CSBA

Center for Strategic and Budgetary Assessments

A NAVY OF NECESSITY

UKRAINE'S UNMANNED SURFACE VESSELS AT WAR

THANE CLARE

A NAVY OF NECESSITY

UKRAINE'S UNMANNED SURFACE VESSELS AT WAR

THANE CLARE

CSBA
Center for Strategic and Budgetary Assessments

2025

ABOUT THE CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS (CSBA)

The Center for Strategic and Budgetary Assessments is an independent, nonpartisan policy research institute established to promote innovative thinking and debate about national security strategy and investment options. CSBA's analysis focuses on key questions related to existing and emerging threats to U.S. national security, and its goal is to enable policymakers to make informed decisions on matters of strategy, security policy, and resource allocation.

ABOUT THE AUTHOR

Dr. Thane Clare is a Senior Fellow at the Center for Strategic and Budgetary Assessments. His work focuses on naval, air, and space power, strategic war planning, defense planning in an era of great-power competition, and the nexus between operational planning and defense acquisition. His recent projects have focused on U.S. Navy strategic concepts, rapid innovation in military technology, and homeland air defense.

Dr. Clare joined CSBA in 2023 following a 25-year career in the United States Navy, retiring at the rank of Captain. His final posting was as Branch Head, Navy Analytics, in the Office of the Chief of Naval Operations. Immediately prior to his final tour, Dr. Clare served as a Strategic Plans Advisor in the Office of the Secretary of Defense, where he authored Defense-wide operational planning guidance for presidential signature. Dr. Clare also published "The Office of the Secretary of Defense," a chapter in the Naval Institute Press volume, *The Naval Officer's Guide to the Pentagon.*

During his Navy career, Dr. Clare deployed to waters around the globe, from the Baltic, Mediterranean, and Arabian seas to the Atlantic, Pacific, and Indian Oceans. He served twice in command at sea, as Commanding Officer (CO) of the coastal patrol ship *USS Whirlwind* (PC 7), deployed to the Persian Gulf for the defense of critical Iraqi oil infrastructure, and most recently as CO of *USS Mustin* (DDG 89), forward deployed to Yokosuka, Japan and operating in the East and South China Seas, Philippine Sea, Pacific Ocean, and adjacent waters.

ACKNOWLEDGMENTS

The author would like to thank Thomas G. Mahnken, Evan Montgomery, and Doyle Hodges for their thoughtful comments on draft versions of this report. He would also like to thank Eleanor Hughes for her careful and thorough work on editing and formatting the report, and Dao Tran for creating the cover art.

The analysis and findings presented here are solely the responsibility of the authors. CSBA receives funding from a broad and diverse group of contributors, including private foundations, government agencies, and corporations. A complete list of these organizations can be found on our website at www.csbaonline.org/about/contributors.

Contents

FIGURES

TABLES

Introduction

On February 24, 2022, Russia launched a full-scale invasion of Ukraine.[1] Since then, drone warfare has played a prominent role in Ukraine's defense. Unmanned aerial vehicles (UAVs) have helped hold Russian ground forces to largely static lines since November 2022 and have brought the war home to Moscow via long-range aerial attack.[2] And Ukrainian unmanned surface vessels (USVs) have placed most of the Black Sea off-limits to the Russian navy, providing the first real-world insights into the wartime use of USVs.

By March 2022, Russia's initial assault had all but eliminated Ukraine's navy. Russian naval operations in the Black Sea posed at least two critical threats: capture of Odesa by Russian ground and amphibious forces, or a blockade of Ukraine's seaborne trade. With grain exports accounting for 41% of Ukraine's trade revenue, and most of that grain moving from ports in the Odesa region, either outcome could have had severe strategic consequences for Ukraine.[3]

Speed was of the essence if Ukraine was to counter Russia's Black Sea Fleet (BSF). Fortunately, Ukraine's innovators delivered. The first publicly reported Ukrainian USV attack was on October 29, 2022, just eight months after the invasion began.[4] This marked the beginning of a USV-centric sea denial campaign that forced Russian warships into a defensive posture that prevented them from blockading trade or supporting ground forces ashore.

Notably, Ukraine did not try to recreate the capabilities of capital ships using USVs, nor did it seek to create autonomous weapons, or pursue a campaign of operational maneuver against Russian "decisive points." Rather, Ukraine used USVs to conduct a campaign of

1 Serhii Plokhy, *The Russo-Ukrainian War: The Return of History* (New York: W.W. Norton & Company, Inc., 2023), p. 153.

2 Michael E. O'Hanlon, Alejandra Rocha, Sophie Roehse, and Mallika Yadwad, "What next on the war in Ukraine?", The Brookings Institution, October 22, 2024, https://www.brookings.edu/articles/what-next-on-the-war-in-ukraine/.

3 U.S. Department of Agriculture, *Ukraine Agricultural Production and Trade* (Washington, DC: Foreign Agricultural Service, April 2022), https://fas.usda.gov/sites/default/files/2022-04/Ukraine-Factsheet-April2022.pdf.

4 Hugo Bachega and James Gregory, "'Massive drone attack on Black Sea Fleet – Russia," *BBC,* October 29, 2022, https://www.bbc.com/news/world-europe-63437212.

attrition analogous to the U-boat wolf packs of World War II, striking where and when possible to inflict cumulative damage on the Russian fleet. And rather than fully autonomous capabilities, the USVs had operators ashore in Ukraine, controlling them via satellite link.

Instead of shooting for the stars, Ukraine practiced what might be called *minimum viable warfare*: fielding USVs as quickly as possible to satisfy, however incrementally, the needs of its defense strategy. Echoing the business concept of "minimum viable product," Ukraine's approach capitalized on the idea that deploying a capability in the field delivers insights much faster than laboratory testing and program reviews. More importantly, this approach also aimed to field capability in time to prevent strategic failure—even if that capability was not yet robust enough to overcome all potential countermeasures. To paraphrase General George S. Patton, Jr., "a good capability fielded *now* is better than a perfect capability fielded next week."[5]

This report describes and analyzes Ukraine's USV-led naval campaign. It highlights four major themes that emerged from the campaign: USVs' critical contribution to *sea denial*, their role as *range extenders* for Ukraine's anti-ship capability, the evolution of their *cross-domain capabilities*—from anti-ship to anti-air and beyond, and the *measure-countermeasure competition* with Russia. It closes with considerations for US and allied planners, outlining the possibilities and limitations of USV employment in other wartime scenarios.

5 *Oxford Essential Quotations: Fourth Edition*, (Oxford University Press, 2016), https://www.oxfordreference.com/display/10.1093/acref/9780191826719.001.0001/q-oro-ed4-00016315.

CHAPTER 1

War in the Black Sea

This chapter describes the maritime environment and the balance of naval forces. It then previews the four main themes that emerge from the subsequent analysis: sea denial, range extension, cross-domain capabilities, and the measure-countermeasure competition. It presents a chronology of key milestones in the naval war. It concludes by reviewing key insights from the timeline, organized around the four themes noted above.

The Geopolitical Environment

Ukraine's USV operations have been decisively shaped by the geography and naval balance in the Black Sea region. Modest in size and sequestered from the global maritime commons, the Black Sea is an ideal laboratory for an "experiment in the wild" focused on USV capabilities.

Political Geography

The Black Sea is bordered by Ukraine, Russia, Georgia, and NATO members Turkey, Bulgaria, and Romania (figure 1). The sole route to the Mediterranean is the Bosporus Strait, which is subject to Turkish control per the Montreux Convention of 1937.[6]

The only other exit from the Black Sea is the Kerch Strait, which affords access to the Sea of Azov—an avenue for Russian logistical support to forces in Crimea and southeastern Ukraine via the port of Berdyansk.[7] The Sea of Azov also provides access to the Caspian Sea via the Volga-Don Canal, which allows Russia to move ships between the BSF and Caspian Flotilla.

6 Adam Aliano and Russell Spivak, "Ukraine Symposium – The Montreux Convention and Turkey's Impact on Black Sea Operations," Articles of War, April 25, 2022, https://lieber.westpoint.edu/montreux-convention-turkeys-impact-black-sea-operations/.

7 "Ukraine to speed up construction of naval base in Sea of Azov – defence minister," *Reuters,* November 13, 2021, https://www.reuters.com/world/europe/ukraine-speed-up-construction-naval-base-sea-azov-defence-minister-2021-11-13/.

FIGURE 1: THE BLACK SEA AND THE SEA OF AZOV

Source: Google Maps

The Black Sea is a regional hub for agricultural trade and accounts for more than 40% of Ukraine's export revenue.[8] The economic stakes are even more stark when one considers Ukraine's individual commercial ports. As of 2021, most of its seaborne exports passed through five ports.[9] Two of these have been captured or cut off by Russia; the remaining three—Odesa and two nearby ports—are operational but subject to frequent aerial attack.[10]

Figure 2 illustrates Ukrainian, Russian, and Russian-occupied navy ports. With Sevastopol and Berdyansk in Russian hands, Odesa is Ukraine's sole remaining large naval port.[11]

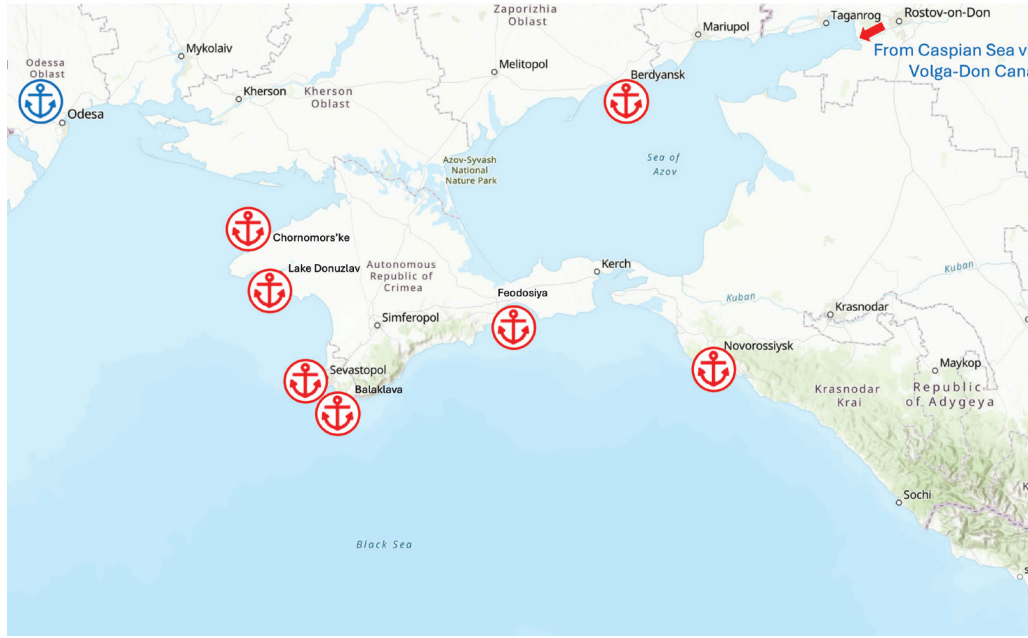
8 "Russia Grain and Oilseed Exports Expand | USDA Foreign Agricultural Service;" Polina Devitt and Vladimir Soldatkin,"Significance of Black Sea ports for Russian commodities exports," *Reuters,* July 20, 2023, https://www.reuters.com/markets/commodities/significance-black-sea-ports-russian-commodities-exports-2023-07-20/; U.S. Department of Agriculture, *Ukraine Agricultural Production and Trade*; World Integrated Trade Solution, "Russian Federation Trade Summary 2021 Data," https://wits.worldbank.org/CountryProfile/en/Country/RUS/Year/2021/Summary.

9 Mariupol, Mykolaiv, Odesa, Pivdennyy, and Chornomors'ke. "Ships, Trains, and Trucks: Unlocking Ukraine's Vital Trade Potential." Center for Strategic and International Studies, July 8, 2024. https://www.csis.org/analysis/ships-trains-and-trucks-unlocking-ukraines-vital-trade-potential.

10 Mariupol is occupied by Russia. Mykolaiv, situated inland on a river, is inaccessible because Russian forces occupy territory at the river's mouth. Karolina Hird, Kateryna Stepanenko, and Mason Clark "Russian Offensive Campaign Assessment, June 10," Institute for the Study of War, June 10, 2022, https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-june-10; Sarah Rainsford and Paul Kirby, "Ukraine ports impossible to defend from attack – Odesa chief," *BBC,* October 11, 2024, https://www.bbc.com/news/articles/clyzpnnwr3jo.

11 Oleksiy Goncharenko, "2023 Review: Ukraine scores key victories in the Battle of the Black Sea," The Atlantic Council, December 5, 2023, https://www.atlanticcouncil.org/blogs/ukrainealert/2023-review-ukraine-scores-key-victories-in-the-battle-of-the-black-sea/.

FIGURE 2: UKRAINIAN AND RUSSIAN/OCCUPIED NAVAL BASES



Of Note: The Ukranian naval bases are blue, and the Russian and Russian-occupied bases are red.
Source: Google Maps and the author

Sevastopol is the traditional headquarters of the BSF.[12] It was also Ukraine's main naval port until Russia's 2014 annexation of Crimea, during which Russia captured the bulk of Ukraine's fleet.[13] Crimea also hosts several smaller naval ports captured by Russia in 2014, including Lake Donuzlav, Chornomors'ke, Balaklava, and Feodosiya. Additionally, Russia maintains a sizeable naval base at Novorossiysk on the eastern shore of the Black Sea.[14]

Maritime Geography

The Black Sea has a maximum span of roughly 630 nautical miles (nm).[15] Its modest dimensions translate into relatively short transit times between strategic points (figure 3). For example, a commercial ship sailing from Odesa to Sevastopol at 15 knots (kt) would complete its voyage in under twelve hours. At 30 knots a warship could cover that distance

12 Igor Delanoe. *Russia's Black Sea Fleet: Toward a Multiregional Force*, (Arlington, VA: Center for Naval Analyses, June 2019), p. 3, https://www.cna.org/archive/CNA_Files/pdf/iop-2019-u-020190-final.pdf. Hereinafter cited as "CNA."

13 Delanoe. *Russia's Black Sea Fleet,* p. 1; Tim Ripley, "Ukrainian navy decimated by Russian move into Crimea," *IHS Jane's 360,* March 25, 2014, https://web.archive.org/web/20140325234737/http://www.janes.com/article/35861/ukrainian-navy-decimated-by-russian-move-into-crimea.

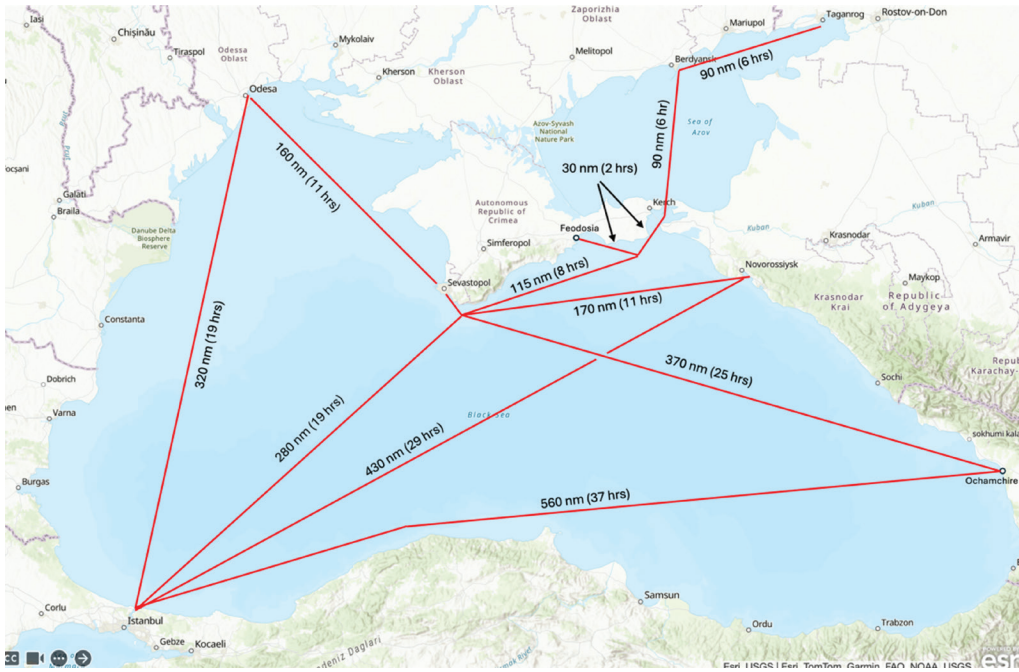
14 Delanoe. *Russia's Black Sea Fleet,* p. 9.

15 "Black Sea," *Britannica*, https://www.britannica.com/place/Black-Sea.

in about five hours in good weather. And Ukraine's *Sea Baby* USV, with a speed of almost 50 kt, could make the trip in less than four hours under optimal conditions.[16]

The average depth is approximately 4,100 feet—sufficient for undersea operations, including deployments by Russia's cruise-missile-armed *Kilo* submarines.[17]

FIGURE 3: DISTANCES AND TRANSIT TIMES AT 15 KNOTS



Source: Google Maps and the author

Balance of Naval Forces

Just as the maritime geography of the Black Sea has shaped Ukraine's use of USVs, so too has the naval balance. As noted earlier, Ukraine's navy was practically eliminated within the first weeks of the war.[18] Russia, on the other hand, had a substantial fleet in the

16 On *Sea Baby* capabilities see Alona Mazurenko, "Ukrainians donate nearly US $7.71 million in record two days for Sea Baby drones," *Ukrainska Pravda,* February 23, 2024, https://www.pravda.com.ua/eng/news/2024/02/23/7443439/.

17 Captain Don Walsh, U.S. Navy (Ret.), "The Black Sea: A Unique Place," U.S. Naval Institute, November 2022, https://www.usni.org/magazines/proceedings/2022/november/black-sea-unique-place.

18 Before the war, Ukraine's fleet consisted of frigate *Hetman Sahaidachny*, a dozen patrol vessels, one minesweeper, two amphibious ships, and eight supply ships. Ukraine scuttled *Sahaidachny* on March 3, 2022, to prevent its capture. Nearly all of Ukraine's remaining warships were destroyed or captured by Russian forces soon thereafter. See The International Institute for Strategic Studies (IISS), *The Military Balance 2024*, (London: IISS, February 2024), p. 213.

Black Sea, including surface ships and submarines armed with *Kalibr* land-attack cruise missiles (LACM).[19]

At the outset of the war, Russia's fleet gave it several major operational advantages: the ability to blockade or otherwise harass Ukraine's cargo shipping; to launch LACM strikes deep into Ukrainian territory; to provide seaborne logistical support to Russian forces ashore; and to conduct amphibious attacks against Ukraine's remaining unoccupied coastline.[20]

Ukraine, in turn, had few means to counter the Russian naval threat. Its anti-ship capability was limited to shore-based *Neptune* anti-ship cruise missiles (ASCMs), whose 162-nm range covered only the northwestern quadrant of the Black Sea (figure 4).[21] One of the USVs' key contributions has been to extend Ukraine's sea-denial capability across the entire Black Sea region.

FIGURE 4: APPROXIMATE RANGE OF NEPTUNE ASCM LAUNCHED FROM ODESA AREA

Source: Google Earth and the author

19 Igor Delanoë, "Russia's Black Sea Fleet in the 'Special Military Operation' in Ukraine," Foreign Policy Research Institute, February 7, 2024, https://www.fpri.org/article/2024/02/russias-black-sea-fleet-in-the-special-military-operation-in-ukraine/.

20 Based at Sevastopol, the Black Sea Fleet (BSF) has played a key role in both Soviet and Russian regional operations. After the collapse of the Soviet Union, Russia retained its use of Sevastopol via lease, and then by occupying Crimea in 2014. Delanoe. *Russia's Black Sea Fleet,* p. 1, 3.

21 Luch: State Kyiv Design Bureau (Kiev: State Enterprise "State Kyiv Design Bureau "Luch"), https://www.luch.kiev.ua/images/data/en/LuchEn.pdf#page=41.

Four Analytic Themes

The following chronology of the naval war in the Black Sea highlights four key themes. First, it shows how Ukraine's campaign of *sea denial* made the Black Sea untenable for the BSF, preventing a blockade or amphibious assault. This enabled Ukraine to sustain its wartime economy through continued grain exports.

Second, it demonstrates Ukraine's USV-driven *extension of operational range* over time, ultimately encompassing the entire Black Sea and Sea of Azov. Absent USVs, most of the Black Sea beyond its northwestern region might have remained a safe haven for Russian warships.

Third, the analysis outlines the evolution of the USVs' tactical capabilities. From humble beginnings as explosive boats, they eventually developed *cross-domain capabilities* including minelaying and anti-aircraft fires, even mounting UAVs to assist with tactical coordination and intelligence, surveillance, and reconnaissance (ISR). (While acknowledging these advances, however, it is essential to recall that Ukraine's "minimum viable warfare" approach allowed it to begin destroying BSF assets well before USVs reached their present capability levels.)

Fourth, the chronology describes the *measure-countermeasure competition*. Ukraine's rapid, iterative approach preserved operational surprise and likely delayed Russian countermeasures, even as its own USV capabilities advanced. Once deployed, of course, Russian countermeasures called for *counter*-countermeasures, such as anti-aircraft missiles to shoot down aircraft providing defense-in-depth to Russian ships. This highlights the need to carefully evaluate "conceal/reveal" options before deploying or otherwise announcing a new capability.

Chronology of the Naval War

The following chronology provides an overview of Ukraine's naval war with Russia.[22] It is divided into three sections: the *Pre-USV Phase*, from the invasion through early September 2022; the *Battle of the Black Sea* from September 2022 through June 2023, during which Ukraine's USVs undertook an increasingly effective sea denial campaign; and the *Tables Turned* phase, from July 2023 to December 2024, in which USV-led sea denial kept the BSF at bay. The discussion focuses on developments consistent with the four themes above.

22 Not all USV attacks are listed after they become routine.

The Pre-USV Phase

Russian warships blockaded Ukraine's ports shortly after the war began on 24 February 2022. Outbound traffic dropped from over 150 ships per day to nearly zero.[23] On 28 February, Turkey closed the Bosporus to warships, sealing Black Sea navies off from the global commons.[24]

TABLE 1: PRE- USV PHASE: FEBRUARY – SEPTEMBER 2022

	Feb 22	**Russian invasion commences**
	Mar 22	Russia achieves maximum territorial gains
Russia's BSF flagship *Moskva* sunk by Neptune missiles	**Apr 22**	Russia withdraws from Kyiv
	May 22	
	Jun 22	
Black Sea Grain Initiative (BGSI) goes into effect	**Jul 22**	**Black Sea Grain Initiative (BGSI) goes into effect**
	Aug 22	
Mykola USV washes ashore near Sevastopol	**Sep 22**	

Note: A consolidated timeline covering all three phases is provided in Appendix 2.

23 Noah Berman, Mariel Ferragamo, and Sabine Baumgartner, "How Ukraine Overcame Russia's Grain Blockade," Council on Foreign Relations, February 27, 2024, https://www.cfr.org/article/how-ukraine-overcame-russias-grain-blockade; Ibid.

24 Heather Mongilio, "Turkey Closes Bosphorus, Dardanelles Straits to Warships," *USNI News,* February 28, 2022, https://news.usni.org/2022/02/28/turkey-closes-bosphorus-dardanelles-straits-to-warships.

On 1 March, Russian forces captured Kherson, opening an overland route to Odesa, 126 miles away by road.[25] Russian forces continued to close in on Kyiv, but withdrew on 6 April after a Ukrainian counteroffensive.[26]

On 13 April, Ukraine sank Black Sea Fleet flagship *Moskva* with shore-launched *Neptune* ASCMs.[27] Russia began keeping its warships beyond *Neptune* range, preventing them from rendering direct support to forces ashore—the first stage of Ukraine's sea denial campaign.[28]

On 22 July, the UN-brokered Black Sea Grain Initiative (BSGI) went into effect, allowing Ukrainian grain exports to resume by reducing the threat of Russian interdiction of cargo ships outside Ukraine's ASCM range.[29] On 29 August, Ukraine launched counteroffensives to dislodge Russian forces from Kherson and Kharkiv, retaking Kharkiv Oblast by 11 September.[30]

Then, on 21 September a *Mykola* remote-controlled explosive USV was found beached outside Sevastopol. The 18-foot *Mykola* mounted optical and forward-looking infrared (FLIR) sensors and a satellite antenna.[31] Its assessed range was 430 nm, with a speed of 43 kt and payload of up to 441 lbs.[32] The failure of this apparent attempt to attack Sevastopol

25 Highway distance from Kherson to Odesa calculated using Google Maps.

26 Richard Engel, Lauren Egan and Phil McCausland, "Ukraine tells Russia 'die or surrender' as its Kyiv counterattack pushes back invaders," *NBC News,* March 24, 2022, https://www.nbcnews.com/news/world/ukraine-tells-russia-die-surrender-kyiv-counterattack-drives-invaders-rcna21197; Idrees Ali and Phil Stewart, "Russia has completed withdrawal from around Kyiv – U.S. defense official," *Reuters,* April 6, 2022, https://www.reuters.com/world/us-assesses-russia-completes-withdrawal-around-kyiv-us-defense-official-2022-04-06/. Had Ukraine's defenders taken substantially longer to turn the tide, BSF amphibious operations might have helped Russian forces mount a multi-axis attack on Odesa, Ukraine's most important hub for seaborne grain exports. Additionally, with Russian ground force logistics heavily dependent on overland communications (*e.g.* across the Kerch Bridge), amphibious and logistics ships provide high-capacity port-to-port transportation—for instance, the movement of troops and supplies from Russian ports on the Sea of Azov to the occupied Ukrainian ports of Berdyansk (also in the Sea of Azov) or to Sevastopol in Crimea.

27 H I Sutton, "Satellite Image Pinpoints Russian Cruiser Moskva As She Burned," *Naval News,* April 15, 2022, https://www.navalnews.com/naval-news/2022/04/satellite-image-pinpoints-russian-cruiser-moskva-as-she-burned/.

28 Seth Cropsey, "Naval Considerations in the Russo-Ukrainian War," *Naval War College Review* 75, no. 4, Autumn 2022, https://digital-commons.usnwc.edu/cgi/viewcontent.cgi?article=8307&context=nwc-review.

29 The United Nations, "Initiative on the Safe Transportation of Grain and Foodstuffs from Ukrainian Ports," July 22 2022, https://www.un.org/sites/un2.un.org/files/black_sea_grain_initiative_full_text.pdf ; Joseph Glauber, Brian McNamara, and Elsa Olivetti, "Russia terminates the Black Sea Grain Initiative: What's next for Ukraine and the world?", International Food Policy Research Institute, July 20, 2023, https://www.ifpri.org/blog/russia-terminates-black-sea-grain-initiative-whats-next-ukraine-and-world/.

30 Kateryna Stepanenko, Grace Mappes, Angela Howard, Layne Philipson, and Frederick W. Kagan, "Russian Offensive campaign Assessment, August 29," Institute for the Study of War, August 29, 2022, https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-august-29; Kateryna Stepanenko, Karolina Hird, Grace Mappes, and Frederick W. Kagan, "Russian Offensive Campaign Assessment, September 11," Institute for the Study of War, September 11, 2022, https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-september-11.

31 H I Sutton, "Ukraine's New Weapon To Strike Russian Navy in Sevastopol," *Naval News,* September 21, 2022, https://www.navalnews.com/naval-news/2022/09/ukraines-new-weapon-to-strike-russian-navy-in-sevastopol/.

32 Yehor Troshkin, "The Role of Naval Strike Drones in the Russia – Ukraine War," *Political Science and Security Studies Journal* 5, no. 2, 2024, https://psssj.eu/index.php/ojsdata/article/view/153/181.

likely resulted from StarLink CEO Elon Musk's decision to temporarily deactivate Ukraine's satellite access.[33]

In line with the themes outlined above, this phase of the war demonstrated that within five months of Russia's invasion, Ukraine had undertaken a nascent *sea denial campaign* against the Black Sea Fleet. And while USVs had not yet been observed to travel more than the roughly 160 nm from Odesa to Sevastopol, their assessed 400-plus nm reach more than doubled Ukraine's anti-ship range relative to its shore-launched ASCMs.

The *Mykola* established the baseline increment of *tactical capability*, contact-fuzed explosion. However, it also incurred Russia's first *countermeasure*: Russian officials reportedly phoned Elon Musk to have StarLink turned off as the September USV attack got underway.

In addition, and perhaps most important from a strategic perspective, this phase revealed that Ukraine had produced operationally-viable USVs within just five months of the outbreak of war.

The Battle of the Black Sea

On 29 October Ukraine mounted its first large-scale USV attack, damaging at least two Russian ships docked in Sevastopol.[34] Then, on 18 November, USVs transited more than twice as far to strike Novorossiysk, hitting an oil terminal.[35] While no warships were damaged, the attack—420 nm from Odesa—validated the assessed range of Ukraine's USVs.[36] (Notably, the BSF's *Kalibr*-capable submarines were then based at Novorossiysk.)

33 Walter Isaacson, "'How am I in this war?': The untold story of Elon Musk's support for Ukraine," *The Washington Post,* September 7, 2023, https://www.washingtonpost.com/opinions/2023/09/07/elon-musk-starlink-ukraine-russia-invasion/.

34 Bachega and Gregory, "'Massive' drone attack on Black Sea Fleet - Russia."

35 Conflicting reports state the attack actually occurred on 16 or 17 November. See H I Sutton, "Ukraine's Maritime Drone Strikes Again: Reports Indicate Attack On Novorossiysk," *Naval News,* November 18, 2022; H I Sutton, "New Technology Sees Through Russian Attempt to Hide Ships from Ukraine," *Naval News,* December 7, 2023, https://www.navalnews.com/naval-news/2023/07/new-technology-sees-through-russian-attempt-to-hide-ships-from-ukraine/.

36 Ibid.

TABLE 2: THE BATTLE OF THE BLACK SEA: OCTOBER 2022 – JUNE 2023

First USV attack on Sevastopol harbor	**Oct 22**	Russia suspends participation in BGSI
First USV attack on Novorossiysk harbor	**Nov 22**	Russia rejoins BGSI
	Dec 22	
	Jan 23	
	Feb 23	
Monobank USV revealed	**Mar 23**	
Toloka UUV revealed	**Apr 23**	
Ivan Khurs damaged in **first known at-sea USV attack**	**May 23**	
	Jun 23	Russia begins applying camouflage to warships

On 22 March 2023, USVs penetrated Sevastopol harbor in coordination with remotely-piloted UAVs. There was no reported damage, but the attack was notable for its combined use of air and surface unmanned systems.[37] Then, on 24 May, USVs attacked Russian intelligence vessel *Ivan Khurs* in the first known successful attack on a ship at sea.[38] Video posted on social media suggested that the USV operators may have targeted *Khurs*' engine room for a mission kill. Notably, an autonomous targeting system might not have been capable of such precise aim.

That same day, Russia claimed that USVs attacking intelligence vessel *Priazovye* in the eastern Black Sea were destroyed by its AK-630 close-in weapon system.[39] Weeks later, Russian warships began showing camouflage paint schemes, likely to foil USVs' optical guidance.[40]

37 Howard Altman, "Ukraine Situation Report: Sevastopol Attacked By Drones From Sea and Air," TWZ, March 22, 2023, https://www.twz.com/ukraine-situation-report-sevastopol-attacked-by-drones-from-sea-and-air.

38 Tayfun Ozberk, "Russian Intelligence ship Seemingly Hit by Ukrainian USV," *Naval News,* May 26, 2023, https://www.navalnews.com/naval-news/2023/05/russian-intelligence-ship-seemingly-hit-by-ukrainian-usv/.

39 Sakshi Tiwari, "6 Ukranian Kamikaza USVs ' Attack' Russian Priazovye Spy Warship; RuMoD Calls Its Unsuccessful Attempt," *Eurasian Times,* June 12, 2023, https://www.eurasiantimes.com/six-ukraines-kamikaze-usvs-attack-russian-priazovye-spy.

40 Sutton, "New Technology Sees Through Russian Attempt to Hide Ships from Ukraine." From the World War I era to the present, navies have used camouflage to obscure the class, heading, and speed of their ships. See Naval History and Heritage Command, "Dazzle Paint Ship Camouflage Designs," https://www.history.navy.mil/our-collections/art/exhibits/conflicts-and-operations/wwi/dazzle-paint-ship-camouflage-designs-.html; P. George Lovell, Rebecca J. Sharman, and Tim S. Meese, "Dazzle camouflage: benefits and problems revealed," *Royal Society Open Science* 11, no. 12, December 4, 2024, https://royalsocietypublishing.org/doi/10.1098/rsos.240624.

Returning to the key themes, this phase of the war illustrated the evolution of Ukraine's *sea denial* campaign. Within just a few months, Ukraine progressed from attacks against stationary ships in harbor to engagements with ships underway at sea, demonstrating that there were few safe havens for the Black Sea Fleet and allowing Ukraine to maintain the initiative.

Furthermore, the October 2022 attack on Novorossiysk confirmed the USVs' value for *range extension*: assuming they were launched from Ukraine-controlled territory, they had to cover more than 330 nm to reach the Russian coast (refer to figure 3).

Tactical evolution was evident on two fronts: the ability to strike both stationary and moving targets, and operators' ability to coordinate unmanned surface and air operations. The latter was an early example of emerging *cross-domain capabilities*.

Russian *countermeasures* evolved in response to Ukraine's tactical advances, albeit with varying effectiveness. Camouflage may have complicated the targeting problem for Ukraine's USV operators; fortunately, the infrared cameras already in use were not affected.[41] Russia's use of gunfire to engage attacking USVs was enabled not by any technical advance, but simply by the loss of operational surprise inherent in overt USV employment. Because USVs were no longer capable of operational surprise, their continued value hinged upon refinements to their tactical employment and the development of counter-countermeasures.

Tables Turned

On 17 July 2023, two USVs struck the Kerch Bridge in the debut of *Sea Baby*, a 20-foot craft with a 540 nm range and speed of 49 knots capable of carrying a nearly one-ton payload—quadruple that of the *Mykola*.[42] (There was no permanent structural damage to the bridge.)[43] The same day, Russia withdrew from the Black Sea Grain Initiative, leading Ukraine to pause seaborne exports.[44] Putin's spokesman denied this was related to the bridge attack.[45]

41 H I Sutton, "Russian Navy's Deceptive Camouflage in black Sea Not Effective Against Infrared," *Covert Shores,* March 10, 2024, http://www.hisutton.com/Russian-Navy-Deceptive-Camouflage-IR-Spectrum.html.

42 Vladimir Socor, "Ukrainian Naval Drone Warfare: Some International Political Implications," *Eurasia Daily Monitor* 20, The Jamestown Foundation, no. 134, https://jamestown.org/program/ukrainian-naval-drone-warfare-some-international-political-implications/; Troshkin, "The Role of Naval Strike Drones in the Russia – Ukraine War."

43 Grace Mappes, Karolina Hird, Nicole Wolkov, Christina Harward, and Frederick W. Kagan, " Russian Offensive Campaign Assessment, July 17, 2023," Institute for the Study of War, July 17, 2023, https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-july-17-2023.

44 Glauber, McNamara, and Olivetti, "Russia terminates the Black Sea Grain Initiative: What's next for Ukraine and the world?"

45 Matthew Mpoke Bigg, Ivan Nechepurenko and Neil MacFarquhar, "Russia pulls out of the Black Sea grain deal," *The New York Times,* July 17, 2023, https://www.nytimes.com/2023/07/17/world/europe/ukraine-russia-grain-deal.html.

TABLE 3: TABLES TURNED: JULY 2023 – DECEMBER 2024

Sea Baby revealed in Kerch Bridge attack Grain exports paused	**Jul 23**	**Russia withdraws from BGSI** Russia prohibits small craft traffic in Kerch Strait
Marichka UUV prototype revealed	**Aug 23**	
***Samum* damaged by USV-laid mine Grain exports restarted via western Black Sea route**	**Sep 23**	
Vladimir Kozitsky strikes mine while minehunting	**Oct 23**	**Nearly all Black Sea Fleet submarines and major warships moved from Sevastopol to Novorossiysk**
MAGURA USV revealed in Chornomors'ke attack	**Nov 23**	
	Dec 23	
***Sea Baby* rocket launcher** capability revealed	**Jan 24**	
	Feb 24	
Avdiivka revealed, featuring modular payloads	**Mar 24**	**Commander of Russian navy sacked; Defense Minister directs BSF to improve USV defenses** **UK Defense Minister states 1/3 of BSF sunk/damaged**
	Apr 24	
AA11 missile capability revealed	**May 24**	
USV attack in Taganrog Bay, Sea of Azov	**Jun 24**	
Weaponized jet ski found on Turkish beach	**Jul 24**	Russian tugboat appears at Ochamchire; last patrol ships have departed Sevastopol
First known gas platform attack (MSP17)	**Aug 24**	
USVs attack city of Novorossiysk with rockets	**Sep 24**	**Black Sea Fleet withdraws from Novorossiysk Port facility buildup underway at Ochamchire**
	Oct 24	
	Nov 24	
Anti-aircraft gun and organic UAV capabilities revealed	**Dec 24**	

On 3 August, a USV was destroyed by gunfire from a Russian helicopter in the eastern Black Sea, demonstrating Russia's evolving layered anti-USV tactics.[46] No longer could operators rely on their USVs remaining undetected outside visual and radar range of their targets.

On 14 September, however, Russian corvette *Samum* struck a mine while departing Sevastopol and had to be towed into port.[47] The mine had been planted by a *Sea Baby* on a 400-nm round trip, showing that USVs were useful in more roles besides direct anti-ship engagements.[48]

Days later, on 19 September—two months after Russia's withdrawal from the Black Sea Grain Initiative—Ukraine resumed grain exports via the territorial waters of Romania, Bulgaria, and Turkey.[49] These western Black Sea waters were well within the extended perimeter established by USVs, tangibly demonstrating that USV sea-denial operations enabled Ukrainian exports despite Russia's withdrawal from the BSGI safe-passage agreement.

By early October 2023, amid ongoing Ukrainian USV and missile attacks, Russia had moved almost all its submarines and major surface ships to Novorossiysk. The smaller vessels still operating from Sevastopol, including patrol ships, tugs, and a mine-hunter, were subsequently damaged by USV-laid mines.

Then, on 10 November, Ukraine attacked Chornomors'ke harbor in Crimea with new MAGURA USVs built for high speed and maneuverability.[50] Two landing ships were damaged.[51] The 18-foot MAGURAs featured a range of 450 nm, speed of 43 kt, and payload of 700 lbs.[52]

46 H I Sutton, "Timeline of Ukraine Invasion: War In The Black Sea," *Covert Shores,* July 6, 2025, http://www.hisutton.com/Timeline-2022-Ukraine-Invasion-At-Sea.html.

47 "Damaged Samum Ship Towed to Sevastopol Base But Repairing It is a Huge Problem," *Defense Express,* September 17, 2023, https://en.defence-ua.com/news/damaged_samum_ship_towed_to_sevastopol_base_but_repairing_it_is_a_huge_problem-7974.html; James Marson, "How Ukraine's Naval Drones Turned the Tide in the Battle of the Black Sea," *Wall Street Journal,* June 24, 2024, https://www.wsj.com/world/naval-drones-innovation-warfare-ukraine-russia-ce35adfa?mod=europe_news_article_pos1.

48 Yevheniia Martyniuk, "WSJ: Ukraine's Sea Baby drones strike 4 Russian ships with underwater mines," *Euromaidan Press,* June 24, 2024, https://euromaidanpress.com/2024/06/24/wsj-ukraines-sea-baby-drones-strike-4-russian-ships-with-underwater-mine-strategy/.

49 Berman, Ferragamo, and Baumgartner, "How Ukraine Overcame Russia's Grain Blockade,"; O'Hanlon et. al, "What next on the war in Ukraine?"

50 MAGURA stands for Maritime Autonomous Guard Unmanned Robotic Apparatus. Ellie Cook, "Rare Trophy Found on Crimea Shore Could Help Russia Foil Future Naval Raids," *Newsweek,* November 23, 2023, https://www.newsweek.com/russia-ukraine-magura-v5-seababy-naval-drones-kamikaze-usvs-crimea-1846330; Marson, "How Ukraine's Naval Drones Turned the Tide in the Battle of the Black Sea."

51 Olena Roshchina, "Ukraine's intelligence special operation: 2 Russian boats damaged in Chornomorske," *Ukrainska Pravda,* November 10, 2023, https://www.pravda.com.ua/eng/news/2023/11/10/7428126/.

52 Troshkin, "The Role of Naval Strike Drones in the Russia – Ukraine War."

On 31 January 2024, MAGURAs sank Russian patrol ship *Ivanovets* on Lake Donuzlav.[53] Video released by Ukraine appears to show the USVs maneuvering to evade Russian fire by "chasing splashes," a tactic in which vessels move toward the spot where the last round hit the water to negate the enemy's fire control corrections.[54]

On 6 March, Ukraine announced *Avdiivka*, an upgraded *Sea Baby*. Official statements suggested that it introduced a modular payload capability.[55]

On March 24, the UK defense minister stated that one third of the BSF had been sunk or damaged, calling the fleet "functionally inactive."[56] By May, other estimates raised this figure to roughly one-half.[57]

On 6 May, Ukraine revealed a USV armed with AA-11 surface-to-air missiles. Later in the year, Ukraine would report that a missile-armed MAGURA had shot down a Russian Mi-8 helicopter.[58] (Later variants of the MAGURA introduced by 2025 mounted AIM-9 Sidewinder missiles, which Ukraine reportedly used to down two Russian Su-30 fighters.)[59]

On 29 May, social media videos showed a USV being hit by a Russian first-person view (FPV) UAV, a new technique in Russia's countermeasures arsenal.[60]

On 8-9 June, USVs passed through the Kerch Strait, penetrated Taganrog Bay in the far north-east of the Sea of Azov, and detonated near a tug and barge. Though the target escaped, the attack showed Azov—roughly 500 nm from Odesa—was no longer a safe haven for the BSF.

53 Lieutenant Tyler Self, "What the Sinking of the Russian Corvette Ivanovets Teaches," *Proceedings* 150, U.S. Naval Institute, May 2024, https://www.usni.org/magazines/proceedings/2024/may/what-sinking-russian-corvette-ivanovets-teaches.

54 Ibid.

55 This may relate to the minelaying operations of September and October 2023. Subsequent Ukrainian imagery of rocket-armed USVs undergoing shore-based testing add further confirmation of this evolution. See Self, "What the Sinking of the Russian Corvette Ivanovets Teaches,"; Howard Altman, "Russian FPV Drone Seen Attacking Ukrainian Uncrewed Surface Vessel For The First Time," *TWZ,* May 30, 2024, https://www.twz.com/news-features/russian-fpv-drone-seen-attacking-ukrainian-uncrewed-surface-vessel-for-the-first-time.

56 Mia Jankowicz, "Russia's Black Sea Fleet is 'functionally inactive' after being pummeled hard by Ukraine, UK says," March 25. 2024, https://www.businessinsider.com/russia-black-sea-fleet-functionally-inactive-after-ukraine-strikes-uk-2024-3?utm_medium=referral&utm_source=yahoo.com.

57 Lauren Frias, "Ukraine has devastated Russia's Black Sea Fleet without even having a real navy. These are the Russian warships Ukraine has taken out.," *Business Insider,* May 22, 2024, https://www.businessinsider.com/warships-in-russia-black-sea-fleet-that-ukraine-wiped-out-2024-2; Caleb Larson, "Russia's Navy In The Black Sea Has Been 'Decimated'," *1945*, February 26, 2025, https://www.19fortyfive.com/2025/02/russias-navy-in-the-black-sea-has-been-decimated/.

58 Tamara Rozouvan, "Ukraine says Magura V5 USV downed Russian Mi-8 helicopter with adapted AAM," *Janes,* January 3, 2025, https://www.janes.com/osint-insights/defence-news/defence/ukraine-says-magura-v5-usv-downed-russian-mi-8-helicopter-with-adapted-aam.

59 Howard Altman, "Two Russian Su-30 Flankers Downed By AIM-9s Fired From Drone Boats: Ukrainian Intel Boss," *TWZ,* May 3, 2025, https://www.twz.com/news-features/two-russian-su-30-flankers-downed-by-aim-9s-fired-from-drone-boats-ukrainian-intel-boss.

60 Altman, "Russian FPV Drone Seen Attacking Ukrainian Uncrewed Surface Vessel For The First Time."

In July, imagery showed a Russian tugboat from Novorossiysk docked in Ochamchire in Georgia's Abkhazia region.[61] Analysts assessed that USVs had made Novorossiysk untenable, leading to a Russian evacuation.[62] And on 15 July, Ukraine announced that the last Russian patrol ships had left Sevastopol.[63]

On the night of 8-9 August, USVs struck gas platform MSP-17, roughly 35 nm off the western spit of Crimea.[64] According to Ukraine, Russia was using MSP-17 as a base for GPS spoofing.[65]

On 4-5 September, USVs with *Grad* rocket launchers attacked the city of Novorossiysk, causing explosions and spurring defensive fires from ashore.[66] With a range of over 20 nm, the rocket launchers gave Ukraine's USVs the ability to impose damage ashore from a distance.[67]

In mid-September, imagery confirmed that the Black Sea Fleet had indeed withdrawn from Novorossiysk in favor of Ochamchire.[68] Demonstrating the operational cost of sea denial, this increased the BSF's transit time to Sevastopol by a factor of three compared to Novorossiysk. Moreover, it imposed logistical cost on Russia by forcing the fleet away from established port facilities, supply lines, and maintenance and repair capabilities.

On 5-6 December, *Sea Baby*s attacked the Kerch Bridge again. Though unsuccessful, the attack featured USVs firing on Russian helicopters with machine guns—another tactical evolution.[69] And on 6-7 December 2024, a USV equipped with FPV UAVs attacks Russian

61 H I Sutton, "New Development in Black Sea, Russian Navy Using Base in Georgia," *Naval News,* October 7, 2024, https://www.navalnews.com/naval-news/2024/07/first-russian-navy-ship-seen-in-base-in-abkhazi-separatist-region-of-georgia/.

62 Ibid.

63 Peter Dickinson, "Russia's retreat from Crimea makes a mockery of the West's escalation fears," Atlantic Council, July 16, 2024, https://www.atlanticcouncil.org/blogs/ukrainealert/russias-retreat-from-crimea-makes-a-mockery-of-the-wests-escalation-fears/.

64 "What's the Gas Rig Ukrainian Navy Has Decimated and What it Meant For Russian Military (Video)," *Defense Express,* August 10, 2024, https://en.defence-ua.com/news/whats_the_gas_rig_ukrainian_navy_has_decimated_and_what_it_meant_for_russian_military_video-11473.html.

65 Ibid.

66 "Maritime Drones Target Black Sea Fleet's Novorossiysk Base," *Kyiv Post,* September 5, 2024, https://www.kyivpost.com/post/38500; Vadim Kushnikov, "Russia announces attack on Novorossiysk by naval drones," *Militarnyi,* September 5, 2024, https://mil.in.ua/en/news/russia-announces-attack-on-novorossiysk-by-naval-drones/.

67 *MLRS "GRAD" and its Modifications* (Belgrade, Serbia: EDePro), https://web.archive.org/web/20160305020310/http://www.edepro.com/files/R122_G2000_Cargo.pdf.

68 https://mil.in.ua/en/news/russian-black-sea-fleet-grouping-leaves-the-base-in-novorossiysk/; Olena Goncharova, "Russia's new naval base raises fears of Georgia's involvement in Ukraine war, WSJ reports," *The Kyiv Independent,* February 1, 2025, https://kyivindependent.com/russias-new-naval-base-raises-fears-of-georgias-involvement-in-ukraine-war-wsj-reports/.

69 Martin Fornusek, "SBU releases video of Sea Baby naval drones repelling Russian helicopter attack," *The Kyiv Independent,* December 9, 2024, https://kyivindependent.com/sbu-video-sea-baby-drones-crimea/.

gas platforms in the Arkhangelskoe oil field.[70] The UAVs likely provide USV operators with situational awareness for tactical coordination, as well as battle damage assessment.

Assessment

Drawing key insights from the chronology above, this section recapitulates observations consistent with the four analytic themes described earlier.

Sea Denial

Ukraine achieved a remarkable feat in denying Russia's navy use of the sea without having a navy of its own. While its USVs have at times operated in coordination with UAVs and anti-ship missiles, Ukraine's sea denial success is largely attributable to USVs alone.

Of course, the strategic value of sea denial is in its impact upon the warring nations' competing objectives. To that end, Ukraine's USV campaign delivered at least two strategically critical outcomes: it precluded Russia from blockading Ukraine's grain exports, or from conducting amphibious operations or naval bombardment against Ukrainian territory. Thus, Ukraine was able to maintain its economic lifeline, while Russia was prevented from taking measures that might have resulted in Ukraine's loss of vital territory.

Moreover, sea denial contributed to Ukraine's air defense effectiveness by pushing Russian *Kalibr* shooters farther and farther east.[71] In missile defense, every second matters, and sea denial has added precious seconds for Ukraine's air defenders to respond to *Kalibr* attacks. It is impossible to judge how much more effective Russia's missiles may have been if launched from closer to Ukraine's shores, but it seems likely that some damage and casualties have been avoided thanks to the effectiveness of the sea denial campaign.

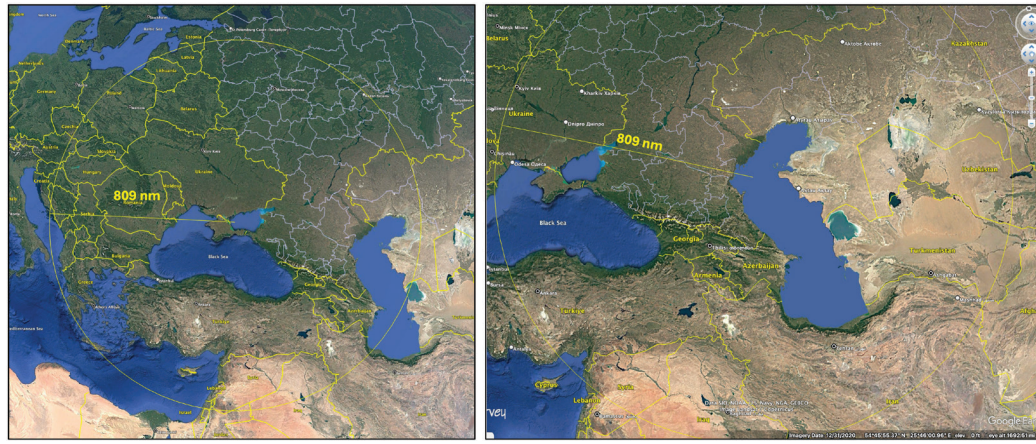
It is important to acknowledge the limitations of Ukraine's sea denial campaign. Although USVs have rendered the Black Sea largely impassable to Russian warships, BSF ships with *Kalibr* land-attack cruise missiles (LACM) can still conduct long-range fires into Ukraine

70 James Bickerton, "Russian Black Sea Gas Platforms Targeted by 'Sea Baby' Drones," *Newsweek,* December 8, 2024; https://www.newsweek.com/russian-black-sea-gas-platforms-targeted-sea-baby-drones-1997325; Vadim Kushinikov, "The Ukrainian Navy received naval drones equipped with strike FPV drones," *Military NYI,* December 8, 2024, https://mil.in.ua/en/news/the-ukrainian-navy-received-naval-drones-equipped-with-strike-fpv-drones/; Joseph Trevithick, "Ukraine's Drone Boats Are Now Shooting Machine Guns At Russian Helicopters, Boats," *TWZ,* December 9, 2024, https://www.twz.com/sea/ukraines-drone-boats-are-now-shooting-machine-guns-at-enemy-helicopters-boats.

71 Marson, "How Ukraine's Naval Drones Turned the Tide in the Battle of the Black Sea."

from the relative sanctuary of the Sea of Azov and the Caspian Sea.[72] Figure 5 shows the approximate range of *Kalibr* LACMs launched from those areas.[73]

FIGURE 5: KALIBR RANGE FROM AZOV (LEFT) AND CASPIAN SEA (RIGHT)



Source: Google Earth and the author

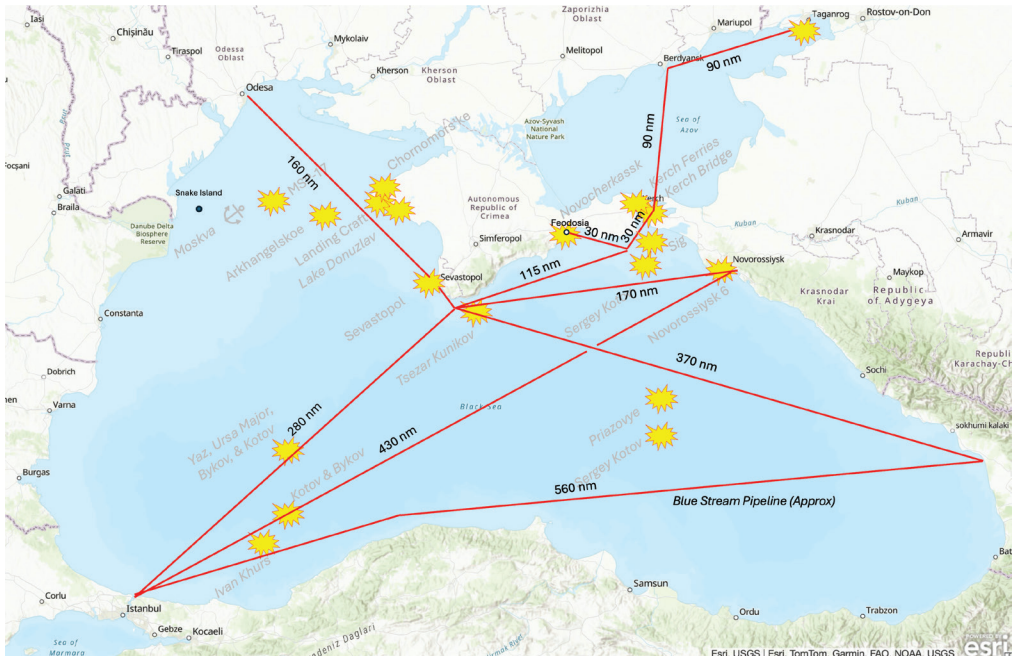
Range Extension

Within the sea denial campaign, USVs have played an important functional role as *range extenders* for Ukrainian operations. ASCMs launched from Ukrainian territory can cover only a relatively small portion of the Black Sea, while Ukraine's USVs have ranged all the way to Novorossiysk and the Sea of Azov. (Figure 6 is a graphic overview of Ukraine's reported USV attacks through December 2024.)

72 Notably, however, Ukraine can now strike Azov-area Russian bases, such as the airfield at Taganrog, using US-supplied ATACMS missiles. See Brendan Cole, "Video Shows Deadly Aftermath of Ukraine ATACMS Strike on Russian Air Base," *Newsweek,* December 12, 2024, https://www.newsweek.com/video-russia-ukraine-atacms-strike-territory-rostov-air-base-blown-away-1999713.

73 Missile Defense Project, "3M-14 Kalibr (SS-N-30A)," *CSIS Missile Threat Project*, Center for Strategic and International Studies, August 11, 2016, last modified April 23, 2024, https://missilethreat.csis.org/missile/ss-n-30a/.

FIGURE 6: ESTIMATED USV ATTACK LOCATIONS



Source: Google Maps and the author

Moreover, Ukraine is also using USVs as range-extenders for UAVs, launching FPV drones to attack Russian targets ashore.[74] And the rocket attacks against Novorossiysk demonstrate a nascent strike capability that Russian defenders must take into account. Of note, Ukraine revealed the existence of its rocket-equipped USVs in January 2024, months before the Novorossiysk rocket attack.[75] This may have caused some additional, if unseen, cost to Russia in terms of defensive preparations and countermeasure development.

Capability Evolution

Ukraine's USVs have evolved from single-use explosive boats to platforms capable of laying sea mines, shooting down aircraft, and even striking targets ashore. Each of these capabilities brings new opportunities for Ukraine to impose costs on Russia's operations.

Mines have obvious benefits for sea denial campaign. Russian ships are no longer at risk only when tied to the pier or accosted by USV "wolf packs;" now they must also be wary of mines in their harbor approaches. In addition to the direct consequences of mine damage,

74 David Axe, "The Ukrainian Navy's Robotic Aircraft Carriers Are Raiding Russian Coastal Defenses," *Forbes,* March 9, 2025, https://www.forbes.com/sites/davidaxe/2025/03/09/the-ukrainian-navys-robotic-aircraft-carriers-are-raiding-russian-coastal-defenses/.

75 H I Sutton, "Ukraine's SBU Reveals Rocket-Armed Sea Baby USV," *Covert Shores,* January 1, 2024, http://www.hisutton.com/Ukraine-Sea-Baby-Rockets.html.

mines impose the broader costs of mine hunting, minesweeping, and the associated ISR requirements.

Ukraine has also used USVs to attack the Kerch Bridge on at least two occasions. However, bridges are notoriously difficult targets to destroy permanently, and Ukraine's ongoing attacks against the bridge have turned to underwater explosives (with so-far inconclusive results).[76] Nevertheless, USVs clearly have potential utility against maritime infrastructure targets, particularly those of more fragile construction (and less heavily guarded) than the Kerch Bridge.

Finally, while not a kinetic capability, USVs can contribute to wartime information operations. Social media and online news sites are awash with videos of Ukrainian USV attacks. These have likely been valuable for countering Russian statements that the USV attacks were repelled. In addition, these videos may contribute to Ukrainian morale by demonstrating military successes. The informational value may be eroded by devaluation of visual evidence arising from the proliferation of AI-generated video; nevertheless, it seems likely that the videos will continue to have at least some value. Developers of autonomous USVs should therefore consider retaining video transmission capability even if it is no longer necessary for targeting and homing purposes.

Measure-Countermeasure Competition

Ukraine's rapid, incremental approach had a more subtle advantage, apart from any particular capability. By fielding the initial version of a system quickly while holding advanced capabilities in reserve for later models, it allowed Ukraine to seize the initiative in the iterative competition between new capabilities and adversary countermeasures.[77]

The USV-led sea denial campaign exemplifies the virtues of bare-bones simplicity followed by iterative improvements. First, simpler technology takes less time to build. The initial USVs required little more than off-the-shelf equipment: speedboats, GPS receivers, cameras, contact fuzes, explosives, and StarLink terminals for remote control.[78] Attempting to make the USVs capable of autonomous operation could have added months or years to their development.

Second, fully autonomous USVs might be defeated by defenses targeting their subsystems for navigation, targeting, and so on. Each subsystem would present a discrete target for countermeasures. By using remotely controlled USVs, Ukraine limited Russia's options to physical destruction, barriers, and/or satellite jamming.

76 CSBA report *Gapping the Bridge: Assessing Methods of Attacking the Kerch Bridge*, November 2023 (Clare, Hacker, and Sharp); Humphrey, Andrew, and Jemma Crew; "Crimea Bridge Reopens after Ukraine Says It Carried out Underwater Explosion," *BBC*, June 3 2025, https://www.bbc.com/news/live/cr58e9yr2ezt.

77 Edward N. Luttwak, *Strategy: The Logic of War and Peace*. (Cambridge, MA: Harvard University Press, 1987).

78 Marson, "How Ukraine's Naval Drones Turned the Tide in the Battle of the Black Sea."

Third, battle with small, fast, maneuverable boats places larger warships at a disadvantage. Simply stated, it is hard to detect these speedy attackers visually or by radar until they are inside the minimum ranges of the defender's missiles and large-caliber guns. This left Russia with few tools beyond small-caliber weapons to counter Ukraine's USVs.

Fourth, the iterative approach conforms with the warfighting principles of *security* and *surprise*. The enemy is likely to develop countermeasures only against the capabilities that it has observed in action, not all the potential capabilities a weapon *might* have. Moreover, the adversary is more likely to be surprised by each new capability that is subsequently rolled out.

Russia's countermeasures, in turn, evolved in response to Ukraine's USV capabilities. Other than leveraging connections to the CEO of StarLink, Russia's initial defenses were limited to gunfire and passive harbor defenses. Its subsequent deployment of aerial anti-USV capabilities and improved harbor defenses threatened to degrade Ukraine's USV effectiveness, but Ukraine reacted by developing minelaying and anti-aircraft capabilities. And when Russia mounted GPS jammers on an oil platform, possibly in an attempt to foil USV navigation, Ukraine used USVs to attack the platform.

Seen from this perspective, Ukraine's rapid incremental approach not only sped capabilities to sea in time to make a difference; it also prolonged Russia's countermeasure development cycle—not just because Russia lacked the foresight to develop comprehensive defensive measures, but because it could not afford long development timelines when Ukraine was fielding operational USVs at speed. "Minimum viable" USVs allowed Ukraine to seize the initiative from Russia in the naval war, and though Ukraine's challenge now is to stay one step ahead tactically, Russia—having been forced onto the defensive at sea—is in the unfavorable position of being one step behind both tactically *and* operationally.

CHAPTER 2

Considerations for the United States, Allies, and Partners

Ukraine's naval war suggests several insights for US and allied decision-makers. The following are among the factors that planners should consider when contemplating USV operations in a war with China or Russia.

Four Themes Revisited

Ukraine's USVs have proven key to sea denial, and could provide similar value in other wartime scenarios. But it is critical to view their achievements in the context of warfare in the Black Sea. Otherwise, some "lessons" might turn out to be red herrings when applied in other settings.

One key point is that Ukraine pursued a campaign of attrition, striking where and when it could to reduce the Black Sea Fleet. This might not have been feasible using expensive, exquisite USVs designed for a decisive war of maneuver—but conversely, had Ukraine waited for such highly-capable USVs, they might not have had any in time to make a strategic difference.

Another observation is that *sea denial* is a logical focus for USVs. USVs are well suited for close-quarters engagements with surface ships, attacks on stationary maritime targets, and minelaying. An important limitation, however, is that they are less well suited for ISR: surface-level sensors are largely constrained to distances of tens of miles, making area searches slow and inefficient; and fuel capacity dictates their operational radii and on-station time. This is less relevant in the Black Sea, which a USV could transit in hours. But even there, a USV would need an operational radius of more than 1,000 nm to make round-trips to Russia's coast and back to the Odesa region. The greater the distance, the more likely a USV is on a one-way trip.

Additionally, Ukraine enjoyed favorable engagement geometry. The sea denial campaign was initially aimed at keeping the Russian fleet away from the Odesa region. The greatest threat—Russian ships heading westward—was also the easiest to intercept with USVs heading east. Tail chases and lateral approaches, especially from long distances, would be more tactically challenging, and possibly infeasible due to fuel constraints.

USVs are therefore likely to be most effective for sea denial when they are launched from the territory to be protected. For an ally or partner facing direct invasion, such as Taiwan, it would make the most sense to stockpile USVs in the threatened territory itself—not just because it is the most efficient approach, but because other engagement geometries may well be infeasible based on USV transit times, endurance, and ISR challenges.

Sea denial is just one mission area where USVs might play a *range-extension* role. An obvious sequel would be sea *control*, in which friendly forces regain the ability to operate naval and commercial fleets at sea. This might include the establishment of USV "pickets" in fixed areas to be monitored and defended; for example, straits and other maritime choke-points. This could be achieved with high-endurance loitering USVs, a regular rotation of shore-based USVs, or some combination of the two. At any rate, it is worth considering how USVs might serve as range extenders across a variety of missions, particularly those which do not call for exquisite capabilities or a high degree of tactical integration with other forces.

With regard to cross-domain capabilities, the key is to prioritize getting *required* capability into the field as quickly as possible, while foregoing *desired* capabilities until they are ready for deployment. The challenge is to discriminate between the two categories. To do so, it is necessary to specify the role that USVs *must* play in the central concept of operations, as opposed to what roles they *could* play. And to do this, there must be a cohesive concept of operations for a given wartime scenario. (This is covered at more length in the next section's discussion of requirements creep.)

The Black Sea *measure-countermeasure competition* holds important lessons. First and foremost, rapid fielding of minimum-viable capability—*without* regard for potential counter-measures—allowed Ukraine to seize the initiative. Countermeasures to that capability will arise over time, but the opportunity to gain the first-mover advantage comes only once.

Additionally, when new USV capabilities are in production, it might be prudent to with-hold them until they are truly necessary, prolonging the value of the simpler, less-expensive models. This also provides "conceal/reveal" options for influencing enemy perception of friendly capabilities, potentially strengthening deterrence or, if war is already underway, upsetting enemy planning assumptions and disrupting ongoing operations.[79]

A final consideration is that forecasts of specific capability requirements may prove incorrect. Wars evolve in unpredictable ways, and investment of scarce time and resources in capabilities

79 See, for instance, Thomas G. Mahnken, *Selective Disclosure: A Strategic Approach to Long-Term Competition*, (Washington, DC: Center for Strategic and Budgetary Assessments, November 2020), https://csbaonline.org/research/publications/selective-disclosure-a-strategic-approach-to-long-term-competition.

that prove irrelevant has obvious negative consequences. The hard lessons of wartime operations tend to lead to faster and better-targeted innovation. For instance, Ukraine might have invested in short-range USVs for the primary purpose of defeating Russian amphibious operations in the Odesa region. But instead, it built USVs of substantial range and endurance, which proved vital to a sea denial campaign that not only safeguarded Odesa but also preserved grain exports and therefore the ability to continue fighting Russian invaders. American planners would be well advised to consider the strategic and operational imperatives of war with China or Russia before committing to any specific tactical and technical characteristics.

Limiting Factors

While USVs offer many possibilities for wartime advantage, they also have limitations that must be taken into account. Often, these limitations are less about unavoidable physical constraints than about choices concerning USV employment and the attendant technical requirements—choices that could make USVs either more or *less* relevant, costly, and timely.

The Connectivity Conundrum

Ukraine has relied on satellite communications to link USVs to their human operators.[80] The operators, in turn, need target cueing from third-party ISR.[81] As nodes in a wider network, USVs are therefore vulnerable to mission failure due to communications interruptions, as probably occurred during Ukraine's first attempt at a USV attack in September 2022.[82]

This vulnerability can be mitigated by using alternative communications methods such as aerial relay of line-of-sight radio signals. Inertial navigation techniques could provide a backup capability, but will not solve the problem of enroute collisions, nor the challenges of target acquisition and terminal engagement. While USV control problems may be solved in time through developments in autonomy, they do not eliminate the need for ISR proportional to the size of the search area, which in many cases—such as war in the Atlantic or Pacific—may be very large. In the near term, therefore, even highly-autonomous USVs will continue to require resilient communications architectures. As such, it is worth asking how much benefit there is to be gained from autonomy if USVs must still be "on the grid" to

80 Kateryna Bondar, "Why Ukraine Is Establishing Unmanned Forces Across Its Defense Sector and What the United States Can Learn from It," Center for Strategic and International Studies, November 19, 2024, https://www.csis.org/analysis/why-ukraine-establishing-unmanned-forces. Hereinafter cited as Bondar.

81 Static chokepoint defense would be one of the limited exceptions to this rule.

82 Ukraine relies heavily on StarLink satellites, which are vulnerable to jamming (albeit less so than other satellite services) and to intentional withholding of service. It appears to have addressed this single point of failure by incorporating alternative means of communication, such as the mesh radios reportedly installed in the MAGURAs, which would enable them to exchange data with aerial relay platforms. Ukraine also employs alternate satellite communication providers, such as that of American firm Kymeta. H I Sutton, "Overview Of Maritime Drones (USVs) Of The Russo-Ukrainian War, 2022 – 24," *Covert Shores,* June 20, 2025, http://www.hisutton.com/Russia-Ukraine-USVs-2024.html; Troshkin, "The Role of Naval Strike Drones in the Russia – Ukraine War."

execute their mission. Again, the answer may depend on the particular mission for which a specific USV is designed.

The Tyranny of Distance

The Black Sea is minute compared to the Pacific and Atlantic Oceans. USVs can cover its span in less than a day. In a war with China, by contrast, USVs from US territory would be severely taxed by the larger distances involved. The transit from Guam to the Taiwan Strait is roughly 1,500 nm, nearly three times the width of the Black Sea. At a fuel-efficient speed of 10 kt, this would take more than six days, and even at a fuel-intensive speed of 30 kt would take two days. (In heavy weather it could take far longer.) And in a Russia-focused anti-submarine warfare scenario, the distance from Maine to the Greenland-Iceland-UK gap is more than 1,800 nm.

Due to the tyranny of distance, USVs may only be operationally useful within a limited set of constraints. They are likely to be *most* useful when, as in Ukraine, deployed from the targeted territory itself (e.g., Taiwan, or a Baltic or Black Sea NATO ally, etc.). They are less likely to be useful when trans-oceanic distances are involved. The effects of distance might be partially overcome by using aircraft or ships to deploy USVs, but this will impose additional operational and technological challenges, with associated expense, delay, and opportunity cost.

Another option would be to pre-station USVs at sea, but this brings a wealth of additional challenges, including the risk of capture, the possibility of enemy misperception of intent, and the added cost and complexity of high-endurance USVs. The risk may be worth the reward, but again, the operational concept is the key to viability.

Enemy Forces

Ukraine's sea denial campaign has been a battle of attrition in which closure of the Bosporus prevented Russia from substantially reinforcing the Black Sea Fleet. In a war of maneuver in which the enemy has a much larger force and a broader battlespace, Ukraine-style USV employment might not have as significant an operational or strategic effect.

Moreover, Ukraine's successful defense of its territory west of Crimea meant that it could continue launching USVs from its shores. Loss of allied coastal territory to a Chinese or Russian invasion would reinforce the problems of distance, rendering USVs unable to reach the area of operations in a relevant timeframe. This does not negate the advantages of USVs intended solely for sea denial along the defended coast; but it does suggest that USVs intended for *other* missions will need more survivable deployment arrangements.

Requirements Creep

It is vital to define the role of USVs within the overarching wartime concept of operations. Ukraine pursued an attrition-based campaign in which the military strategy hinged on having *something* to fight the Black Sea Fleet as quickly as possible, but was less reliant on

the tactical timing of operations. Put bluntly, Ukraine's operational concept was constrained by its USVs' capabilities. Attempting to build operational concepts and engineer USVs on disconnected parallel tracks will inevitably impose unanticipated technological and operational demands (i.e., "requirements creep") resulting in cost growth and delay.

Planners have three basic options to deal with this chicken-or-egg dilemma. First, they can build operational concepts that do not rely on USVs at all. Then, USVs can be added to existing plan as supporting efforts or force-multipliers, potentially with very positive results. The downside is that if the concept does not require USVs, it will be difficult to justify investing in USVs—unless the logic of this approach is explicitly embraced by military and political decision-makers.

Second, planners can build concepts that rely explicitly on USVs. This sends the strongest possible signal to decision-makers to prioritize USV investments; but it stakes operational outcomes on successful fielding of USVs and increases the likelihood of requirements creep as the detailed challenges of USV-centric operations come into better focus.

A third option is to make rapid, large-scale investments in USVs with a corresponding operational concept that can be "snapped" into place in the larger wartime strategy when ready—while maintaining current forces and plans until the new concept and capabilities are fully ready. This will require decision-makers to forego the typical defense planning approach in which new capabilities are introduced incrementally over a period of years while legacy forces are "ramped down" to achieve a net-zero cost. In other words, they must plan to bear the full cost burden of maintaining the existing force *and* a future force being built in parallel.

All three of these options are politically challenging, but failure to decide on one or another of these paths will almost certainly result in delay, cost-growth, and under-performance.

Organization for Innovation

Finally, it is noteworthy that Ukraine's USVs were developed and operated not by its navy, but by its intelligence services, GUR (Defense Intelligence of Ukraine) and SBU (Security Service of Ukraine).[83] And in 2024, Ukraine established an Unmanned Systems Force as an

83 H I Sutton, "Uncrewed Platforms Have Been Critical to Ukraine's Success in the Black Sea," Royal United Services Institute, August 20, 2024, https://www.rusi.org/explore-our-research/publications/commentary/uncrewed-platforms-have-been-critical-ukraines-success-black-sea.

independent military service, forestalling "roles and missions" debates in favor of speed and unity of effort.[84]

Ukraine's organizational approach holds positive lessons and potential challenges for the United States and its allies. Letting a good idea bloom where it is planted rather than insisting on ownership by traditional stakeholders can help speed capabilities into the field. Additionally, non-traditional innovators should be less likely than entrenched bureaucracies to deceive themselves about what they can achieve on a given timeline, or to incur delay due to diffusion of responsibility and competing organizational priorities.

On the other hand, Ukraine's "navy of necessity" came about because it had no other option for contesting Russian sea control beyond the range of shore-based ASCMs. With its navy gone, Ukraine adopted operational innovations from whichever agency could field them first. It is unknowable whether the navy *might* have fielded USVs on the same timeline and operated them with similar effectiveness. At any rate, this aspect of Ukraine's USV effort bears further scrutiny before considering it a gold standard for innovation.

Moreover, because Ukraine had no other military assets to speak of in the Black Sea, it had few coordination problems—avoiding friendly fire, synchronizing time-on-target, and so on. US and allied navies may be harder pressed to integrate USVs. The US Navy's concept for a "hybrid fleet" of manned and unmanned surface vessels remains undefined, and the Navy has not publicly stated whether USVs are to be tactically integrated or limited to playing "deconflicted" or detached roles.[85] If the former approach is selected, the technical and tactical problems will be much more complex and challenging, potentially taking years rather than months to solve.

84 Kateryna Bondar, "Why Ukraine Is Establishing Unmanned Forces Across Its Defense Sector and What the United States Can Learn from It," Center for Strategic and International Studies, November 19, 2024, https://www.csis.org/analysis/why-ukraine-establishing-unmanned-forces. It is interesting to note that there is a long history of intelligence forces leading the development and fielding of unmanned systems in war. For instance, during World War II, the US Office of Strategic Services (OSS) partnered with the US Army Air Forces in Operation *Campbell* (later renamed *Javaman*) to develop naval attack drones controlled from aircraft aloft; more recently, in 2025 the Israeli intelligence service, Mossad, smuggled disassembled UAVs and munitions into Iran and used them for surprise attacks against air defenses and missile launchers. On *Campbell/Javaman*, see Office of the Assistant Secretary of War, *War Report of The OSS (Office of Strategic Services),* (Washington, DC: 1976, Walker Publishing Company, Inc.), https://www.governmentattic.org/58docs/WarRptOSSvolI_1947_1976.pdf. On Mossad's operations, see Dov Lieber and Andrew Dowell, "How Israel's Mossad Smuggled Drone Parts to Attack Iran From Within," *The Wall Street Journal,* June 15, 2025, https://www.wsj.com/world/middle-east/how-israels-mossad-smuggled-drone-parts-to-attack-iran-from-within-633516a9?gaa_at=eafs&gaa_n=ASWzDAgYVHSuD3WytDkxBIwQgonAhFYK3_23QBd2w5pYTWJSEFZB1N-iXNG8gALonJ8%3D&gaa_ts=685c37df&gaa_sig=0ZyhYAnsbWNoQDxH8FzVG1anUDFH-lfMC_-3gAkuy-nOETniJIWr0UJMH4AFo7HuSaQAPDOWo34PWIjUk1jopA%3D%3D.

85 Captain George Galdorisi, U.S. Navy (ret.), "A Concept of Operations for the U.S. Navy's Hybrid Fleet," Center for International Maritime Security, June 5, 2024, https://cimsec.org/a-concept-of-operations-for-the-u-s-navys-hybrid-fleet/; U.S. Department of the Navy Science and Technology Board, *The Path Forward on Unmanned Systems,* (Washington, DC: Department of the Navy, December 2024), https://www.secnav.navy.mil/donsandtboard/Shared%20Documents/DON%20S%26T%20Board%20-%202024%20-%20Path%20Forward%20on%20Unmanned%20Systems%20-%20Final%20for%20public%20release%20(1).pdf.

CHAPTER 3

Conclusion

In less than three years, Ukraine produced USVs capable of anti-ship, anti-aircraft, strike, and UAV operations—a stunning sprint relative to typical US military development timelines. But what must not be overlooked is that Ukraine did not wait to perfect these capabilities before fielding its first USVs. Rather, it deployed what it could, when it could—starting with kamikaze boats within months, and culminating with multi-mission USVs in subsequent years.

Moreover, while Ukraine's operations have focused on sea denial, the main accomplishment *of* sea denial has been to enable continued grain exports. If the Black Sea Fleet had severed this economic lifeline, it is an open question how long Ukraine could have continued fighting. Just-in-time delivery of tactical capability produced just-in-time delivery of strategic survival.

From this perspective, the decisive period may have been from July, when Russia withdrew from the Black Sea Grain Initiative, to October 2023. Beginning in July, Ukraine's trade routes from Odesa to the Bosporus were in Russia's crosshairs. But by October, USV attacks forced the Black Sea Fleet to withdraw to Novorossiysk. Later, it retreated even farther, to Ochamchire. Meanwhile, Ukraine's grain exports achieved rough parity with prewar levels, sustaining vital economic support for its war machine.

Ukraine's naval war against Russia provides many valuable lessons for designers, operators, planners, and strategists. Perhaps the most important lesson, however, is that *sooner is better.*

APPENDIX: A CONSOLIDATED TIMELINE

	Feb 22	**Russian invasion commences**
	Mar 22	Russia achieves maximum territorial gains
Russia's BSF flagship *Moskva* sunk by Neptune missiles	**Apr 22**	Russia withdraws from Kyiv
	May 22	
	Jun 22	
Black Sea Grain Initiative (BGSI) goes into effect	**Jul 22**	**Black Sea Grain Initiative (BGSI) goes into effect**
	Aug 22	
Mykola USV washes ashore near Sevastopol	**Sep 22**	
First USV attack on Sevastopol harbor	**Oct 22**	Russia suspends participation in BGSI
First USV attack on Novorossiysk harbor	**Nov 22**	Russia rejoins BGSI
	Dec 22	
	Jan 23	
	Feb 23	
Monobank USV revealed	**Mar 23**	
Toloka UUV revealed	**Apr 23**	
Ivan Khurs damaged in **first known at-sea USV attack**	**May 23**	
	Jun 23	Russia begins applying camouflage to warships
Sea Baby revealed in Kerch Bridge attack Grain exports paused	**Jul 23**	**Russia withdraws from BGSI** Russia prohibits small craft traffic in Kerch Strait
Marichka UUV prototype revealed	**Aug 23**	
***Samum* damaged by USV-laid mine** **Grain exports re-started via western Black Sea route**	**Sep 23**	
Vladimir Kozitsky strikes mine while minehunting	**Oct 23**	**Nearly all Black Sea Fleet submarines and major warships moved from Sevastopol to Novorossiysk**
MAGURA USV revealed in Chornomors'ke attack	**Nov 23**	
	Dec 23	
***Sea Baby* rocket launcher** capability revealed	**Jan 24**	
	Feb 24	
Avdiivka revealed, featuring modular payloads	**Mar 24**	**Commander of Russian navy sacked; Defense Minister directs BSF to improve USV defenses** **UK Defense Minister states 1/3 of BSF sunk/damaged**
	Apr 24	
AA-11 missile capability revealed	**May 24**	
USV attack in Taganrog Bay, Sea of Azov	**Jun 24**	
Weaponized jet ski found on Turkish beach	**Jul 24**	Russian tugboat appears at Ochamchire; last patrol ships have departed Sevastopol
First known gas platform attack (MSP17)	**Aug 24**	
USVs attack city of Novorossiysk with rockets	**Sep 24**	**Black Sea Fleet withdraws from Novorossiysk** **Port facility buildup underway at Ochamchire**
	Oct 24	
	Nov 24	
Antiaircraft gun and organic UAV capabilities revealed	**Dec 24**	

LIST OF ACRONYMS

ASCM	Anti-ship cruise missiles
BSF	Black Sea Fleet
BSGI	Black Sea Grain Initiative
FLIR	Forward-looking infrared
FPV	First-person view
GUR	Defense Intelligence of Ukraine
ISR	Intelligence, surveillance and reconnaissance
KT	knots
LACM	Land-attack cruise missiles
MAGURA	Maritime Autonomous Guard Unmanned Robotic Apparatus
NM	Nautical miles
SBU	Security Service of Ukraine
UAV	Unmanned aerial vehicles
USV	Unmanned surface vessels

CSBA
Center for Strategic and Budgetary Assessments

1667 K Street, NW, Suite 900
Washington, DC 20006
Tel. 202.331.7990 • Fax 202.331.8019
www.csbaonline.org