McKenzie, "When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea," *Melbourne Journal of International Law* 21 (2020): 13-14.; Hitoshi Nasu, "Book Review: Disruptive Technology and the Law of Naval Warfare by James Kraska and Raul Pedrozo," *Asian Journal of International Law* (2022), <https://doi.org/10.1093/oso/9780197630181.001.0001>.; Michael Schmitt and David Goddard, "International law and the military use of unmanned maritime systems," *International Review of the Red Cross* 98, no. 2 (2017): 592, <https://doi.org/10.1017/s1816383117000339>.

⁴⁷ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 77.

⁴⁸ David Letts and Raul Pedrozo in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 113, 115.

ship must exhibit to the satisfaction of its flag state, including being “in the charge of a master.”⁴⁹ McKenzie advocates for “evolutionary interpretation” of what devices constitute a ship, as a vessel’s deployment need not be physically overseen, just sufficiently safe (according to the standards mentioned above).⁵⁰ Other definitions concern functions or features, requiring shifts in status during a single sortie or specific rights of registration.⁵¹ In any case, many experts say that UUVs *can*, by various metrics, sometimes qualify as ships.

To the second point, all maritime vehicles, crewed or uncrewed, fall into government vs. non-government and vessel vs. non-vessel categories. *Government-owned, non-commercial* vehicles (vessels or any “state property” for “public use”) enjoy sovereign immunity in all maritime zones—including foreign territorial waters—which shelters them from other states’ jurisdiction (military, criminal, civil), regardless of their crewed or uncrewed status.⁵² Private and government-owned commercial vehicles (e.g., state-owned ferries and cargo ships) lack sovereign immunity.⁵³ Government-owned, non-commercial UUVs can thus enjoy sovereign immunity as distinct platforms, as an appendage to a mothership, and—though contested—as public-use devices.⁵⁴

Experts have not fully settled whether UUVs can be warships due to UNCLOS Article 29’s ambiguity around requiring that a vessel be “manned by a crew which is under regular armed forces discipline.”⁵⁵ Some argue that this language could adapt to armed-forces oversight rather than people on a boat, in addition to the original provision not accounting for novel technologies, rather delineating state vessels from privateers.⁵⁶ Warship status is important because “coastal states are not entitled to board a foreign warship or use force against it to assert law enforcement jurisdiction, even in response to violations of innocent passage.”⁵⁷ That they can be belligerents in wartime is relevant if they commit irregular acts during peacetime, as retribution could portend escalation.⁵⁸

⁴⁹ McKenzie, “When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea,” 25, 29.; United Nations, “United Nations Convention on the Law of the Sea,” Article 94 (4) § (1982), https://www.un.org/depts/los/convention_agreements/texts/unclos/part7.htm.; Schmitt and Goddard, “International law and the military use of unmanned maritime systems,” 567, 77.; Ruhal, “The evolving seascape of naval warfare: unmanned underwater vehicles and the challenges for international law,” 356.; Igor Vio and Mate Brdar, “Maritime Autonomous Surface Ships – International and National Legal Framework,” *Pomorski zbornik* 64 (2022): 144.

⁵⁰ Simon McKenzie, “When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea,” 12-14.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 90, 94.

⁵¹ Vio and Brdar, “Maritime Autonomous Surface Ships – International and National Legal Framework,” 153.

⁵² Natalie Klein, James Kraska, David Letts, Raul Pedrozo, and Rob McLaughlin in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 13, 77, 80, 83-84, 89, 91, 101, 112, 156, 158. McKenzie notes that UNCLOS does not explicitly provide for non-vessels’ sovereign immunity, though it is derived from custom and other laws.

⁵³ Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 8-9.

⁵⁴ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 75, 78, 95.

⁵⁵ “United Nations Convention on the Law of the Sea,” (1982), Article 29 https://www.un.org/depts/los/convention_agreements/texts/unclos/part7.htm.; Materna, “Adjusting the Aperture: The International Law Case for Qualifying Unmanned Vessels as Warships,” 461.

⁵⁶ Materna, “Adjusting the Aperture: The International Law Case for Qualifying Unmanned Vessels as Warships,” 454, 67-68, 74.; McKenzie, “When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea,” 15-16, 26, 29.; Vio and Brdar, “Maritime Autonomous Surface Ships – International and National Legal Framework,” 144.

⁵⁷ James Kraska in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 83, 97-98.

⁵⁸ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 97.

To the third point, this paper has already established that U MVs can, in some cases, be vessels. An ongoing debate is whether U MVs represent a new category of vessels or simply a novel method of operating within existing categories of assets.⁵⁹ This suggests that operator status—or the degree to which a human pilots the vehicle—has legal bearing on responsibility for and responses to an action. The more human involvement, the less of an issue: “There is nothing to prevent a flag state from ensuring that the master, officers, and crew that are remotely manning and operating a UMS are fully competent to observe the applicable international regulations ... and maintain radio communications.”⁶⁰ Partially or fully autonomous (and AI-enhanced) systems pose hanging issues for a variety of legal dicta—but it is not clear that the answers to those questions will mandate new U MV classification(s).

In practice, practitioners are likely to classify many U MVs as ships or vessels, while others may fall into non-vessel categories, such as weapons, devices, or sensors.⁶¹ How a lack of onboard crew and incorporation of autonomy affect these categories’ privileges/rights and restrictions is still up for debate. This paper does not address those intricacies for the sake of simplicity—the main takeaway is that non-vessels may operate less freely and receive less legal deference. Indeed, ongoing legal uncertainties may lead to disputes over U MVs’ statuses if an incident occurs, particularly those within contested areas and including devices with diverse payloads and missions.⁶² This is not hypothetical: in the 2016 *Bowditch* Incident, Beijing seized a U.S. U MV in contested waters, classifying it as an “unidentified object,” while the United States claimed sovereign immunity and requested its expeditious return.⁶³ Standards of practice have advanced since then, but the rapid proliferation of this technology over the last several years is sure to introduce new cases.

Navigation Rights: Navigation rights depend on maritime zones, as defined by UNCLOS. Each zone has specific privileges and overlapping or exclusive authorities. Broadly, the farther and deeper from a state’s coast an irregular U MV incident occurs, the less jurisdiction that state has to respond.⁶⁴

Ships have the rights of innocent passage through territorial seas, transit passage through straits and sea lanes, and freedom of navigation from EEZs to the high seas. As alluded to above, the jury

⁵⁹ Henrik Ringbom and James Kraska in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 51, 80.

⁶⁰ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 90.

⁶¹ Natalie Klein, David Letts, and Raul Pedrozo in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 6, 112.

⁶² Wangwang Xing and Ling Zhu, “A functional approach to reassessing the legal status and navigational rights of ships and ship-shaped structures,” *Transport Policy* 106 (2021): 121, 24, <https://doi.org/10.1016/j.tranpol.2021.03.025>;

Vladislav Belyakov, “К вопросу о правовом статусе морских автономных аппаратов [On the Issue of the Legal Status of Marine Autonomous Vehicles],” *Eurasian Integration: Economics, Law, Politics*, no. 1 (2021),

<https://doi.org/10.22394/2073-2929-2021-01-62-67>; Xing and Zhu, “A functional approach to reassessing the legal status and navigational rights of ships and ship-shaped structures,” 120, 25.

⁶³ Richard Dunley, “Uncrewed naval vessels and the span of maritime tasks,” *Marine Policy* 149, 105481 (2023): 4,

<https://doi.org/10.1016/j.marpol.2023.105481>; Ruhul, “The evolving seascape of naval warfare: unmanned underwater vehicles and the challenges for international law,” 369; McKenzie, “When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea,” 3; Schmitt and Goddard,

“International law and the military use of unmanned maritime systems,” 568.; Arthur Michel in John Jackson, ed., *One Nation, under Drones*, 60-61.; James Kraska in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 87.

⁶⁴ Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 76-83-84.

is still out on whether UMVs classified as *non-vessels* will have the same navigational rights as vessels, though current signs point to no right of innocent passage, with category-dependent navigational privileges preserved.⁶⁵

The flag state must ensure that UMVs meet technical/physical competency standards. Wangwang Xing and Ling Zhu argue that UMVs should only gain navigation rights through autonomous safety performance metrics.⁶⁶ A possible implication is that regulators may have to classify every platform with exchangeable payloads individually to ensure its physical dynamics do not compromise safe and reliable performance.⁶⁷ Another is that UMVs might “warrant more precautions” internally and from surrounding vessels, thus possibly meriting “compulsory insurance.”⁶⁸ They could create a “‘chilling’ effect on commercial shipping over a wide area—and therefore impinge on the right of freedom of navigation,” highlighting the need for legislation to soberly weigh civilian and commercial operations against UMV proliferation and applications.⁶⁹

Similarly, UMVs must comply with traffic rules and communicate with coastal states and third-party vessels—particularly when closely scrutinized in territorial waters—to avoid being interpreted as non-innocent. This means that underwater UMVs must both be physically able and willing to surface and deactivate any suspect systems to prove innocent passage.⁷⁰ In territorial seas, UMV “passage is considered prejudicial” to a coastal state if engaging in force or threats of force, exercising weapons, amassing information against the coastal state, propaganda, launching or taking military devices, carrying out marine science, and impeding communications.⁷¹ Their capacity to interfere with other vessels’ navigation through EW and other means may justify a coastal state’s response to preserve the safety of their coast, but these disruptions do not necessarily constitute a use of force and thus furnish the right to self-defense.⁷²

Interdiction, therefore, is an important sub-topic. For example, as argued by Richard Dunley, human interaction is an integral part of Freedom of Navigation Operations; the absence of a crew may tempt observers to disregard norms or question perceived commitment.⁷³ Put otherwise, even if regulators classify a UMV as a ship and grant it navigational privileges, it may not command the same respect or legal weight as crewed vessels and warships. As a result, UMVs are more

⁶⁵ Simon McKenzie in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 126-128, 143.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 99, 103.

⁶⁶ Xing and Zhu, “A functional approach to reassessing the legal status and navigational rights of ships and ship-shaped structures,” 127.

⁶⁷ *Sustainability in the Maritime Domain: Towards Ocean Governance and Beyond*, ed. Angela Carpenter, Tafsir M. Johansson, and Jon A. Skinner (Cham, Switzerland: Springer, 2021), 326.

⁶⁸ Iva Parlov, “Can the International Regulatory Framework on Ships’ Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?” *Ocean Development & International Law* 54, no. 2 (2023): 173, <https://doi.org/10.1080/00908320.2023.2211781>.; Jhonnie Mikael Kern in Abhinayan Basu Bal et al., *Regulation of Risk: Transport, Trade and Environment in Perspective* (2023), 385.

⁶⁹ Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 84-87, 96.

⁷⁰ Simon McKenzie in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 134-135, 138, 144.

⁷¹ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 103.; David Letts, Raul Pedrozo, and Simon McKenzie in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 118, 133.

⁷² Tracy Reynolds and Hitoshi Nasu in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 161, 178-179.; United Nations, “Chapter VII — Action with Respect to Threats to the Peace, Breaches of the Peace, and Acts of Aggression,” Article 51 § (August 2016), <https://legal.un.org/repertory/art51.shtml>.

⁷³ Dunley, “Uncrewed naval vessels and the span of maritime tasks,” 4.

vulnerable to swift detainment or destruction, and malicious actors may exploit them as bait for aggression.

Though this section does not address all important navigation considerations, including their changes during war, it does demonstrate that navigation rights, themselves dependent on vehicle classification, are one element that informs what stakeholders might consider acts irregular in the first place.⁷⁴ The rights regulators bestow to both perpetrators and victims and the degree of violation may sway how a subsequent back-and-forth evolves, if at all.

Environment and Resources: Like other categories, the environmental legal challenge depends on where an irregular act takes place and whether the perpetrator has sovereign immunity. The three primary concerns are litter, such as abandoning expendable UUVs as debris, pollution, such as chemical spills, and resource theft, such as illegal fishing and mining.⁷⁵ The former two acts could affect a target population by endangering marine life and creating downstream hazards.

States highly value oceanic resources, hence their likely candidacy for gray-zone activity, but they are hard to proactively protect. Most of the time, civil maritime authorities will operate unless a military authority occupies a zone—the former means that coastal states will usually exercise sovereign rights over the resources within their continental shelves and EEZ. No vessels, including UUVs, can legally “occupy” contested shelves or EEZs, whether in peacetime or formal conflict, but they may intrude upon these waters to establish *de facto* control or covertly extract.⁷⁶

The maritime domain does boast considerable environmental legislation, though private interests occasionally politicize compliance and interaction with domestic laws.⁷⁷ International bodies have made clear the dire effects of oceanic contamination and the necessity of responsibly extracting resources, but the ocean is vast, and UUVs can be small or hidden. If authorities fail to interdict or gather persuasive evidence of an act, it is difficult to hold perpetrators accountable.

Attribution: Attribution is a straightforward and consequential legal problem at sea, which UUVs aggravate. Put simply, besides their own information flows and sensor packages, maritime platforms and coastal entities rely on voluntary vessel signals for situational awareness, meaning uncommunicative or deceptive objects could attempt to obscure their presence or disguise their origin, if found.⁷⁸

⁷⁴ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 36-37.

⁷⁵ Marina Lesse, Philip DeCocco, and Kristen Fletcher, "Advancing Clarity: Analysis of UxS Legal Questions" (OCEANS 2022, Hampton Roads, 2022).; Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 267-268.

⁷⁶ Shani Friedman, "The Application of the Law of Occupation in Maritime Zones and Rights to 'Occupied' Marine Resources," *The International Journal of Marine and Coastal Law* 36 (2021): 421, 24, 23, 28-29, 31, 33, <https://doi.org/10.1163/15718085-bja10064>.

⁷⁷ So Yeon Kim, "Problems and Processes of Restricting Navigation in Particularly Sensitive Sea Areas," *The International Journal of Marine and Coastal Law* 36 (2021): 454, 62-63, <https://doi.org/10.1163/15718085-bja10062>.

⁷⁸ Louis Von Kahle and Robert Alexander, "Multi-INT fusion to support port and harbor security and general maritime awareness" (Sensors, and Command, Control, Communications, and Intelligence (C3I) Technologies for Homeland Security and Homeland Defense V, 2006).; Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 272.

The possibility of proxy operations, in which a third party operates an asset flagged by a given state, further muddles matters.⁷⁹ According to Jonathan Wilkenfeld et al., not only are non-state proxies more likely to use violence than their state counterparts, sponsors, or opponents, but they also tend to elicit more aggressive responses from their targets in the gray zone.⁸⁰ Proving that a proxy is conducting illicit activities by identifying an independently controversial genuine link to the perpetrator state or statelessness is very demanding.⁸¹ A shipowner's contractual links between a proxy and flag state may help prevent the latter from fully abdicating responsibility.⁸²

In the past, inaction has sprung from simply not having conclusive evidence of a specific asset committing an irregular act, letting the suspected culprit off through plausible deniability.⁸³ While attribution is not necessarily dispositive of remediation on its own, without it, a victim may have few responsive levers to pull.

Liability and Accountability: The question of remote vs. autonomous operation is essential to finding liability for accidents or offenses involving UMs. That is, it partially depends on if one can trace the command of an uncrewed vessel to an operator, which conceptually extends to commercial or military entity, or even upstream designers and engineers.⁸⁴

Disjunct standardization efforts indicate that remote operators must have appropriate education, which may include prerequisite time on a physical ship.⁸⁵ Studies note confusion among operators on whom to consult and how when faced with abnormal occurrences, given the “regulatory vacuum” around uncrewed operations.⁸⁶ Other variables are differing degrees of autonomy during a single sortie and the extent to which developers incorporate AI decision-making into a vessel's

⁷⁹ Sergiu Mitrescu and Martin Sokolov in *Defending Maritime Assets - Approaches to Critical Infrastructure Protection*, 81.; Rob McLaughlin and Natalie Klein, "Maritime Autonomous Vehicles and Drug Trafficking by Sea: Some Legal Issues," *The International Journal of Marine and Coastal Law* 36 (2021): 407, <https://doi.org/10.1163/15718085-bja10061>.

⁸⁰ Jonathan Wilkenfeld et al., "Escalation Management in Gray Zone Crises: The Proxy Factor," *International Studies Quarterly* 66 (2022): 2, 11-12, <https://doi.org/10.1093/isq/sqac038>.

⁸¹ Serhii Kuznietsov, "The 'Genuine Link' Concept: Is It Possible to Enhance the Strength?" *Lex Portus* 7, no. 6 (December 29, 2021), <https://doi.org/10.26886/2524-101x.7.6.2021.3>.

⁸² Henrik Ringbom in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 61, 64-65, 72.

⁸³ Jill Goldenziel, "Law Can't Stop Submarine Cable Sabotage. Russia And China Know It.," *Forbes*, February 14, 2025, <https://www.forbes.com/sites/jillgoldenziel/2025/02/13/law-doesnt-protect-undersea-cables-russia-and-china-know-it/>.; Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," 57.

⁸⁴ Anastasiya Golovina, "On the issue of the legal status of persons exercising control of a maritime autonomous surface vessel," *SHS Web of Conferences* 134, 00114 (2022): 2, <https://doi.org/10.1051/shsconf/202213400114>.; Vio and Brdar, "Maritime Autonomous Surface Ships – International and National Legal Framework," 147.; Justyna Nawrot and Zuzanna Peptowska-Dąbrowska, "Revolution or Evolution? Challenges Posed by Autonomous Vessels for National and International Legal Framework," *Comparative Law Review* 25 (2019): 255, <https://doi.org/10.12775/clr.2019.008>.; Andréia Propp Arend, "Liability and Responsibility in Autonomous Navigation: A Content Analysis " *Ratio Juris* 20, no. 40 (2025): 3-4, 16-17, <https://doi.org/10.24142/raju>.; Petrig, "Autonomous offender ships and international maritime security law," 42.

⁸⁵ Yemao Man et al., "Human factor issues during remote ship monitoring tasks: An ecological lesson for system design in a distributed context," *International Journal of Industrial Ergonomics* 68 (2018): 241, <https://doi.org/10.1016/j.ergon.2018.08.005>.; Nawrot and Peptowska-Dąbrowska, "Revolution or Evolution? Challenges Posed by Autonomous Vessels for National and International Legal Framework," 252.

⁸⁶ Man et al., "Human factor issues during remote ship monitoring tasks: An ecological lesson for system design in a distributed context," 238.

behavior.⁸⁷ Though not the focus of this piece, ethical persuasions around what operators can reliably relinquish to AI may eventually find expression in legal edicts.⁸⁸ Complicating the matter further is whether a state purchases or operates loaned UMVs under an allied framework or if states and non-states gain fleets through industry deals.⁸⁹ Spelling out the “rights and obligations” of these systems, individuals, and parent entities at the domestic and international levels will have decisive consequences for legal responses to irregular actions.⁹⁰

Effective public-private interactions are essential to successfully executing maritime law. For at least pollution (and maybe for cyber issues), liability primarily lies with the shipowner. If they feel unfairly accused of participating in a gray-zone act, a shipowner could become embittered and potentially act rashly against an actor who may have provoked or framed them, or if unquestionably responsible, refuse to cooperate with an oversight body/state or obfuscate blame.⁹¹ So appears an elemental principal-agent problem, in which a private entity escalates without government consent.

Moreover, public-private interactions complicate emergency responses, which could temper or flare tensions. Submarine cables, for example, can be owned by one up to a few dozen companies responsible for their hardening and repair.⁹² This dynamic is problematic if parties determine that cables are a legitimate military objective and attack them during armed conflict; in peacetime, they have some protection, but existing accords do not account well for the fact that many states rely on the same dual-use cables and may thus fall prey to collateral damage from cyberattacks and sabotage.⁹³ Sound safeguards and coordinated response strategies are essential to mitigate gray-zone crises, avoiding cascading consequences that tempt escalation.

On accountability, salient is whether actors might use and abuse UMVs for constabulary purposes. Law enforcement vessels must be governmental property and therefore sovereign immune, which is important in light of situations like The PRC’s reidentification of commercial or other civilian vessels to carry out policing or coast-guard-like duties.⁹⁴ Using UMVs for similar activities conjures several issues, such as if autonomous systems can sufficiently mitigate against human injury or death, damage of vessels or other UMVs, and whether they can or must render assistance.⁹⁵

⁸⁷ *Sustainability in the Maritime Domain: Towards Ocean Governance and Beyond*, 333, 22.; Parlov, "Can the International Regulatory Framework on Ships' Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?" 178.; Arthur Michel and Christopher Ford in John Jackson, ed., *One Nation, Under Drones*, 62, 151, 153.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 124-125.

⁸⁸ Duane Davis et al., "Ethical Mission Definition and Execution for Maritime Robotic Vehicles: A Practical Approach" (OCEANS 2016 MTS/IEEE Monterey, Monterey, California, 2016).

⁸⁹ "Oceanography and Remote Monitoring," 38, 50.

⁹⁰ Golovina, "On the issue of the legal status of persons exercising control of a maritime autonomous surface vessel," 3-4.

⁹¹ Natalie Klein and Yurika Ishii in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 16-17, 287-290.

⁹² Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 180-181, 184.

⁹³ *Ibid.*, 192-193, 196, 199-201.

⁹⁴ Douglas Guilfoyle and Edward Sing Yue Chan, "Lawships or warships? Coast guards as agents of (in)stability in the Pacific and South and East China Sea," *Marine Policy* 140, 105048 (2022): 6, <https://doi.org/10.1016/j.marpol.2022.105048>.

⁹⁵ McLaughlin and Klein, "Maritime Autonomous Vehicles and Drug Trafficking by Sea: Some Legal Issues," 409-10, 16-17.; Petrig, "Autonomous offender ships and international maritime security law," 36.; Barbara Stępień, "Navigating New Waters: IMO's Efforts to Regulate Autonomous Shipping," *Chinese Journal of International Law* 23 (2024): 600, <https://doi.org/10.1093/chinesejil/jmae025>.; Sabrina Hasan, "Legal Challenges in Enforcing the Duty to Render Assistance at Sea: Implications for Maritime Autonomous Surface Ships (MASS)," *Journal of Legal Studies* 35, no. 49

On the flip side, dedicated law-enforcement vessels can confiscate proven stateless, misbehaving UUVs in sovereign and international waters.⁹⁶ Authorities might more easily prosecute UUVs with sovereign immunity for smuggling, for example, in straits and territorial seas. How to confiscate and prosecute assets with both licit and illicit cargo, unknown stowaways, or sovereign immunity—especially outside of a state’s singular jurisdiction and without hot pursuit—remain open questions.⁹⁷ Authors note that terrorism and piracy laws likely accommodate delinquent UUVs, granting caveats around fully autonomous systems and the SUA Convention’s exclusion of warships as piracy victims.⁹⁸

Finally, liability and accountability are dependent on the authority of international and domestic bodies available to hear cases and prosecute offenses. Critically, UNCLOS and other regulations prohibit maritime assets from polluting, threatening force, unfairly capturing natural resources, engaging in smuggling or piracy, and other illegal actions.⁹⁹ However, these rules are often unenforceable due to lacking chains of legal command, particularly outside of territorial seas.¹⁰⁰ Though this paper focuses on core legal principles, it is critical in future research to thoroughly investigate international bodies’ authority during armed conflict and peacetime, in addition to their past effectiveness and precedent on issues relevant to UUVs.

Charting Gray Waters

This inquiry has so far covered how UUVs may be technically capable of irregular acts, as well as how operational characteristics of those acts vex maritime law. It now employs three tables to iteratively analyze prevalent legal challenges by activity and maritime area. The tables outline the throughlines between legal complications derived from UUVs’ irregular acts and how such conditions may foster escalation—a more thorough discussion of the latter follows. Their framing proffers that the gray zone is challenged by 1) military UUVs operating provocatively in peacetime, 2) antagonistic state-flagged commercial or academic UUVs, or 3) unflagged delinquent UUVs.

(2025): 31, <https://doi.org/10.2478/jles-2025-0002>; Md Saiful Karim and Alexander Proelss in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 203-204.; Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 80.

⁹⁶ Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 268.

⁹⁷ Natalie Klein, Md Saiful Karim, Alexander Proelss, and Sianne Tsandidis in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 4-5, 8-10, 15, 183, 185, 252.

⁹⁸ Natalie Klein, Md Saiful Karim, and Douglas Guilfoyle in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 22, 207, 210-211, 213, 215, 218, 221, 223-224.

⁹⁹ United Nations, “United Nations Convention on the Law of the Sea,” (1982), Articles 58, 88, 92, 94, 101-110, 211, https://www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm; Yurika Ishii in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 290-291.

¹⁰⁰ Pratik Jakhar, “Whatever happened to the South China Sea ruling?” Lowy Institute, July 12, 2021, <https://www.lowyinstitute.org/the-interpretor/whatever-happened-south-china-sea-ruling>.

Table 3. Analysis of key legal challenges posed by U MVs.¹

| Legal Challenges | Key Documents | Relevant Concepts and Legal Principles | Main Gray-Zone/Legal Uncertainties & Gaps | Main Escalation Implications |
|---|---|--|--|--|
| Ship Classification and Operator Status | UNCLOS; SOLAS; STCW; Load Lines Convention; COLREG; SAR Convention | Sovereign immunity; Documentation; Duty of seaworthiness; Innocent passage; Transit passage; Flag-state law observance | Which, where, when, and how responsive legal levers might be pulled; Classification and/or sovereign immunity privileges dictate status of perpetrator craft and, if present, victim craft | Whether a U MV is a ship, warship, device, or weapon is consequential for perpetrator and victim calculus, as the same act by different classifications of vehicles might elicit different effects |
| Navigation Rights | UNCLOS; COLREG; SOLAS; LOAC | Freedom of navigation; Innocent passage; Transit passage; Hot pursuit; Duty to avoid collisions; Duty to report incidents; Obligation to maintain communications; Due diligence | Certain types of assets' statuses contested, particularly regarding innocent passage in territorial seas | Opportunities for misinterpretation of intent; Obstructing civilian/commercial navigation has major secondary effects; Potential forceful responses or detainment |
| Environment and Resources | MARPOL; CLC; LDC and London Protocol; Various IMO pollution Conventions; UNCLOS; Regional conventions like the Polar Code | Obligation to prevent, reduce, and control pollution; Environmental impact assessment; Polluter pays; Due diligence | Shipowner responsibility for pollution complicated by uncrewed systems due to other opportunities for upstream and downstream error | Potentially wide-ranging primary and secondary effects on living and non-living resources; Resource theft or compromise may be inflammatory for highly competitive actors |
| Attribution | UNCLOS SUA Convention LOAC | State responsibility; Genuine link; Effective control; Circumstantial evidence | Most fundamental consideration for which responsive levers are available to be pulled | No attribution leaves very few response mechanisms, mostly signaling; Misattribution opens doors to misled responses, risking conflict spreading beyond perpetrator-victim pair(s); Lack of legal mechanisms available may favor more aggressive solutions |
| Liability and Accountability | UNCLOS; LLMC; STCW; SUA Convention; SOLAS | Duty of care; Due diligence; Vicarious, strict, fault-based liability; Duty to compensate; Duty to render assistance; Due diligence; Duty to cooperate over the repression of piracy | Crewless assets potentially difficult to prosecute, especially if stateless or disguised as such; Disputes over responsibility and/or blame within victim or target entity | Principal-agent problem of private entities acting unilaterally; Unclear enforcement mechanisms for actors found to be liable and nominally disciplined |

Table 4. Analysis of UUVs' irregular interfaces with maritime law and propensity to affect escalation.²

| Irregular Activities | Principal Legal Challenges | Perpetrator's Competitive Advantages | Escalation Consequences |
|--|--|---|--|
| Military and/or civilian/commercial asset ISR | Ship classification and operator status | Stealthy, maneuverable, comparably cheap method of information collection | May be considered expected and tolerated statecraft |
| Military and/or civilian/commercial EW and ASW | Ship classification and operator status; Attribution; Liability and accountability | Stealthy, maneuverable, comparably cheap method of jamming and/or spoofing | Traditionally punished through sanctions, unlikely to cause significant escalation unless costing lives and expensive assets |
| Military and/or civilian/commercial navigational obstruction or non-destructive harassment (blockage; noise/light) | Ship classification and operator status; Attribution; Liability and accountability | Stealthy, maneuverable, comparably cheap instrument to delay or frustrate any range of targets | Inflammatory, and past legal dictates (e.g., 2016 South China Sea) have done little to quell determined harassers |
| Military and/or civilian/commercial kinetic attack (water cannon, loitering munition/mine; torpedo; ramming; piracy) | Ship classification and operator status; Attribution; Liability and accountability | Stealthy, maneuverable, comparably cheap instrument to inflict damage on expensive, high-value assets | Highly provocative, one of the most escalatory options, certainly if targeting military assets |
| Cyber sabotage and/or data/IP capture | Ship classification and operator status; Attribution; Liability and accountability | Gain technological knowledge; Deniability through technological malfunction or destruction of evidence; Some ambiguity around what counts as kinetic attack | Use of a victim's own asset against them complicates retribution available, but likely not independently escalatory unless it sustains damage itself or inflicts it on a more valuable asset |
| Critical infrastructure manipulation, obstruction, or destruction (undersea cables; pipelines; landing stations; ports; offshore energy and extraction installations) | Attribution; Liability and accountability; Navigation rights; Environment and resources | Economic damage to victim; Victim's domestic preoccupation with mitigation | Depending on degree to which civilian population is affected, can range from relatively minor escalatory consequences to almost certain crossing of red line |
| Drug, weapons, technology, or other illicit material trafficking/smuggling | Attribution; Liability and accountability; Navigation rights | Potential to blame other state or non-state actor; Downstream effects on victim's domestic and broader geopolitical stability | Unlikely to escalate to independently escalate to state-level war, though risks state-non-state kinetic exchanges with follow-on consequences for any sponsor |
| Cargo and/or loitering for boundary contestation | Ship classification and operator status; Navigation rights | Jurisdictional ambiguity exploitable until and perhaps even after official arbitration | Building installations the most escalatory |
| Marine resource theft (fish; minerals) | Attribution; Liability and accountability; Navigation rights; Environment and resources | Economic damage to victim, perpetrator reaps benefits of harvest | Though dependent on abundance and end-use of material, unlikely to be independently escalatory |
| Marine resource contamination or destruction | Attribution; Liability and accountability; Navigation rights; Environment and resources | Economic damage to victim; Victim's domestic preoccupation with mitigation | Direct threat to civilian population may heighten threat of escalation, as with other chemical or biological attacks |

Table 5. Analysis of UMV irregular activity’s legal and escalatory facets by maritime area.³

| Maritime Areas | Relevant Legal Traits | Plausible Gray-Zone Acts | Escalation Consequences | Geographic Jurisdictional Takeaways |
|--|---|--|--|---|
| Territorial Sea | Domestic law reigns; Non-innocent passage provisions (e.g., asking an asset to leave, boarding, seizing, arrest); Sovereign immunity of qualified foreign vessels; Self-defense | ISR; EW and ASW; Navigational obstruction or non-destructive harassment; Kinetic attack; Critical infrastructure manipulation, obstruction, or destruction; Trafficking/smuggling | UMV as a lower-stakes/less valuable target or agent than a crewed vessel, employers may gamble with higher-risk missions and the possibility of interception; Privacy and consent considerations from ISR; Actively blocking or chilling shipping has significant second-order effects (either on a perpetrator’s or victim’s coast) | Domestic law and international law are sometimes in tension; Sovereign immunity for antagonistic assets problematic; Direct, rapid intervention most likely |
| EEZ and Continental Shelf | Limited coastal-state powers, but due include resource-based sovereignty; Considered high seas in wartime; Subject to other states’ critical infrastructure; Overlapping maritime zones; Different states interpret requirements of due regard differently (e.g., ISR); Shelf disputes fairly common | Cargo and/or loitering for boundary contestation; Marine resource theft; Marine resource contamination or destruction; ISR; EW and ASW; Navigational obstruction or non-destructive harassment; Kinetic attack; Critical infrastructure manipulation, obstruction, or destruction; Trafficking/smuggling | Necessity of recognizing surrender—algorithmic or human error; UMVs de-valued compared to crewed vessels, seen as less consequential to lose and thus encouraging bolder retaliation; Frequency of small-scale events over time may accumulate in target’s strategic consciousness unpredictably; Unclear if ISR/ASW/EW between UVMs and target assets will be acceptable statecraft—has implications for as dramatic of problems as second-strike security | Limited coastal-state jurisdiction and different interpretations of acceptable conduct problematic may encourage strategic miscalculation; Resources contentious; Historically, hot spots for provocative kinetic and non-kinetic acts and disregard for international edicts |
| Straits and Archipelagic Waters | May contain one or a few maritime zones; Some contention around innocent and transit passage | ISR; EW and ASW; Navigational obstruction or non-destructive harassment; Kinetic attack | Interference with civilian assets in contested spaces may cause quick escalation to military intervention; Hard-to-spot UVMs may embolden state and non-state actors to threaten high-value targets, eliciting worries over their survivability | Geopolitical and geographic chokepoints leave open possibility of sudden breakout of conflict |
| High Seas | No one state has overarching sovereignty; Weak crime enforcement, oversight, prosecution (with exceptions) | Cyber sabotage and/or data/IP capture; ISR; EW and ASW; Navigational obstruction or non-destructive harassment; Kinetic attack; Critical infrastructure manipulation, obstruction, or destruction | UMVs may not satisfactorily mitigate the risk of death or injury of an opponent, possibly exaggerating a perpetrator’s original ends; Proportionality requires a rich and consistently up-to-date understanding of an adversary’s intentions and willingness to fight, potentially a problem for fully autonomous UVMs | Monitoring and enforcement difficulties may leave irregular activities un- or misattributed and otherwise legally unchecked |
| International Seabed (“The Area”) | No one state has overarching sovereignty; ISA short of credible monitoring and enforcement | Marine resource theft; Marine resource contamination or destruction | Competing interests among powerful states, potential sidelining of less powerful actors; Critical infrastructure sabotage difficult to mend, significant geopolitical and domestic ripple effects | Few options for policing and recourse; Increasingly geopolitically salient due to critical minerals and other untapped resources |

Piercing the Fog: Prospects for Escalation in the Gray Zone

While it is not possible to directly map legal issues in the gray zone to escalation risks, legal uncertainty or inaction clearly inform actors' inclination toward irregular UMV use.¹⁰¹ Such ambiguity may encourage actors to goad victims into what could be illegal retaliation or keep offenses limited enough to stall counteraction.¹⁰² Gray-zone aggression manifests incrementally and ambiguously, with perpetrators possibly escaping identification or hiding behind the excuse of an innocent mistake or malfunction.¹⁰³ While the perpetrator "enjoys ... freedom to maneuver," the victim of a gray-zone activity is in the unenviable position of crafting a response, therefore contending with tricky variables like proportionality, avenue, and visibility.¹⁰⁴

Operating in the gray zone at sea therefore poses significant escalatory risks—not despite, but because of complexities and limitations within supranational legal architectures. An actor might engage irregularly to gain short-term competitive advantages, even if counterproductive to long-term interests.¹⁰⁵ If conflict is not a dichotomy, but a gradient, an aggressor might cross from contention into a violent altercation not necessarily because of a single act, rather a gradual accumulation of many more or less incendiary events¹⁰⁶—the question being how the perpetrator could have known beforehand that an action was the last straw.¹⁰⁷ If the answer is through

Sample of Escalation Factors

Levers Available: prevention, interdiction, and response to irregular acts are limited by explicit legal provisions, and tensions between authorities (or lack thereof) offered by domestic and intentional law

Classification: vehicle status is fundamental to legitimate rights and disciplinary measures, but also a primary factor in potential misattribution, misinterpretation, and miscalculation

Target and Means of Targeting: statecraft norms, recipient, scale, location, and downstream effects of a gray-zone act influence victim's perception, and red lines for repeated acts particularly ambiguous

Geopolitical Context: certain maritime regions with more actors and contested zones may be prone to greater disruption, but do not necessarily enjoy more robust legal safeguards

Private-Public Nexus: principal-agent problem and/or private pressure may obstruct, heighten the stakes of, or otherwise complicate means of resolution

¹⁰¹ Please refer to the Appendix B for a thorough discussion of the logic behind this section.

¹⁰² Mazarr, *Mastering the Gray Zone: Understanding a Changing Era of Conflict*, 10, 65-66, 69.

¹⁰³ Sugio Takahashi, "Development of gray-zone deterrence: concept building and lessons from Japan's experience," *The Pacific Review* 31, no. 6 (2019): 798, <https://doi.org/10.1080/09512748.2018.1513551>. Takahashi frames this discussion through Thomas Schelling's *Arms and Influence*.; Brands, *Paradoxes of the Gray Zone*.

¹⁰⁴ Jordan, "International Competition Below the Threshold of War: Toward a Theory of Gray Zone Conflict," 3.; Schmitt and Goddard, "International law and the military use of unmanned maritime systems," 588.; Sergiu Mitrescu and Martin Sokolov in *Defending Maritime Assets - Approaches to Critical Infrastructure Protection*, 79.; Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," 62.

¹⁰⁵ Brands, *Paradoxes of the Gray Zone*.

¹⁰⁶ Robert Haddick, "America Has No Answer to China's Salami-Slicing," War on the Rocks, August 7, 2015, <https://warontherocks.com/2014/02/america-has-no-answer-to-chinas-salami-slicing/>.; Mazarr, *Mastering the Gray Zone: Understanding a Changing Era of Conflict*, 70.

¹⁰⁷ Takahashi, "Development of gray-zone deterrence: concept building and lessons from Japan's experience," 794.

deterrence, naturally, the irregular context is confounding; an opponent must perceive its victim's deterrent posture—denial, discipline, and rewards for restraint—accurately and credibly.¹⁰⁸

Actors do have some mechanisms to curb gray-zone escalation. Minimal damage, international pressure, domestic circumstances, and other deterrence measures may dissuade victims from responding aggressively. Moreover, perpetrators may wish to send one-time or limited signals, avoiding triangulation of several acts—that is, stopping if the costs of continuing gray-zone trajectory are higher than the benefits. This report does not address the particulars of how escalatory decisions might be deliberated among decision-makers. That being said, it does remark that conflict in the gray zone behaves much like a function approaching an asymptote, itself bold, faint, or even invisible. Gently prodding this boundary over time with an often deniable, expendable, but possibly unreliable technology may result in an unexpected shift in or collapse of the status quo. The legal landscape lacks measures to prevent this. Actors must therefore be mindful of how much normative and institutional erosion they expect a victim will endure.¹⁰⁹

Red-Line Blind

The maritime domain, itself physically formidable, hosts many expensive, high-strategic-value commercial and military assets and pieces of critical infrastructure, as well as countless organic and inorganic resources that are currently impossible to comprehensively monitor.¹¹⁰ Its legal apparatus also entails areas of intense and sparse regulation. Under these conditions, it therefore seems simultaneously true that 1) a perpetrator can, if carefully calculated, surgically assault or manipulate assets to elicit a competitive advantage and avoid unendurable retribution; and 2) risk unintended and potentially dramatic consequences.¹¹¹ UUVs' fundamental contribution to this problem is that they are a relatively low-cost, covert, and scalable way for all kinds of actors to gather valuable information, inflict potentially many billions of dollars of damage, and bring about direct or indirect human harm.¹¹²

One illuminating question worth special attention is whether UUVs change accepted standards of practice around ISR and other common statecraft. States know well that submarines and dual-use commercial and research ships carry out ISR in and outside of armed conflict. "Intentionally unregulated by international law due to its importance for national security," ISR is perfectly legal at war, and in peacetime, it is expected in both the EEZ and territorial sea—though perhaps

¹⁰⁸ Jordan, "International Competition Below the Threshold of War: Toward a Theory of Gray Zone Conflict," 18.; Takahashi, "Development of gray-zone deterrence: concept building and lessons from Japan's experience," 799-800.; Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone." This idea is discussed in detail in Appendix B.

¹⁰⁹ Takahashi, "Development of gray-zone deterrence: concept building and lessons from Japan's experience," 795-96.; Jordan, "International Competition Below the Threshold of War: Toward a Theory of Gray Zone Conflict," 9-17.

¹¹⁰ Esser and Ferretti, *Autonomy for Security: Using Unmanned Platforms for Commercial Marine Security Services*, 18.; Bowers and Kirchberger, "Not so disruptive after all: The 4IR, navies and the search for sea control," 630.; Henri van Soest et al., *Undersea Cables: Evidence submission by RAND Europe* (RAND Europe, 2025), 4, 13.; Soest et al., *Evolving threats to critical undersea infrastructure: Implications for European security and resilience*, 11, 25.

¹¹¹ Keir Giles and Kim Hartmann, "Adversary Targeting of Civilian Telecommunications Infrastructure" (2021 13th International Conference on Cyber Conflict, 2021).

¹¹² Jianmin Zou et al., "Bio-Inspired Topology Control Mechanism for Autonomous Underwater Vehicles Used in Maritime Surveillance" (2013 IEEE International Conference on Technologies for Homeland Security (HST), Waltham, Massachusetts, 2013).; Esser and Ferretti, *Autonomy for Security: Using Unmanned Platforms for Commercial Marine Security Services*, 17.; Mykhailo Samus in *Defending Maritime Assets - Approaches to Critical Infrastructure Protection*, 133.; McLaughlin and Klein, "Maritime Autonomous Vehicles and Drug Trafficking by Sea: Some Legal Issues," 392, 405.

permitted without consent in the latter—and at least nominally limited in straits and sea lanes beyond what is necessary for safety.¹¹³ This means that states’ domestic laws may contradict opponents’ lawful exercise of freedoms in abidance with international law in EEZs and continental shelves.¹¹⁴ Some suggest distinguishing ISR from peaceful maritime research, but how to do so among dual-use vehicles and their needed situational awareness for navigation are not obvious.¹¹⁵

A covert ISR mission in territorial sea conducted by a non-vessel UMV is rendered moot if it surfaces, thus defaulting to non-innocent passage (which is technically not banned by UNCLOS).¹¹⁶ If a state discovers a sovereign-immune UMV has obscured its passage through territorial waters, the target can raise alarm and request that it exit the territorial sea immediately; a private or commercial, independent, non-vessel UMV may not be allowed there in the first place due to not enjoying the right of innocent passage.¹¹⁷ However, the craft can simply refuse, risking heightened tensions and use of force.¹¹⁸ This raises important questions about if and when common, predicted statecraft may be judged unacceptable—and legally so—by an observed actor.

A Surfacing Case

The intermingling legal/gray-zone logical chain this analysis describes is not just theoretical. For example, the PRC has persistently employed maritime gray-zone tactics to extract concessions from militarily inferior actors. Both military and nominally civilian vessels repeatedly harass vessels from or interfere with activities in the peripheral maritime zones of Indonesia, Vietnam, Malaysia, and the Philippines in the South China Sea. Legal ambiguities around “resolving overlapping claims of boundaries at sea” have only encouraged these incursions.¹¹⁹ Onlookers have watched as states try to appeal to supranational authorities or send limited responses, resisting legal precedent-setting to little avail.¹²⁰

Beijing’s strategy is deliberate and coordinated. Internal and external literature on the PRC’s ambitions for local maritime dominance frame it as a whole-of-nation effort.¹²¹ Max Zhang and Shihui Yu describe a window of opportunity for PRC scholars to fill a growing demand within industry for maritime legal expertise. They suggest that PRC universities could even “leapfrog their foreign counterparts” by increasing the quality and quantity of curriculums that anticipate relevant

¹¹³ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 67.; David Letts, Raul Pedrozo, and Rob McLaughlin in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 123, 155, 159.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 104-105.

¹¹⁴ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 131-132.

¹¹⁵ Natalie Klein, Simon McKenzie, and Rob McLaughlin, and Sofia Galani in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 21, 137-138, 148, 150, 301, 310-311.

¹¹⁶ Rob McLaughlin in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 152-153.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 104.

¹¹⁷ Simon McKenzie and Rob McLaughlin in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 139, 154-155, 159.

¹¹⁸ Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 83.

¹¹⁹ Muhamad Arif et al., “Grey Zone Conflict in the South China Sea: The Challenges for Indonesian Maritime Security Governance,” *Contemporary Southeast Asia* 46, no. 3 (2024): 409-12, 23-25, <https://doi.org/10.1355/cs46-3c>.; Clark, Gunzinger, and Sloman, *Winning in the Gray Zone Using Electromagnetic Warfare to Regain Escalation Dominance*, 4.

¹²⁰ Gregory Poling, “China’s Military and Security Footprint in Southeast Asia and the Pacific Islands: China’s Grey Zone Predations in the South China Sea,” testimony before the U.S.-China Economic and Security Review Commission, March 20, 2025, <https://www.csis.org/analysis/crossroads-competition-china-southeast-asia-and-pacific-islands>.

¹²¹ Zhang and Yu, “A review on the preparedness of Chinese maritime law education for emerging industry and technology trends: Sustainable net-zero shipping, maritime digitalization, and application of artificial intelligence technologies,” 2.

subjects like “data governance, cybersecurity protocols, and international standardization efforts,” as well as “International Environmental Law Regime under Sustainable and Net-Zero Development; Data Laws and Digitalization; and AI and Automation”; these themes undergird Xi Jinping’s vision of a “Maritime Community with a Shared Future.”¹²² Put simply, PRC academics recognize that a robust network of maritime legal scholars who understand loopholes offers more dynamic gray-zone options and narrative flexibility to pursue its regional goals.¹²³ Legal expertise, then, might be cultivated in tandem with—rather than isolated from—EDTs. UUVs are one tool primed to exploit these evolving conditions.

¹²² Zhang and Yu, “A review on the preparedness of Chinese maritime law education for emerging industry and technology trends,” 3, 6, 7.

¹²³ Clark, Gunzinger, and Sloman, *Winning in the Gray Zone Using Electromagnetic Warfare to Regain Escalation Dominance*, 67.

Stillwater? The Evolving Legal Regime at Sea

Though it resists prophesying, this report recognizes that legal entities are sure to make headway on regulating various UMV cadres in the coming years.

For the legal structures listed above, the question of whether adaptation is feasible or replacement necessary arises. Scholars appear to occupy two loose and internally disputatious camps: 1) existing maritime regulations are either already implicitly supportive of or flexible enough to newly accommodate UMV use with limited tweaks;¹²⁴ and 2) UVMs represent a paradigm shift the current legal regime is unequipped to handle, requiring a more deliberate reckoning with fundamental maritime legal principles.¹²⁵ The majority appear to agree that while the creators of original regulations did not necessarily envision these technologies, core documents can accommodate them, as happened historically with innovations like submarines.¹²⁶

The IMO is so far leading the way. Its Maritime Safety Committee finished a regulatory scoping exercise in May 2021 for Maritime Autonomous Surface Ships (MASS), the findings of which contribute to a developing draft MASS Code likely to focus on “maritime safety, prevention or marine pollution, and liability and compensation issues” over security.¹²⁷ Developing specific risk projections for various autonomous tasks will ideally constitute strides on safe autonomous navigation and communications, training, “harmoniz[ation]” with existing domestic and international regulations and AI decision-making liability.¹²⁸

However, military strategists need not wait with bated breath for the IMO to release its MASS Code. Barbara Stępień details that the IMO is behind schedule—with an entry into force in 2032—and faces controversy over its very authority to regulate MASS beyond UNCLOS parties.¹²⁹ Moreover, the document will provide clearer but not totally definitive guidance on all elements of UMV

¹²⁴ Parlov, “Can the International Regulatory Framework on Ships’ Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?.”; Nawrot and Pełowska-Dąbrowska, “Revolution or Evolution? Challenges Posed by Autonomous Vessels for National and International Legal Framework.”; Xiang-Yu Zhou et al., “A Study of the Application Barriers to the Use of Autonomous Ships Posed by the Good Seamanship Requirement of COLREGs,” *Journal of Navigation* 73 (2019), <https://doi.org/10.1017/s0373463319000924>.; Martin Leopardi in Bal et al., *Regulation of Risk: Transport, Trade and Environment in Perspective*, 454.

¹²⁵ Negenborn et al., “Autonomous ships are on the horizon: here’s what we need to know.”; Maximo Mejia in Bal et al., *Regulation of Risk: Transport, Trade and Environment in Perspective*, 523.

¹²⁶ Materna, “Adjusting the Aperture: The International Law Case for Qualifying Unmanned Vessels as Warships,” 453, 77.

¹²⁷ International Maritime Organization, “Autonomous Ships: Regulatory Scoping Exercise Completed,” imo.org, May 25, 2021, <https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx>.; Petrig, “Autonomous offender ships and international maritime security law,” 37.

¹²⁸ Floris Goerlandt, “Maritime Autonomous Surface Ships from a risk governance perspective: Interpretation and implications,” *Safety Science* 128, 104758 (2020), <https://doi.org/10.1016/j.ssci.2020.104758>.; Negenborn et al., “Autonomous ships are on the horizon: here’s what we need to know,” 32-33.; Huiru Liu and Maximo Mejia in Bal et al., *Regulation of Risk: Transport, Trade and Environment in Perspective*, 492, 543-44.

¹²⁹ Stępień, “Navigating New Waters: IMO’s Efforts to Regulate Autonomous Shipping,” 626, 29.; Vladislav Sergeevich Veremchuk, “The role of international organizations in developing the legal framework for Maritime Autonomous Surface Ships,” *Analytical and Comparative Jurisprudence*, no. 1 (2025): 845-47, <https://doi.org/10.24144/2788-6018.2025.01.140>.; Natalie Klein and Henrik Ringbom in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 10, 57.

operations.¹³⁰ Authors worry that, in the meantime, states might be willing to take greater risks in legal areas awaiting codification if they play by the rules in other domains.¹³¹

States might benefit from clarifying their regard of UMMVs' legal statuses. Policy may follow from how states want others to perceive them as interstate stakeholders, as well as their threat perception of UMMVs. Scholars and practitioners at least agree that it is unhelpful to try to ban UMMV use altogether, though opinions range from cautious permission to enthusiastic pursuit.¹³² Conversely, one-to-one replacements of crewed vessels with UMMVs are unlikely to materialize exactly because these platforms may not offer users and convince onlookers of high-confidence, flexible peacetime operations.¹³³ Nonetheless, for UMMV-holding states, procrastination does not abrogate their responsibility to build and/or employ the technology in anticipation of and intended compliance with admiralty and other international law, nor will it absolve international institutions of their charge to keep better, albeit imperfect pace with EDT innovation.¹³⁴

Accountability mechanisms could materialize at the state, mini-multilateral, and multilateral levels.¹³⁵ The order of operations matters for setting precedent—early international efforts might frame how individual states may tackle accountability, the alternative being international regulations either having to accommodate myriad state conclusions or require state-level retrofitting.¹³⁶ Igor Vio and Mate Brdar propose several ways this legal conversation might manifest, including adding a chapter on autonomous vessels to SOLAS; concertedly considering the status of device UMMVs within foreign waters; prioritizing remotely operated before fully autonomous ships; determining whether individuals in control centers are crews; and the use of agentic vs. pre-determined AI algorithms.¹³⁷ Overall, absent definitive treaty language on UMMVs' statuses, it is possible that disparate regulatory efforts and cases will determine retroactive treaty interpretation on an ad hoc basis "through practice and expressions of *opinio juris*."¹³⁸

Though not the focus of this inquiry, domestic law and military doctrine also introduce tensions between what may be technically possible and legally practical. A 2024 report from the U.S. Government Accountability Office demonstrated that, in its ambition to incorporate uncrewed vessels into their workflows, the U.S. Coast Guard has struggled with transparency from potential suppliers and sponsors, in addition to statutory obligations around crew numbers—the takeaways

¹³⁰ Henrik Ringbom and Sofia Galani in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 71-73, 304, 306, 313.

¹³¹ Natalie Klein, "Maritime autonomous vehicles and international laws on boat migration: Lessons from the use of drones in the Mediterranean," *Marine Policy* 127, 104447 (2021): 7, <https://doi.org/10.1016/j.marpol.2021.104447>; Stępień, "Navigating New Waters: IMO's Efforts to Regulate Autonomous Shipping," 610.

¹³² *Sustainability in the Maritime Domain: Towards Ocean Governance and Beyond*, 331.

¹³³ Dunley, "Uncrewed naval vessels and the span of maritime tasks," 6.

¹³⁴ Materna, "Adjusting the Aperture: The International Law Case for Qualifying Unmanned Vessels as Warships," 481.; Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 20.

¹³⁵ Liu and Feng, "Navigating uncharted waters: Legal challenges and the future of unmanned underwater vehicles in maritime military cyber operations," 3-4, 8.

¹³⁶ Golovina, "On the issue of the legal status of persons exercising control of a maritime autonomous surface vessel," 5.

¹³⁷ Vio and Brdar, "Maritime Autonomous Surface Ships – International and National Legal Framework," 153.

¹³⁸ Schmitt and Goddard, "International law and the military use of unmanned maritime systems," 577-78, 92.; Martin Leopardi in Bal et al., *Regulation of Risk: Transport, Trade and Environment in Perspective*, 463-64.; Sergiu Mitrescu and Martin Sokolov in *Defending Maritime Assets - Approaches to Critical Infrastructure Protection*, 78.; Yurika Ishii in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 284.

here being 1) that the forthcoming IMO framework may conflict with internal guidance; and 2) that the sometimes dysfunctional or opaque private-public nexus is a significant sore spot for incident, attribution, liability, and accountability.¹³⁹ Finally, the U.S. Navy has also decried unethical uses of UUVs, advocating for self-constraint that it argues will ultimately prove a “competitive advantage.”¹⁴⁰ In this vein, states may narratively exploit the United States’ continued reticence to accede to UNCLOS and formally substantiate its nominal commitments to upholding international maritime law.¹⁴¹

States that abdicate crewed responsibilities and confidence in favor of UUVs will naturally develop and deploy the technology more quickly, perhaps at the cost of safety. Some authors posit that a mixture of subsidies and deregulation may ultimately inform UUV manufacturers’ and buyers’ risk tolerance, perhaps incentivizing various states and their companies to pursue more permissive standards to improve returns on investment.¹⁴² The bottom line is that different states and their private actors are willing to accept various levels of risk—physical, legal, ethical—to take advantage of UUVs’ peaceful, irregular, and military capabilities while devoid of comprehensive international guidance.

Looking Ahead and Concluding Thoughts

This paper focused on the progressively complex intersection of *irregular* applications of UUVs and the seas’ supranational governance architectures. It synthesized UUV technological maturity, how that maturity informs potential gray-zone uses, how those activities will interface with maritime law, and—putting it all together—how outstanding legal questions around problematic UUV employment could affect gray-zone escalation. It argued that the UUV ‘problem’ features intertwined legal and strategic questions that could shape how actors calculate competitive advantage gain versus escalation risk in the gray zone. Specifically, it found that:

1. **UUV maturation will enable gray-zone activities:** UUVs’ dual-use nature/mission elasticity and relative accessibility to actors of all stripes are not side effects, but an essential characteristic of UUVs’ strategic viability in the gray zone. Irregular UUV activity may aim to debilitate, manipulate, or otherwise undermine critical infrastructure or scientific, civilian, commercial, and military assets from a victim’s coast and inland territory to the high seas. Victims must carefully consider what levers they can pull for preemption, intervention, and response.
2. **Irregular UUV uses will strain their maritime legal interface:** The legal regime lacks sufficient gravity and instruments to deter and remediate gray-zone activity on its own. Maritime law is normative, heterogeneous, and ambiguous, meaning its credibility relies on

¹³⁹ Coast Guard: Autonomous Ships and Efforts to Regulate Them, GAO-24-107059, 2, 7, 13 (2024).

¹⁴⁰ Unmanned Campaign Framework, 31 (2021).; *Impact of Unmanned Systems to Escalation Dynamics*.

¹⁴¹ Muhammad Bilawal Khaskheli et al., "Technology advancement and international law in marine policy, challenges, solutions and future prospective," *Frontiers in Marine Science* 10 (2023): 12, <https://doi.org/10.3389/fmars.2023.1258924>.

¹⁴² Takuya Nakashima, Bryan Moser, and Kazuo Hiekata, "Accelerated adoption of maritime autonomous vessels by simulating the interplay of stakeholder decisions and learning," *Technological Forecasting and Social Change* 194, 122710 (2023): 1-2, <https://doi.org/10.1016/j.techfore.2023.122710>.

an actor-specific sense of responsibility and good-faith interstate conduct. Faced with parallel problems of UMs and the gray zone, it is not ineffectual, but its authority is limited.

3. **The gaps this interface expose hold implications for escalation:** It is not fully clear whether UMs will have a net chilling or aggravating effect on gray-zone escalation. At minimum, UM-enabled irregular activities probably expand options for *peacetime* competition—and due *in part* to their legal environment, perhaps unpredictably so. Irregular acts can be low-level or probe right against expected adversary’s threshold for wider violence. Because irregular acts perturb but do not necessarily dismantle norms and codes, even with a known perpetrator, inertia against a dramatic deterioration of relations may give way to tolerance. Alternatively, if a perpetrator miscalculates its victim’s forbearance, an accumulation of low-to-medium-stakes aggression might trend increasingly violent, or a single, incisive event could cross a newly discovered red line.

Going forward, there are several related research avenues that merit attention. First, building directly on this paper, policy practitioners would benefit from works dedicated to detailed, practical case studies of real-world and hypothetical gray-zone UM uses in order to better understand dependent variables affecting escalation. Some might include differences between dual-use UMs and conventional weapons like torpedoes, UM classifications, the interests of great vs. local powers vs. non-state actors, the interests and rights of landlocked vs. coastal states, domestic sedatives vs. catalysts for adoption, etc.

Moreover, the rich literature on escalation management covers the most minor of diplomatic exchanges to strategic nuclear war. Researchers could rigorously dissect how the maritime domain at large interacts with those theories in the gray zone. Also valuable is how actors might *quell* escalation in the maritime domain by dint of its physical and legal characteristics.¹⁴³

More comparative work on other global commons, such as outer space, would be instructive. Some important topics are how states and international bodies exercise jurisdiction over supranational or foreign assets, liability for accidents, environmental damage, and aggression, and the rights of and incentives for private entities to act in common interests, among many more.

Finally, a thorough exploration of the moral vagaries posed by UMs and how those might strain legal mandates in and outside of war would be useful, particularly regarding how parties might design UMs to execute ethical choices related to, at minimum, distinction and proportionality.¹⁴⁴

Far from highfalutin, legal frameworks practically dictate how actors might start, fight, win, or avoid conflict at sea. It is not the intention of this paper to depict the international legal regime as utterly inflexible or obsolete in the face of technological change. Indeed, maritime law has demonstrated remarkable resilience during past sea changes. Rather, this report submits that UMs may agitate this architecture for years to come, especially because of the currently disjunct efforts to legally forecast these technological developments. This predicament may produce unexpected conditions that foment volatile escalation; it is prudent to anticipate their arrival.

¹⁴³ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 117.; Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 88-89. For example, how can parties better wield existing maritime legal bodies and tools?

¹⁴⁴ Robert Sparrow, George Lucas Jr., and Christopher Ford in John Jackson, ed., *One Nation, Under Drones*, 78, 82, 170.

Appendix

Appendix A

This addendum elaborates on the underlying technical requirements for effective UMV use.

Propulsion: Propulsion determines how far and how frequently individual UMVs can travel unaided. While earlier UMVs usually had tethers to motherships, current designs are trending toward completely independent, agentic, and other non-deterministic movement.¹⁴⁵ A principal challenge is engineering a UMV to reliably cover long distances. A vehicle's expected mileage, power usage under active mission guidance, and ability to passively loiter all shape its operational profile. Propulsion, along with communications, navigation, and specialized tasks like sensing drain a UMV's energy reserves.

Modern UMVs are capable of missions ranging from hours to several months, with longer deployments plausible in the future. Some researchers suggest augmenting mission longevity with green energy sources, though these depend on favorable environmental circumstances. Other options include expensive, vulnerable charging stations or prioritizing low-energy drifts and glides.¹⁴⁶ Effective propulsive power management is essential to avoid complete loss of power; retrieval or abandonment leaves assets vulnerable to compromise and criticism.¹⁴⁷

Data Management: Data management refers to a UMV's capacity for secure storage and use of its probably considerable internal information—either to relay to its end-user or employ for navigation. UMVs are almost exclusively edge devices, meaning that unless they are consistently offloading their data to a cloud-based server or physical waystation, hardware will struggle with the computational demands (e.g., high bandwidth, large memory, thermal regulation, power, etc.) of AI-enhanced autonomous systems' long sojourns.¹⁴⁸

Cybersecurity is another critical element of data management. Hostile UMVs could interfere with crewed or uncrewed seaborne or shoreline assets, including hijacking platforms or enacting false flag operations.¹⁴⁹ Threats include disrupting radio frequencies, misleading sensors, manipulating

¹⁴⁵ Donald Costello and Huan Xu, "Generating certification evidence for the certification of collision avoidance in autonomous surface vessels," *Maritime Policy & Management* 51, no. 7 (2023): 2, <https://doi.org/10.1080/03088839.2023.2180156>.

¹⁴⁶ Xi-Yu Li, Wei-Ting Chao, and Ting-Jung Kuo, "Design a Drift Path for Unmanned Surface Vehicles using Nonlinear Model Predictive Control" (2025 IEEE Underwater Technology (UT), 2025).; Haitong Xu, Lúcia Moreira, and Carlos Guedes Soares (eds.), "Maritime Autonomous Vessels," *Journal of Marine Science and Engineering* (2023): 43, 67.

¹⁴⁷ Susanna Kristensen, Alberto Dallolio, and Ingrid Utne, "A systems approach to hazard identification for solar-powered and wave-propelled unmanned surface vehicle," *Journal of Marine Engineering & Technology* 23, no. 2 (2024): 131, <https://doi.org/10.1080/20464177.2024.2315646>.

¹⁴⁸ Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 89.

¹⁴⁹ Shuxin Li et al., "A Novel Robustness-Enhancing Adversarial Defense Approach to AI-Powered Sea State Estimation for Autonomous Marine Vessels," *IEEE Transactions on Systems, Man, and Cybernetics: Systems* 55, no. 1 (2025): 28, 29, <https://doi.org/10.1109/tsmc.2024.3451718>.; Md Saiful Karim, Douglas Guilfoyle, and Yurika Ishii in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 194, 284-285. Bilawal Khaskheli et al., "Technology advancement and international law in marine policy, challenges, solutions and future prospective," 4-5.; Tafsir Matin Johansson, Dimitrios Dalaklis, and Aspasia Pastra, "Maritime Robotics and Autonomous Systems Operations: Exploring Pathways for

communications, attacking on operational and information technology systems, exploiting AI for more sophisticated attacks, backdoor supply chain vulnerabilities, and physical access."¹⁵⁰ In this case, based on potentially long operational timelines, if not transmitted in real-time wirelessly or intermittently through a station, analysts may have to wait anywhere between days to many months to receive a UMV's data and/or realize it is compromised.¹⁵¹ The vast distances and treacherous conditions typical of the open ocean make cyber resilience of any uncrewed system especially difficult to guarantee or enforce.¹⁵²

Communications: A UMV's communications apparatus decides how regularly and by what means it can 'talk' to a mothership, operator, or other headquarters. Not only do these technologies need dependable, economical sensor packages to gather data and traverse their environment, but UMVs must also integrate into a complicated ecosystem of ports and commercial crews.¹⁵³

UMVs therefore must contend with the tremendous noise—both acoustically and signal/sensor-wise—typical of the ocean, particularly near busy shipping lanes.¹⁵⁴ Aggressive weather, high waves, and general oceanic humidity, salinity, and temperature may all deteriorate sensors and other UMV hardware over time.¹⁵⁵ Moreover, contested environments commonly contain jammed or spoofed signals. Without reliable communications, UMVs' users and other actors have little insight into their physical trajectory and mission objectives.

Navigation: Navigation is perhaps the most treacherous technical area of all, with collisions or confusion on the table everywhere, especially around cluttered coasts. Fully autonomous systems rely especially on high-fidelity, intelligent computer vision and a variety of possible sensors and external systems, including (but not limited) to global navigation satellite systems, radar, the AIS, sonar, and physical steering mechanisms.¹⁵⁶ Many studies propose sophisticated, piecemeal

Overcoming International Techno-Regulatory Data Barriers," *Journal of Marine Science and Engineering* 9, 594 (2021): 3, 17, 22, <https://doi.org/10.3390/jmse9060594>; Adam James Fenton and Ioannis Chapsos, "Ships without crews: IMO and UK responses to cybersecurity, technology, law and regulation of maritime autonomous surface ships (MASS)," *Frontiers in Computer Science* 5 (2023), <https://doi.org/10.3389/fcomp.2023.1151188>.

¹⁵⁰ Erwin Orye et al., "Enhancing the Cyber Resilience of Sea Drones" (CyCon 2024: Over the Horizon 16th International Conference on Cyber Conflict, 2024).

¹⁵¹ Orye et al., "Short Enhancing the Cyber Resilience of Sea Drones." 85.

¹⁵² Jiawei Huang et al., "Physical Layer Encrypted Maritime Communications Utilizing UAV-Enabled Virtual Antenna Array" (ICC 2024 - IEEE International Conference on Communications, 2024).; Jan Martin Lemnitzer, "Back to the Roots: The Laws of Neutrality and the Future of Due Diligence in Cyberspace," *European Journal of International Law* 33, no. 3 (2022): 816-18, <https://doi.org/10.1093/ejil/chac053>.

¹⁵³ Negenborn et al., "Autonomous ships are on the horizon: here's what we need to know," 31.; Joseph A. Curcio et al., "Self-Positioning Smart Buoys, The "Un-Buoy" Solution: Logistic Considerations using Autonomous Surface Craft Technology and Improved Communications Infrastructure" (OCEANS 2006, 2006).; Parlov, "Can the International Regulatory Framework on Ships' Routing, Ship Reporting, and Vessel Traffic Service (VTS) Accommodate Marine Autonomous Surface Ships (MASS)?" 177.

¹⁵⁴ José Antonio Moreira Lima et al., "The Brazilian Santos basin underwater soundscape monitoring project (PMPAS-BS)," *Frontiers in Marine Science* 11 (2024), <https://doi.org/10.3389/fmars.2024.1416590>.; Agus Hasan, "Physics-informed discovery of marine vessels dynamics from noisy data," *Ocean Engineering* 317, 120032 (2025), <https://doi.org/10.1016/j.oceaneng.2024.120032>.

¹⁵⁵ Jiankun et al., "Advances and frontiers of key technologies in intelligent navigation for unmanned surface vehicles," 8.

¹⁵⁶ Aleksanteri B. Vattulainen et al., "G-band FMCW Doppler radar for sea clutter and target characterization" (Radar Sensor Technology XXVI, 2022).

solutions to how UMVs can elude certain navigational snags, buttressing against difficult seas and better planning paths to avoid collisions with vessels and environmental obstacles.¹⁵⁷

One interesting offshoot considers how interested parties might exploit machine-learning architectures like neural networks for enhanced “situational awareness, sensor fusion and mapping, and planning and control,” enabling precise and flexible deployment of one or many autonomous craft.¹⁵⁸ Indeed, swarm agility will heavily inform irregular UMV activity; like single UMVs, swarms may coordinate remotely as a “single entity” or self-organize as agents (in addition to just having many drones remotely piloted, though not algorithmically coordinated).¹⁵⁹ However, swarms and individual vehicles in edge settings currently depend on vulnerable external infrastructure like the internet.¹⁶⁰

Operating on or underwater presents the obstacle of GPS denial, as signals struggle to penetrate and traverse water.¹⁶¹ One promising position, navigation, and timing supplement to GPS is quantum sensing, especially gravimetry—though ocean maps’ resolution limit it.¹⁶² In the near term, incremental advances in navigation technologies will be crucial for actors considering UMVs for high-risk or sensitive missions.

¹⁵⁷ Chris Denniston et al., "On-line AUV Survey Planning for Finding Safe Vessel Paths through Hazardous Environments" (2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV), Porto, Portugal, 2018).; Awanish Chandra Dubey, Anantha V. Subramanian, and V. Jagadeesh Kumar, "Steering model identification and control design of autonomous ship: a complete experimental study," *Ships and Offshore Structures* 17, no. 5 (2021), <https://doi.org/10.1080/17445302.2021.1889193>.; Castano-Londono et al., "Evolution of Algorithms and Applications for Unmanned Surface Vehicles in the Context of Small Craft: A Systematic Review," 2.; Rafał Sztapczyński and Hossein Ghaemi, "Framework of an Evolutionary Multi-Objective Optimisation Method for Planning a Safe Trajectory for a Marine Autonomous Surface Ship," *Polish Maritime Research* 26, no. 4 (2019).; Mirosław Tomera and Kamil Podgórski, "Control of Dynamic Positioning System with Disturbance Observer for Autonomous Marine Surface Vessels," *Sensors* 21, 6273 (2021), <https://doi.org/10.3390/s21206723>, <https://www.ncbi.nlm.nih.gov/pubmed/34695937>.; Jordan D. Mayo, Dr. Kevin Murrant, and Dr. Siu O’Young, "Preliminary Definition of Detection and Reaction Boundaries for Autonomous Marine Traffic" (2020 IEEE/OES Autonomous Underwater Vehicles Symposium (AUV), St. Johns, NL, Canada 2020).; Xu, Moreira, and (eds.), "Maritime Autonomous Vessels," 5, 25, 181.

¹⁵⁸ Matheus F. Reis et al., "A ROS Implementation of the Situational Awareness and Maneuvering Systems for an Autonomous Marine Vessels" (OCEANS 2021, San Diego, California, 2021).; G. Y. Li et al., "Hierarchical control of marine vehicles for autonomous manoeuvring in offshore operations," *Ship Technology Research* 62, no. 2 (2015), <https://doi.org/10.1179/0937725515z.0000000013>.; Li et al., "A Novel Robustness-Enhancing Adversarial Defense Approach to AI-Powered Sea State Estimation for Autonomous Marine Vessels."; Xu, Moreira, and (eds.), "Maritime Autonomous Vessels," 107.; Sabine Knapp and Michel van de Velden, "Exploration of machine learning methods for maritime risk predictions," *Maritime Policy & Management* 51, no. 7 (2023), <https://doi.org/10.1080/03088839.2023.2209788>.

¹⁵⁹ Arthur Michel in John Jackson, ed., *One Nation, Under Drones*, 64.

¹⁶⁰ Paul Mahacek, Ignacio Mas, and Christopher Kitts, "Cluster Space Control of Autonomous Surface Vessels Utilizing Obstacle Avoidance and Shielding Techniques" (2010 IEEE/OES Autonomous Underwater Vehicles, Monterey, California, 2010).; Ivan Berman et al., "Trustable Environmental Monitoring by Means of Sensors Networks on Swarming Autonomous Marine Vessels and Distributed Ledger Technology," *Front Robot AI* 7, no. 70 (2020): 5, <https://doi.org/10.3389/frobt.2020.00070>, <https://www.ncbi.nlm.nih.gov/pubmed/33501237>.; Zou et al., "Short Bio-Inspired Topology Control Mechanism for Autonomous Underwater Vehicles Used in Maritime Surveillance." 201.

¹⁶¹ Bowers and Kirchberger, "Not so disruptive after all: The 4IR, navies and the search for sea control," 619-20.

¹⁶² Mary Burkey, *How Quantum Sensing Will Help Solve GPS Denial in Warfare*, Center for Global Security Research (Lawrence Livermore National Laboratory, 2025), 33, 35-36.

Appendix B

To unpack the escalation lens this paper adopts, this appendix furthers a compelling discussion featured in Richard Maass' "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone."¹⁶³

Maass' highly relevant piece builds out a holistic theory of legal deterrence by denial for all gray-zone activity. He thoughtfully defines the gray zone as "a category of aggressive activities that threaten core aspects of statehood while avoiding the threshold of armed force that has traditionally legitimized military retaliation in self-defense."¹⁶⁴ He further suggests that if the gray zone is "a realm of unconventional, ambiguous, and limited aggression that undermines another state's sovereignty, territorial integrity, or political independence," activity within it can "heighten the risk of escalation toward war."¹⁶⁵ Building on Maass' original focus on political independence and territorial integrity, the below analysis elaborates on the nuances UMVs and maritime law present for escalation toward outright war.¹⁶⁶

To start, Maass offers that holding states' interests at risk "without provoking military retaliation often requires targeting peripheral interests where credible commitments are lacking and opportunities for exploitation exist."¹⁶⁷ The maritime domain fits this bill—for great powers, the world's seas are 1) mostly physically peripheral (though strategically less so); 2) when states are not the principal enforcers, interstate institutions' enforcement credibility is questionable; and 3) states often exploit the normative (that is, frequently non-binding), heterogeneous, and ambiguous characteristics of maritime law. Moreover, the domain's difficult physical conditions enhance this inconsistent legal environment and perhaps foster unpredictable escalation.¹⁶⁸

Maass suggests that many countries face higher likelihoods of gray-zone aggression than military invasion; the above analysis contends that UMVs will make gray-zone aggression more prevalent at sea, which is problematic for a legal architecture that serves as the seas' main supranational means of deterrence.¹⁶⁹ In that vein, Maass conveys a few key, interrelated points to address:

1. Gray-zone activities count as aggression. Legal deterrence by denial should deprive states of the incentives and potentially means and ways to aggress in the gray zone.

¹⁶³ This analysis is informed by a discussion between the author and Dr. Richard Maass.

¹⁶⁴ Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," 55. Maass mentions 'lawfare,' which describes activities that weaponize law in hostilities (e.g., filing baseless petitions to bog down courts), though not necessarily those that circumvent law. While this paper does not employ this framing, it is certainly pertinent to discussions of this topic.

¹⁶⁵ *Ibid.*, 59. This definition helps distinguish the scope of gray-zone activities from 'asymmetric' or 'hybrid' activities carried out during wars.

¹⁶⁶ *Ibid.*, 55-72.

¹⁶⁷ *Ibid.*, 57.

¹⁶⁸ *Ibid.*, 64. This author means only to highlight that 'if, then' and doctrinal verbiage may insufficiently describe the complexity of coercive and risk-based logic between competitive but non-warring states; this paper does not posit its own theory of gray-zone escalation. For discussions on ladder-like escalation and rule-based models, see Paul Davis and Peter Stan, *Concepts and Models of Escalation* (RAND Strategy Assessment Center, 1984). See also Reid Pauly, *The Art of Coercion* (New York: Cornell University Press, 2025), for how coercion theory may converse with conceptualizations of gray-zone escalation.

¹⁶⁹ Richard Maass, "Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone," 55, 58.

Maass advocates for significant innovations in international law to favor preemptive “deterrence by denial,” highlighting that international law erroneously “relies for deterrence on the prospect of military retaliation in self-defense.”¹⁷⁰ That is, “Rather than using international law to legitimize post hoc punishments for states that engage in nonwar aggression, legal entrepreneurs should seek to raise the upfront costs of gray-zone activities and deny them a clear path to success.”¹⁷¹ He submits that legal deterrence by denial constitutes:

*1. Implementing a clear legal concept of ‘gray-zone aggression’ to delegitimize such activities and establish a focal point for collaboration against them; 2. criminalizing the unconventional means employed by gray-zone aggressors to hinder their agents and reduce their likelihood of success; and 3. developing new collaborative legal mechanisms to increase attribution and streamline international law enforcement.*¹⁷²

Criminalizing unconventional means and developing collaborative attribution and law enforcement mechanisms at sea are useful to the extent that they can delineate legal from illegal activities—and thus clarify risks—for interested private or public parties.¹⁷³ However, the huge up-front costs required to relieve the attribution dilemma at sea could remain constrictive.¹⁷⁴ When states confront unattributed acts, international maritime law provides scant recourse; generalized, unilaterally imposed punishments on a suite of suspects can be infeasible and counterproductive.¹⁷⁵

In the maritime context, more discussion is needed on whether criminalization at the level of international law can exist independent of recursive mechanisms supranational bodies independently supply, lest groups of states with compatible objectives wield or circumvent this power in unexpected ways.¹⁷⁶ In this light, amending maritime law writ large requires overcoming the willingness of states with shared strategic interests to operate in the gray zone.¹⁷⁷ In all, gray-zone activities may count as aggression, but given their strategic attractiveness, international law’s practical criminalization mechanisms may only be effective insofar as there is a way transcendent of state interests to enforce them. The discussion below further parses this idea.

¹⁷⁰ *Ibid.*, 55, 60.

¹⁷¹ *Ibid.*, 55-56.

¹⁷² *Ibid.*, 65.

¹⁷³ One option could include making gray-zone capabilities scarcer through levers like export controls on enabling technologies.

¹⁷⁴ *Ibid.*, 66-70. For those ways that can increase the scope of surveillance and thus attribution, does deterrence by denial incentivize a race to the bottom around defensive and offensive surveillance platforms? UUVs’ uses and misuses are relevant.

¹⁷⁵ *Ibid.*, 64.

¹⁷⁶ *Ibid.*, 65. See James Harrison and Oliver Turner in Lucrecia García Tommi and Richard Maass, eds., *The United States and International Law: Paradoxes of Support across Contemporary Issues* (Ann Arbor: University of Michigan Press, 2022).

¹⁷⁷ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 71.

Importantly, the tenets of LOAC and the Law of Naval Warfare may not apply until delinquency is so extreme as to initiate armed conflict. Complicating matters, some key states have not ratified important elements of LOAC, even if they usually adhere to its principles—for example, the United States has not ratified Additional Protocol I. In line with Maass, the most important takeaway is that—at least in terms of *aggressive* interactions between states—regulations bind the conduct of war more clearly than that of peace. Please refer to *Kraska and Pedrozo, Disruptive Technology and the Law of Naval Warfare*, 19-20, 32-33, 36-37, 40, 100-101, 171-172, 176.

2. Gray-zone activities are unconventional.

Maass rightly points out that, “While propaganda, sabotage, and cyberattacks contravene the principles of sovereignty and non-intervention, these actions are not usually considered acts of war—especially when employed via ambiguous ways in service of limited ends. As a result, military responses to such activities are usually seen as escalatory,” even when the *targets* are defense-related.¹⁷⁸ One readily grants that these unconventional forms of aggression complicate escalation prospects.

However, are gray-zone acts *necessarily* unconventional and limited in scope and effect? At sea, maybe not. Two confounding elements for the maritime legal regime are kinetic activities and cumulative activities, both of which occur in the PRC’s irregular behavior in the East and South China Seas.¹⁷⁹ After the 2016 Hague tribunal, Beijing and its neighbors continued to antagonize each other with relative impunity.¹⁸⁰ Obvious gray-zone acts, which Beijing frequently commits with dual-use assets, reoccur and even reach physical aggression; in one of several water-cannon incidents, a PRC Navy ship even accidentally rammed a PRC Coast Guard boat that was pursuing a Philippine boat.¹⁸¹ Several important questions appear: What *kind* of kinetic act initiates armed conflict? How does a victim state gauge proportional responses to repeated acts and/or acts with ostensibly limited aims that add up to greater than the sum of their parts?¹⁸² Does maritime law offer recursive options for either situation that do not spark legally recognized armed conflict?¹⁸³

These Indo-Pacific events challenge the notion that international law is effectual independent of state-level abidance and enforcement.¹⁸⁴ Indeed, states appear to be the movers identifying when kinetic or repeated acts are sufficient threats to their vital interests to graduate relations to formal armed conflict. Definitions of gray-zone aggression that exclude conventional armed aggression and/or single or repeated acts with significant downstream effects are problematic for this reason.¹⁸⁵ Put differently, it seems that states *are* willing to accept *some* conventional aggression or activity without declaring formal armed conflict, especially when potentially obfuscating the purpose of an act that elicits conventional armed defenses (e.g., 2023 PRC balloon incident).¹⁸⁶

¹⁷⁸ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 63.

¹⁷⁹ Isaac Kardon, “Combating the Gray Zone: Examining Chinese Threats to the Maritime Domain,” testimony before the House Committee on Homeland Security, Subcommittee on Transportation and Maritime Security, June 4, 2024, <https://carnegieendowment.org/posts/2024/06/combating-the-gray-zone-examining-chinese-threats-to-the-maritime-domain?lang=en>.

¹⁸⁰ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 70.; Ying Fu, “Why China Says No to the Arbitration on the South China Sea,” *Foreign Policy*, July 10, 2016, <https://foreignpolicy.com/2016/07/10/why-china-says-no-to-the-arbitration-on-the-south-china-sea/>.

¹⁸¹ Richard Heydarian, “A South China Sea collision brings US-Philippines alliance to the fore,” Lowy Institute, August 14, 2025, <https://www.lowyinstitute.org/the-interpreter/south-china-sea-collision-brings-us-philippines-alliance-fore>.

¹⁸² For example, erosion of confidence in institutional efficacy.

¹⁸³ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 63.

¹⁸⁴ This notion is not new. In the maritime context, it may be worthwhile to dissect to what extent international law acts as an aspirational connective tissue between states within the broader conversation on the ‘liberal international order.’

¹⁸⁵ *Ibid.*, 62, 68. This author emphasizes that definitions of conventional aggression are fuzzy due to the proliferation of dual-use assets and the ability of military assets to aggress by numerous kinetic and non-kinetic means to lethal and non-lethal effects. This leaves room for conceptual overlap with the gray-zone in times of competition.

¹⁸⁶ “China balloon: US shoots down airship over Atlantic,” *BBC*, February 4, 2023, <https://www.bbc.com/news/world-us-canada-64524105>.

This fact complicates what interstate norms become *de facto* legitimate parts of peacetime competition—and peacetime deterrence, to boot—even if bodies deem them illegal.¹⁸⁷

The gray zone’s breach of the conventional sphere muddles legal interventions. If it is the case that, in their current form—without some kind of unique enforcement authority—maritime accords might be no more credible than their champion parties, what would an alternative authority look like?¹⁸⁸ Maass fairly states that, “International norms, many of which are formalized via international law ... [shape] policymakers’ expectations of the costs and benefits of different courses of action.”¹⁸⁹ That is, international law has *ex ante* and *ex post* effects on what constitutes acceptable behavior at sea. But even institutionalized norms are still norms, and thus interpretable.¹⁹⁰ In terms of who is to do the interpreting, questions persist around whether some kind of centralized, maritime-specific interventionist or peacekeeping organization is legally preferable, attractive to the interstate public, or more effective than the state-based model; this paper only notes that the existing model nonetheless faces delinquency problems.¹⁹¹ To Maass’ point, better coordination among states and private actors acting in good faith would surely streamline international law enforcement.

3. Gray-zone activities do not legitimize self-defense.

As Maass says, “States can legitimately undertake armed conflict [through] either self-defense... or authorization by the United Nations Security Council.”¹⁹² In parsing what triggers self-defense, Maass claims that international law currently conceptualizing “aggression as a subset of war... leaves international law ill-prepared to address gray-zone activities: If an ‘act of aggression’ requires ‘the use of armed force,’ then aggression short of war cannot logically exist.”¹⁹³ Indeed, the International Criminal Court’s (ICC) Rome Statute prohibits “sending irregular forces to commit violence” as a “crime of aggression” that can trigger armed conflict in self-defense—but those parameters may well include certain gray-zone actions, and the ICC can only prosecute individuals.¹⁹⁴ That is, not only is it true that states can aggress short of war, as Maass argues, but this author suggests that *is* also the case that the *use of force* as aggression at least conceptually exists outside of legally recognized war—and in the gray zone.¹⁹⁵

Looking deeper into the more common self-defense justification for formal armed conflict, let one temporarily accept that states do tolerate some kinetic activity without embarking on war—and thus the gray zone cannot *necessarily* be delimited by the absence of conventionally armed forces. Under these conditions, in positing that “efforts to develop a new legal concept should rigidly

¹⁸⁷ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 65.

¹⁸⁸ *Ibid.*, 58, 68.

¹⁸⁹ *Ibid.*, 56.

¹⁹⁰ *Ibid.*, 61.

¹⁹¹ *Ibid.*, 67, 71.

¹⁹² *Ibid.*, 61.

¹⁹³ *Ibid.*, 62.

¹⁹⁴ *Ibid.*, 62.; International Criminal Court, *Rome Statute of the International Criminal Court* (2011), 10-11, <https://www.icc-cpi.int/sites/default/files/2025-05/Rome-Statute-EN-2025.pdf>.

¹⁹⁵ Egle Murauskaitė, David Quinn, and Jonathan Wilkenfeld, “Regime, Power, and the Use of Violence in Gray Zone International Crises,” paper presented at the Central and Eastern European International Studies Association and International Studies Association Joint International Conference, June 18, 2019, <https://www.icons.umd.edu/papers/CEEISA.pdf>

distinguish between armed aggression (which legitimizes war in self-defense) and gray-zone aggression (which does not) in order to avoid complicating current mechanisms designed to prevent wars of aggression or making war more likely by encouraging armed retaliation against gray-zone threats,” Maass draws a complex dichotomy.¹⁹⁶

In reference to the discussion above, there very well may be a kinetic and armed overlap between the gray zone and formal armed conflict, where states choose not to initiate the latter after experiencing *and responding to* non-traditional kinetic or conventional belligerence in the former. That is to say, Maass reasonably distinguishes between formal war and the gray zone, but it might not be the case the gray zone *only* involves *unconventional* means, excluding physically violent altercations that *could* include military assets. A rigid legal delineation between armed and gray-zone aggression would require a granular breakdown of exactly which military (or defined ‘conventional’) assets are and are not part of the latter. If that exercise excludes *all* dual-use and strictly conventional means, states may have to relinquish elements of their current gray-zone operations to avoid handing their opponents explicit justification for a defensive war. This may be theoretically desirable, but it again begs the questions of whether states will credibly enforce the upper and lower extrema of the legally defined gray zone.¹⁹⁷ Recall, for example, the earlier discussion of acceptable statecraft outside of war—a highly compartmentalized interpretation of legal denial *could* deter war, but it equally strips states of many contemporary methods of competition and thus may be a non-starter.

Under these circumstances, great powers, in particular, could feel internally compelled to initiate legally recognized defensive war at lower thresholds than they currently tolerate—otherwise, they forego retaliation, endure illegal acts, and undermine the intended precedent set by the delineation in the first place.¹⁹⁸ States already do, as argued above, sometimes accept technically illegal acts against them and purvey such acts themselves—but this is not necessarily because of clear delineations between types of aggression, rather ambiguity. This suggests that states have already made some *de facto* adjudications around irregular aggression they are unwilling to go to war over, as well as potential boundaries they are willing to push.

Would it always be the case, then, that state and public “skepticism would likely doom any international legal proposal that seeks to legitimize military responses to gray-zone threats”?¹⁹⁹ This opens up questions around preemptive action against known, albeit unrealized threats or repeated, limited offenses that put states’ vital interests at risk. For instance, Maass acknowledges that international law focuses on “heinous crimes like genocide, war crimes, and crimes against humanity,” but it does not necessarily follow that gray-zone acts always (though they usually) are

¹⁹⁶ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 67, 72.

¹⁹⁷ Maass prefers defining the gray zone in terms of threats to political independence and territorial integrity exactly because of this problem—the means by which someone can achieve these goals may overlap with more localized, run-of-the-mill criminal activity. Cyberattacks that merely mean to extract money from individuals or financial institutions, for example, do not necessarily fall into the national-security-centric purview of the gray zone.

¹⁹⁸ To that end, much debate swirls around legal interpretations of uses of force vs. ‘armed attack,’ with implications for armed conflict; the legal interplay between state consent and international body recognition around *jus ad bellum* and *jus in bello* is contentious. This author only suggests that irregular behavior that trends kinetic is not only possible, but also very relevant to the earlier discussion of red lines in and beyond the gray zone. See Adil Ahmad Haque, “Between the Law of Force and the Law of Armed Conflict,” *Just Security*, October 13, 2016, <https://www.justsecurity.org/33515/law-force-law-armed-conflict/>.

¹⁹⁹ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 72.

“lower echelons of international crimes,” as they can have significant transnational effects or reap long-term domestic destabilization (e.g., cyberattacks, disinformation campaigns, major critical-infrastructure sabotage with civilian and military effects).²⁰⁰ Regarding the lower threshold, Maass astutely observes that “many states currently share strong incentives to delegitimize gray-zone aggression, though it remains to be seen whether they can overcome longstanding currents pushing the opposite direction”—as this paper argues, particularly around mostly tacitly accepted statecraft like ISR.²⁰¹ If attempting to closely reflect the status quo, legal divisions between armed and gray-zone aggression may have to account, then, for unconventional, dual-use, and certain conventional means and ways in the latter.

Clearly, even knowing that gray-zone operations are likely to grow in numbers and effects, legally defining the gray zone in a way that is satisfying and meaningful to all states and their publics seems intractable—but not necessarily because onlookers think that gray-zone acts, viewed individually or holistically, are exempt from military (‘conventional’) acts or military responses. In short, it seems that 1) thresholds for violence may unpredictably reveal themselves *in* the gray zone; and 2) states’ vs. international bodies’ recognized trigger(s) for *war* in self-defense may be convoluted (in part) because of this. States that sustain armed attacks ultimately decide *post hoc* to exercise their legal right to defensive war or let the conflict stay in the gray zone. Going forward, analyzing in detail the puzzling interactions between gray-zone unconventional and conventional aggression, the legal concepts of ‘use of force’ and ‘armed attack,’ and the ultimate red lines that introduce formal armed conflict is warranted in and outside of the maritime domain.

4. Legal deterrence by denial is a more effective strategy than legal deterrence by punishment for gray-zone operations.

Maass argues well that legal denial instruments should raise the upfront costs of or obstacles to gray-zone actions. This author nonetheless offers that it may be difficult to fully extricate the concept of legal deterrence by denial from punishment. Legal denial options may shift states’ normative relationships between legal threats and risk perception, disincentivizing irregular acts. However, the gravity of said legal threats may (at least in part) rely on an actor’s understanding that the social, political, economic, and legal *costs* it would retroactively bear from acting in the gray zone, getting caught, and a state having a clear path to respond would overwhelm any positives.

Moreover, as stated previously, it is not clear that supranational legal denial initiatives are more actionable at sea than legal punishment—particularly *absent* of already reliable domestic punitive mechanisms among constituent states.²⁰² Just as in the case with deterrence by punishment, deterrence by denial relies on states resourcing efforts and valuing them politically. Great powers, especially, cannot consider one without the other when background capability-based architectures, such as nuclear and conventional military deterrence, inform risk assessments.²⁰³ If

²⁰⁰ *Ibid.*, 66-67. Indeed, the problem of purely *unconventional* gray-zone acts having built-up or incisive consequences for states’ vital interests persists.

²⁰¹ *Ibid.*, 70, 71.

²⁰² *Ibid.*, 64. This also does not account for states being willing to formally sign onto international legal accords, abide by them informally, etc.

²⁰³ *Ibid.*, 68, 70, 72.; Lukas Milevski, “When Does Gray Zone Confrontation End? A Conceptual Analysis,” *Joint Force Quarterly* 112 (2024), <https://ndupress.ndu.edu/Media/News/News-Article-View/Article/3678004/when-does-gray-zone-confrontation-end-a-conceptual-analysis/>.

these variables render the threshold for formal war between great powers *high*, over time, more provocative, even conventional kinetic aggression may encroach *de facto* on the gray zone—simply because interacting states are reticent to enter into formal war as long as they gain sufficient strategic advantage at acceptable risk outside of it.²⁰⁴ This delicate geopolitical dance asks that perpetrators and victims accurately perceive the other’s motivations and desired red lines in order to identify “reasonable” costs for committing gray-zone acts and options for recourse.²⁰⁵ How states receive aggression and proceed with mixed vertical, horizontal, otherwise non-stepwise, or even *no* escalation within and potentially beyond the gray zone eludes distillation.

All said, Maass’ theory of legal deterrence by denial in the gray zone is convincing. This author only adds that the maritime domain’s idiosyncrasies and other status quo irregular activities complicate its adoption. If international law at least serves to distinguish legitimate from illegitimate conduct and facilitate collective or individual responses to the latter, then the current legal seascape does not raise sufficient preemptive or reactive costs against gray-zone aggression.²⁰⁶ So, not only is it the case that “not much good recourse exists for states targeted by activities that are aggressive—that infringe on their sovereignty, territorial integrity, or political independence—but do not meet the international legal standard for ‘armed conflict,’” but it is also the case that especially great powers may not predictably exit what they consider to be the gray zone and choose to enter armed conflict, even if they *did* legally earn the right to self-defense.²⁰⁷ In other words, if actors operating in the gray zone mean to *avoid* escalation to lawfully recognized armed conflict, then this paper highlights the irony that exploiting legal gaps and uncertainties can perhaps tempt escalation toward what resembles it in means, ways, or effects.

Studying deterrence and escalation in the global commons undoubtedly requires a deeper appreciation of international law’s legitimating influence and efforts to strengthen it. Maass’ analysis and this paper’s findings have shown that the legal landscape is dynamic, though inconsistently subscribed to. It can and perhaps should offer tension-mitigating tools that dissuade escalation toward conventional *and/or* strictly unconventional acts that threaten states’ vital interests—or at least render escalatory steps more predictable. In this light, legal deterrence by denial and punishment are in conversation with other realms of deterrence.

The international legal challenges articulated in the paper above and this appendix may well have practicable solutions. Nonetheless, as stated earlier, the irregular context confounds deterrent efforts in and outside of a legal perspective. In particular, gray-zone operations expose how absorbable prosecutions of specific individuals/entities or even whole perpetrator states are; international legal mandates may be only as robust as *states’* individual investment in upholding and concertedly advancing them. Consequently, for behavior in the global commons, the emergent whole of governance is currently not greater than the sum of its parts.

²⁰⁴ Richard Maass, “Legal Deterrence by Denial: Strategic Initiative and International Law in the Gray Zone,” 64. This idea interacts with the earlier thought that a very strict version of legal denial may lower the threshold for war between great powers. This interplay requires further dissection.

²⁰⁵ *Ibid.*, 64, 72. A long history of espionage, unattributed sabotage, etc. makes the maritime domain a compelling case.

²⁰⁶ *Ibid.*, 71. Especially inadequate are costs for small-scale, discrete acts and sustained acts with more diffuse goals.

²⁰⁷ *Ibid.*, 62. International law does not demand that a state pull the levers it offers.

Table Notes

- ¹ United Nations, "United Nations Convention on the Law of the Sea," (1982), https://www.un.org/depts/los/convention_agreements/texts/unclos/UNCLOS-TOC.htm. Though the entire Convention is applicable to UMs to various degrees, of note are Articles 17-33, 36, 38-45, 55-62, 73, 77-83, 87-115, 117-120, 136-147, 150-153, 156-211, 214-221, 223-233, 235-265, 279-311.; International Maritime Organization, "Convention on the International Regulations for Preventing Collisions at Sea," (1972), <https://tinyurl.com/5498jtxz>; International Maritime Organization, "International Convention for the Safety of Life at Sea," (1974), <https://tinyurl.com/494bhjm7>. Chapter V is particularly relevant.; International Maritime Organization, "International Convention for the Prevention of Pollution from Ships," (1973/1978), <https://tinyurl.com/zcssuw97>; International Maritime Organization, "International Convention on Standards of Training, Certification and Watchkeeping for Seafarers," (1978, as amended in 1995), <https://tinyurl.com/bdfz2se5>; International Maritime Organization, "International Convention on Load Lines," (1966), <https://tinyurl.com/32spisut>; International Maritime Organization, "Convention on Limitation of Liability for Maritime Claims," (1976), <https://tinyurl.com/22m49w74>; International Maritime Organization, "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter," (1972), <https://tinyurl.com/37t8dc3a>; International Maritime Organization, "International Convention on Civil Liability for Oil Pollution Damage," (1969), <https://tinyurl.com/2frn94s5>; International Maritime Organization, "Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation," (1988/2005), <https://tinyurl.com/557df7ax>; International Maritime Organization, "List of IMO Conventions," www.imo.org, n.d., <https://www.imo.org/en/About/Conventions/Pages/ListOfConventions.aspx>; International Maritime Organization, "Regional Agreements," www.imo.org, n.d., <https://www.imo.org/en/ourwork/environment/pages/regional-arrangements.aspx>; Yurika Ishii in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 290-291.
- ² Chaomin Liu and Yuan Feng, "Navigating uncharted waters: Legal challenges and the future of unmanned underwater vehicles in maritime military cyber operations," *Marine Policy* 171, 106430 (2025): 3-4, 8, <https://doi.org/10.1016/j.marpol.2024.106430>; Daniel Esser and Stephen Ferretti, *Autonomy for Security: Using Unmanned Platforms for Commercial Marine Security Services* (Sea Technology, 2023), 19. Noise and light may be used offensively.; Petrig, "Autonomous offender ships and international maritime security law," 27.; McLaughlin and Klein, "Maritime Autonomous Vehicles and Drug Trafficking by Sea: Some Legal Issues," 405.; Max Zhang and Shihui Yu, "A review on the preparedness of Chinese maritime law education for emerging industry and technology trends: Sustainable net-zero shipping, maritime digitalization, and application of artificial intelligence technologies," *Sustainable Futures* 9 (2025): 4, <https://doi.org/10.1016/j.sftr.2025.100752>; Schmitt and Goddard, "International law and the military use of unmanned maritime systems," 569, 74.
- ³ Natalie Klein in Klein et al., eds., *Maritime Autonomous Vehicles and International Law*, 10, 29-30, 268.; Schmitt and Goddard, "International law and the military use of unmanned maritime systems," 587.; McKenzie, "When is a ship a ship? Use by State Armed Forces of Uncrewed Maritime Vehicles and the United Nations Convention on the Law of the Sea," 30.; Ruhal, "The evolving seascape of naval warfare: unmanned underwater vehicles and the challenges for international law," 362.; Romică Cernat, "Lethal Autonomous Weapon Systems – Emerging and Potentially Disruptive Technology" (Romanian Military Thinking, 2022).; *Impact of Unmanned Systems to Escalation Dynamics*, CNA.; Christian Richer, "'No Sense in Military Terms:' Reconsidering the Surprising Use of Force in a Gray Zone Conflict," *Journal of Military and Strategic Studies* 23 (2024): 177.; George Woodhams and John Borrie, *Armed UAVs in Conflict Escalation and Inter-State Crisis*, United Nations Institute for Disarmament Research (2018).; Dunley, "Uncrewed naval vessels and the span of maritime tasks," 5.; Kraska and Pedrozo, *Disruptive Technology and the Law of Naval Warfare*, 133, 135.; Robert Sparrow and George Lucas Jr. in John Jackson, ed., *One Nation, Under Drones*, 91, 95.