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Tactical Fruit Flies and a Strategic Petri Dish

The Black Sea as Testing Ground for the Future of Maritime Conflict

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Tactical Fruit Flies and a Strategic Petri Dish

The Black Sea as Testing Ground for the Future of Maritime Conflict

While likely familiar to readers, Ukraine's undisputable military success at sea despite not having a navy to speak of bears reemphasis. Two dozen hulls in Russia's Black Sea Fleet are out of commission, including two successive flag ships, a *Kilo*-class submarine, a top-of-the-line *Karakurt*-class corvette, and numerous amphibious landing vessels.¹ Russia's key Crimean maintenance and logistical base of Sevastopol has for now been rendered essentially unusable. The threat of Russian amphibious assault has been eliminated, and merchant shipping out of Ukrainian ports continues to grow.²

Many of these achievements can be attributed to Ukraine's novel and aggressive use of uncrewed air and surface vessels. Their spectacular successes have led the UK's First Sea Lord to refer to the rise of naval drones as a "dreadnought moment" that is "rewriting the rules of naval warfare."³ A former NATO commander observes that "we are at a pivot point in maritime combat."⁴ What should the world's leading naval power learn from this?

When it comes to drones, the answer is...not much, at least at this point.⁵ From the U.S. Navy's perspective, the Black Sea is simply not central to either its preparation for or learning about naval warfare. China remains the official pacing threat and countering a Chinese invasion of Taiwan the pacing scenario for the U.S. military. The United States' ongoing combat operations against the Houthi threat in the Red Sea differ considerably from those in the Black Sea. The U.S. Navy remains committed to supporting NATO operations, particularly in the Baltic, but this environment again bears little resemblance to the waters east of the Bosporus.

Finally, Ukraine's success is based on a set of uniquely favorable circumstances for drones. Black Sea drones are the equivalent of fruit flies in biological research: large in number, short in lifespan, and little more than an annoyance outside of their laboratory environment. One can still learn from fruit flies, but it takes both many generations' worth of research and circumspection in applying lessons to larger, more complicated fauna.

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¹ Kollakowski 2025: 6-10.

² Miller and Diakun 2024.

³ Key 2023.

⁴ Stavridis quoted in Boot 2024.

⁵ Tallis 2024.

While the uncrewed maritime war in the Black Sea is of limited direct relevance for the United States at a tactical or operational level, there remain many lessons to be learned from any naval clash given their rarity.⁶ The Black Sea's constrained environment allows for analysis, on a small scale and in a controlled environment, of the strategic role played (and not played) by naval assets in modern warfare. To add a second scientific metaphor, if maritime drones are tactical fruit flies, the Black Sea is a strategic petri dish.

1 Fruit Flies

Generations of drones resemble fruit flies, dying almost as soon as they are born.⁷ The Turkish TB-2, which once dominated the Ukrainian skies, is now hardly relevant. Approximately 75% of all drones are lost to electronic warfare in Ukraine, leading the French Chief of Staff to predict that the "life of impunity of small, very simple drones over the battlefield is a snapshot in time."⁸ But a short lifespan also means fast evolution. The development of the Magura V5 surface drone was announced in November 2022; and it sunk its first ship just a year later.⁹ While the tactical and operational lessons learned now are of limited value for the United States, we should not dismiss the potential implications of future drone generations. But the engineering and operational challenges that must still be overcome are massive.

What the Ukrainians have accomplished is not easy. Coordinating strikes between multiple platforms in the air and on the water not only requires significant hardware, but extensive software, intelligence, and communications capabilities. But then Kiev's efforts are simplified by environmental and structural factors. Compared to the North Atlantic and portions of the Pacific Ocean, the Black Sea boasts a relatively benign sea state, especially in the summer. The Black Sea is also a confined water space, allowing Kiev's USV operations to benefit from both proximity to Ukrainian controlled shoreline and limits to Russian reinforcement due to Turkey's application of the Montreux Convention. In addition, USV operations are conducted in a relatively benign information and electronic environment, thanks to intelligence provided from multiple friendly sources, the continued robustness of Starlink at sea, and the collapse of Russian maritime domain awareness thanks to successful Ukrainian attacks on command ships and airborne surveillance platforms early in the war. These conditions have few analogues outside the theater.

The economics of generating effects at scale and at distance against a determined and sophisticated adversary are likely to be another matter entirely. Consider the two most prominent kinetic sea drones operated by Ukraine, both of which cost roughly the same per unit, a far from trivial 220,000 to 280,000 USD.¹⁰ The Magura V5 sacrifices explosive power and flexibility for speed, while the Sea Baby makes the opposite tradeoff. A drone able to do both would cost much more than double the cost; prices do

⁶ Hoffman and Garrett 2024.

⁷ Pettyjohn et al: 2024.

⁸ Ruitenberg: 2024

⁹ Troshkin 2024.

¹⁰ Hatton 2024. Lagrone 2022.

not increase linearly.¹¹ Once translated to a theater outside the Black Sea, drones will have to become more sophisticated (and therefore expensive) to perform in more challenging environments.¹²

For the Ukrainians to pursue the Black Sea Fleet past the Kerch Strait, where it controls no coastline, their drones and concepts of operations will need to develop further. Russia controls the entire coast of the Sea of Azov. USVs will have to pass under the heavily defended Kerch Bridge or be covertly portaged over land, and will then have to operate inside a formidable integrated air and electronic warfare defense bubble. Reaching the Kerch area will extend one-way transit distances by 150 miles.¹³

Drones generally cannot be the only component of a successful maritime campaign. Despite drones receiving the lion's share of attention in the Black Sea conflict, Ukraine's success has fundamentally rested on the threat of its shore-based anti-ship missile systems. These weapons gave Ukraine its first victory in the naval war by sinking the cruiser *Moskva*, made a Russian amphibious assault of Odessa impossible, and turned the western Black Sea into a denial zone from which drones could operate with impunity.¹⁴ Ukraine has prioritized its preciously few Storm Shadow and SCALP cruise missiles for the Black Sea fleet and its ports.¹⁵ The relative value of missiles over drones will likely increase with range, which is why Ukraine is investing in a long-range version of its indigenous Neptune missile and increasing production rates "tenfold."¹⁶

U.S. systems, which must operate over greater distances and in harsher conditions than their Ukrainian cousins, face a more complex set of challenges. Increasing the power and range of uncrewed systems requires considerable growth because the sophisticated system that enables them also must be extended. These weapons' success depends on the ever-changing balance between communications and sensing systems and their ugly stepchild of electronic warfare. Mechanical casualties, which are more likely in vessels that must operate in more challenging conditions for longer times, cannot be easily monitored or fixed without a human on board. An unrepaired vessel will fail earlier. Even if remote repair is possible, the process creates exploitable electronic vulnerabilities that raise the risk of mission failure.¹⁷ The fundamentals of war in the Black Sea do not force Ukraine to deal with these questions.

Finally, the success of Ukrainian naval drones is predicated on one other less appreciated aspect of the naval battle: Russia does not appear to be replicating Ukrainian platforms and tactics with any sense of urgency, and has only slowly developed tactics and technologies that allow it to defeat USVs.¹⁸ While it has mitigated attacks on its naval facilities with simple physical barriers, its ships at sea remain vulnerable.

Several factors might explain Russia's lack of attention to maritime drones. First, and most obviously, the Ukrainians no longer have a navy to attack. Second, Russia is no doubt focusing its limited resources on the far more dynamic, violent, and consequential land war. Third, and perhaps most importantly, Russia still possesses plenty of

¹¹ Everly et al 2015. On inflation in defense more generally, see Hove/Lillekvelland 2017.

¹² Tallis 2024.

¹³ Altman 2024.

¹⁴ Tallis 2024.

¹⁵ Watling et al 2023.

¹⁶ Harman et al 2024.

¹⁷ Panter/Falcone 2022.

¹⁸ Kretsul/Ramm 2023.

long-range ground- and sea-launched missiles that can threaten Ukrainian ports as well as vessels. According to a Ukrainian spokesperson, Russia retains the ability to project power into the larger Black Sea with *Kilo*-class submarines, three of which are armed with Kalibr cruise missiles.¹⁹

Thus, while Ukrainian tactics have played a key role, perhaps the major reason Russia is no longer contesting the Black Sea with surface ships is because it can still accomplish its primary maritime missions – long-range land attack and protection of critical infrastructure like the Kerch Bridge – without having to take risks at sea.²⁰ To date, while Russian tactical behavior has changed, its strategic behavior has not.²¹

We do not argue that the fruit flies are not evolving; it appears that for a given level of uncrewed capability, the cost curve is being driven down.²² Initial phases of technological advancement often show exponential price increases with performance gains, whereas mature technologies tend to exhibit power law relationships due to cost reductions and economies of scale. And even current capabilities suggest the potential for defense dominance in similarly small and constrained bodies of water; the "hellscape" posited by the American Indo-Pacific commander within the Taiwan Strait almost certainly is taking cues from the Black Sea.²³

But these capabilities' use in many other places by (or more likely against) the U.S. Navy remains implausible.²⁴ At longer ranges, against better defenses, and in a contested electronic environment where the United States Navy plans to operate, the current potential is modest. Given simple physics, as higher-order species of USV evolve, they will either have to more closely resemble ships or missiles. In its recent, admittedly telegraphed, retaliatory attack on Israel, Iran launched 170 drones, 30 cruise missiles, and 120 ballistic missiles.²⁵ While an unspecified number of missiles made it through the considerable defenses, none of the drones did.

2 Petri Dish

But while the tactics of the Ukrainian-Russian maritime drone war little resemble those appropriate to higher priority theaters for its Navy, the United States and other maritime powers still have much to learn from this conflict in terms of strategy. The Black Sea starkly features two venerable maritime struggles. The first is the ongoing and uncertain contestation over the size and shape of zones of sea denial and sea control, a strategic competition that differs greatly from its terrestrial analogy.²⁶ The second, related strategic struggle epitomized in the Black Sea stems from the Nelsonian adage that a "ship is a fool to fight a fort."

While current Black Sea drone tactics do not necessarily scale up to larger, more challenging theaters it is more plausible to see how these struggles are quite readily

22 Hollenbeck et al 2025.

¹⁹ Grotnik 2024.

²⁰ Peterson 2023.

²¹ Kornev 2024.

²³ Rogin 2024.

²⁴ Spender 2024.

²⁵ Federman/Gambrell 2024.

²⁶ Caverley/Dombrowski 2020.

portable to a potential Baltic or Western Pacific conflict between major powers. And yet there is very little analysis of the Black Sea from this perspective.

2.1 Economic Warfare in a Mutual Denial Environment

The ability to control one's littoral is a fundamental component of a country's sovereignty. For example, the traditional international legal standard of two nautical miles for territorial waters was determined by contemporary cannon ranges. In a tightly constrained body of water, observers can see the strategic impact of advances in coastal defense. While the technologies have changed somewhat, coastal defense continues to rest on elements U.S. Naval Academy professor Armstrong associates with Mahan: "shore-based gunnery, the use of mines, and small attack craft."²⁷ Modernized versions of all three have allowed to extend denial if not control to what is left of Ukraine's littoral.²⁸

While control of land is relatively easy to ascertain, the control and denial balance at sea entails vastly more uncertainty. Until recently the United States Navy has not needed to worry about this, at least since the Cold War's end. But Mahan and other naval theorists have always admonished that sea control is generally limited in space and episodic in time. Operating in such an environment is therefore an exercise in competitive risk-taking to send signals and apply coercive effects. Navigating this eternal struggle is the current primary interest of the United States, as it seeks to maintain its own sea control – what Posen famously called "command of the commons" – while extending denial essentially up to the Chinese mainland, particularly the Taiwan Strait.²⁹ And of course China is seeking to do the opposite. Naval strategists should look to the Black Sea to address the question: What happens when a body of water becomes "no man's sea," at least part of the time?³⁰

The growing flow of merchant traffic to Ukraine, as well as the continued shipping of Russian oil through the Black Sea despite the existential nature of this war, bears consideration. Although a Ukrainian officer described the opening of a transit corridor as "unilateral" after the reconquest of Snake Island, this is simply not the case.³¹ Rolling back initial Russian sea control early in the war does not mean that Ukraine has established sea control even in its littoral. While pushing the Russian surface navy, which had previously been used to disrupt Ukrainian trade, out of the Black Sea surely plays some role, Ukraine's funding of insurance for merchant ships is another, costly, prerequisite for merchants to begin transiting to and from Odessa.³²

But Russian restraint remains necessary. Despite limited attacks on merchant shipping early in the war and an ongoing, if inconsistent, campaign against grain infrastructure, Russia has largely avoided attacking merchant ships at sea. But Russia still officially regards commercial traffic to Ukrainian ports as potential carriers of military cargo. Even if its ability to board and search ships has been hindered, the Russian Navy

²⁷ Armstrong 2022.

²⁸ Lancaster 2022.

²⁹ Posen 2003, Caverley forthcoming.

³⁰ Gholz et al 2019.

³¹ Kormych/Averochkina 2023.

³² Cohn/Saul 2023.

retains the capability to threaten ships from standoff ranges in the Black Sea. In late 2023 and early 2024, Ukraine also demonstrated its willingness to target Russian merchant vessels but has since backed off these attacks.³³ Despite the two nations failing to formally agree to avoid such strikes, both sides have nonetheless mainly refrained from attacking each other's merchant shipping.³⁴

Whether the relatively smooth resumption of commerce through a zone of mutual denial is a function of capability or will is an urgent research question for the United States and its allies. As in the Cold War nuclear balance, the mutual ability to hurt the other no doubt hangs over both sides' strategic deliberations, and can be manipulated for political gain through brinksmanship. But for now, it must be acknowledged: Sea control is unnecessary in the Black Sea for the flow of trade. Mutual denial appears to be enough.

2.2 When the Land Matters for the Sea

The struggle for the Black Sea is one over ports even more than ships. Even if drones still struggle to reach some key coastal hubs, both sides have the ability to strike any of them via surface-to-surface missiles, launched from ships and from land. The possession and location of ports and their continued viability under this threat drives both the naval capability and significant amounts of the economy on both sides. We have for example already observed the geographical limitations on Ukrainian drone effectiveness given its dearth of sea bases in the Sea of Azov.

For Russia, the most consequential maritime loss was not any ship but the strategic elimination of Sevastopol naval base, which has been fought over for centuries as the key to the northern Black Sea.³⁵ Not only has Russia repositioned what remains of its Black Fleet, according to a Ukrainian military spokesperson, Ukraine has "rendered unusable" the port's capacity to deliver, reload, and service Kalibr missiles. It is not clear that Russia currently has the infrastructure to load these missiles elsewhere in the theater.³⁶

Russia's ability to reconstitute its land-based support capability for its maritime forces in the theater remains uncertain. As noted earlier, it may not be a high priority for scarce resources. Russia is clearly taking steps to defend its remaining naval assets in Novorossiysk.³⁷ While Ukraine has targeted the oil infrastructure of that port with aerial and surface drones in limited numbers (with few results), it has not employed surface-to-surface missiles.³⁸ Developments in the breakaway territory of Abkhazia also bear watching.³⁹

On the other hand, Russia has devoted significant portions of its strike capacity to target Odessa, primarily a commercial rather than naval port, with apparently limited

³³ Lister 2023.

³⁴ Faulconbridge/Gumrukcu 2024.

³⁵ Lambert 2020.

³⁶ Cook 2024.

³⁷ Ministry of Defence 2024.

³⁸ Brennan 2025.

³⁹ Demytrie et al 2023.

success. It remains to be seen if either belligerent is able and willing to cause severe damage to trade without threatening merchant ships at sea.

For all the attention to maritime drones, around the world, the primary threat under which the United States must operate is posed by missiles.⁴⁰ Every major (and indeed minor) naval base and economic hub in theaters will be vulnerable to a portfolio of long-range missiles. How Ukraine and Russia will operate in this environment will provide significant clues for potential operations in war under these circumstances, and the relative value of missile defense, hardening, and repair.

3 Conclusion

Observers of the security assistance effort have criticized the U.S. military for failing to learn from Ukrainian experience in battle. The United States military leadership tends to focus on tactical rather than strategic problems. This brief analysis suggests the urgent need to overcome these biases in order for the United States to learn the potential lessons from the Black Sea laboratory. But this analysis also identifies a necessary third, perhaps even harder, change in mindset.

Ironically, even as it continues to support Ukrainian defense, when it comes to the Black Sea the most relevant lessons for the United States are likely to come from the aggressor's reaction. It is Russia that has struggled to maintain sea control against a land-based anti-access/area denial threat. It is Russia's forward bases that have been made militarily irrelevant. Russia has for now given up on maritime blockade as a potential form of coercion. Russia has struggled with logistics and reconstitution due to the limitation of its internal waters and Turkey's management of the Bosporus and Dardanelles (and the United States' logistics problems in the Indo-Pacific are vastly more challenging). If it is going to learn much from the Black Sea laboratory, the U.S. Navy needs to recognize that it likely has more in common with the beleaguered Black Sea Fleet, rather than its scrappy maritime antagonist.

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⁴⁰ Caverley forthcoming.

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