THE ROLE OF AUTONOMOUS DRONES IN THE BLACK SEA NAVAL WAR AND THEIR IMPACT ON THE NAVAL STRATEGY

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The future of naval warfare is shaped by a series of technological innovations such as autonomous ships and remote-operated vehicles, advanced submarine technologies, naval cyber warfare, naval sensors, naval missile systems, maritime patrol aircraft, hypersonic missiles, underwater drones, satellite communications, laser weapons and stealth technology. These advancements enhance the capabilities of naval forces, ensuring they remain effective in the face of ever-evolving threats. As these technologies continue to develop, they will play a key role in redefining the maritime strategy.

This article highlights the fact that autonomous drone is the key technology of the new naval war. The Black Sea is a relevant case that confirms this trend, with a major impact on how naval fleets and strategies will be designed in the coming decades. Doctrinal adaptation, investment in military AI and international regulation will become priorities for fleet reform.

Keywords: Distributed Maritime Operations; stealth technology; Trans Adriatic Pipeline; NATO Sea Shield 25; Black Sea Fleet;

INTRODUCTION

In recent years, naval warfare has gone through significant changes, fuelled by technological advancements and major geopolitical changes. Thus, in the ever-evolving naval warfare strategy, a profound transformation is about to take place, due to the operational integration of new USV-type technologies. The use of these technologies has grown from a smaller scale use in Yemen in the mid-2010s to a genuine Ukrainian naval program of USVs, operational since 2023. At the heart of this change is the advent of autonomous naval drones, equipped with sensors and explosives, which offer an effective and cost-effective alternative to traditional naval forces. In this context, the conflict in the Black Sea, triggered after the annexation of Crimea in 2014, and amplified by the Russian invasion of Ukraine in 2022, became an operational laboratory for testing and validating new autonomous means of combat. The Russian war against Ukraine has transformed the Black Sea into an experimental space for drones, electronic warfare and naval missiles, being the first region where autonomous maritime drones (e.g.: Sea Baby, Magura V5) are systematically used in combat. These unmanned technologies are introducing new norms in naval warfare and are close to revolutionizing the theatre of maritime operations. Unquestionably, the emergence of autonomous combat systems and anti-access technologies will produce a profound transformation in contemporary naval strategy. These technologies increase the possibilities of data collection and processing in certain maritime districts of interest, extend the operational reach of naval combat groups and, very importantly, introduce new tactics for asymmetric warfare and anti-access strategies (A2/AD).

In the ever-evolving naval warfare strategy, a profound transformation is about to take place, due to the operational integration of new USV-type technologies.

Ukraine's use of these technologies during the Black Sea war has resulted in the restoration of the strategic balance at sea and a fundamentally altered maritime operational environment. These developments forced Russia to make radical decisions on the withdrawal

of most Black Sea Fleet ships from Sevastopol port and their relocation to relatively safe ports further east. It is evidence of a strategic victory for Ukraine in demonstrating how a state with an incomparably smaller maritime power manages to ban maritime control of a large naval power in its own area of responsibility. Undoubtedly, the key element in breaking the blockade of Russian ships and reopening vital sea routes for Ukrainian exports was the fleet of sea drones. Of course, this success is a real lesson in countering a superior conventional opponent by capitalizing on the advantages of asymmetric tactics. It was not achieved by building a fleet that would equal the Russian ship-by-ship fleet, but by prohibitively increasing the cost of maintaining a tight blockade.

Ukraine's success in blocking Russia's Fleet at the Black Sea leads to the conclusion that the emergence and development of autonomous systems and anti-access technologies are calling into question the traditional naval strategy, centred on large ships, missiles and artillery, and the physical control of the seas.

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Russia's reaction to the current operational situation in the Black Sea is uncertain due to various factors, such as military, political, economic, and technological. We know, however, that *Russia*

will not give up the Black Sea, as this maritime space is essential for its projection of regional power and control. Its strategy will become *more asymmetric, more autonomous and more aggressive-dissuasive*. Most likely, instead of a large fleet, it will stake on a lethal combination of technology, denial of access and hybrid warfare.

This study examines the role of autonomous drones in the naval war in the Black Sea and how these technologies will change the paradigm of the classical naval strategy.

GEOPOLITICAL AND STRATEGIC CONTEXT OF THE BLACK SEA

Located at the intersection of three major regions – Europe, Middle East and Caucasus –, the Black Sea has become an area of major strategic interest, both for regional actors and for external actors interested in this region. At the forefront is the illegal war started by Russia against Ukraine, which generates an intense military dynamic at regional level. This dynamic, felt since 2014, has been marked, at first, by the indirect and then increasingly direct use of modern military means, including autonomous maritime and air drones, and has produced increased effects in maritime space as well.

The Black Sea holds a key geostrategic position, being a connecting point between Europe, Asia and the Middle East. Through the Bosphorus and Dardanelles straits, it communicates with the Mediterranean Sea, and through its connection with the Caspian Sea, it leads to Central Asia.

But, apart from military and geopolitical interests, there were other reasons related to the geographical position, energy resources

or interests of global actors, which made the Black Sea an area of major strategic interest. For example, the Black Sea holds a key geostrategic position, being a connecting point between Europe, Asia and the Middle East. Through the Bosphorus and Dardanelles straits, it communicates with the Mediterranean Sea, and through its connection with the Caspian Sea, it leads to Central Asia. The Black Sea also provides strategic access to the Balkans, the Caucasus and Ukraine, which, in the context of the Russian-Ukrainian war, becomes extremely important. These communications make the Black Sea a strategic axis of commercial and military transit, a transport artery for goods, grain, oil and armament, in which the key ports of Constanta, Odessa, Varna, Novorossiysk have turned into strategic logistics hubs. That is why maritime traffic and maritime surveillance have become intensely disputed.

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In addition, the projects of capitalization on the important offshore natural gas resources, discovered, in particular, in the economic area of Romania (the Neptun Deep perimeter, operated by OMV Petrom and Romgaz, with deposits estimated at over 100 billion cubic meters

of gas, Neptun Deep) and Ukraine (the deposits off Crimea, mostly taken over by the Russian Federation after its annexation by Russia in 2014), have turned the region into an *energy corridor* that avoids Russia-controlled distribution routes. In this context, control over maritime energy infrastructure, in particular those within projects such as AGRI (Azerbaijan-Georgia-Romania Interconnector – planned to transport liquefied gas from the Caspian Sea to Europe via Constanta), TAP (Trans Adriatic Pipeline) and TANAP (Trans Anatolian Natural Gas Pipeline Project, which bring natural gas from Azerbaijan to Europe, via Turkey and Greece) is essential for Europe's energy independence from Russia. Thus, the energy interests of the Black Sea region play an important role in regional geopolitics and are essential for Europe's energy security. Therefore, the Black Sea becomes a regional energy hub, and whoever controls access to these resources and infrastructures has a significant influence on European energy policy and geopolitical relations with Russia and Central Asia.

After 2014, with the annexation of Crimea by Russia, regional tensions have increased exponentially, turning the area into an hotbed of direct military competition. After taking control of the peninsula, Russia massively militarized Crimea, placing advanced Bastion/Bal coastal defence systems, S-400 missiles and complex A2/AD (Anti-Access/Area Denial) devices (Minich, 2018), which blocks almost the entire sea for adverse forces. In addition, the Black Sea fleet has submarines and frigates equipped with Kalibr missiles that can hit targets including inside Turkey, Bulgaria or Romania.

In these circumstances, the North Atlantic Alliance decided to strengthen its presence in the region and to conduct a series of complex military exercises, such as *NATO Sea Shield 25* (which was conducted by Romania in April 2025, with the involvement of more than 2,300 troops from 12 allied states)[1], intensifying the training for asymmetric tactics, including defence against fast and hard-to-detect naval drones on the model used by Ukraine in attacks against the Russian fleet[2].

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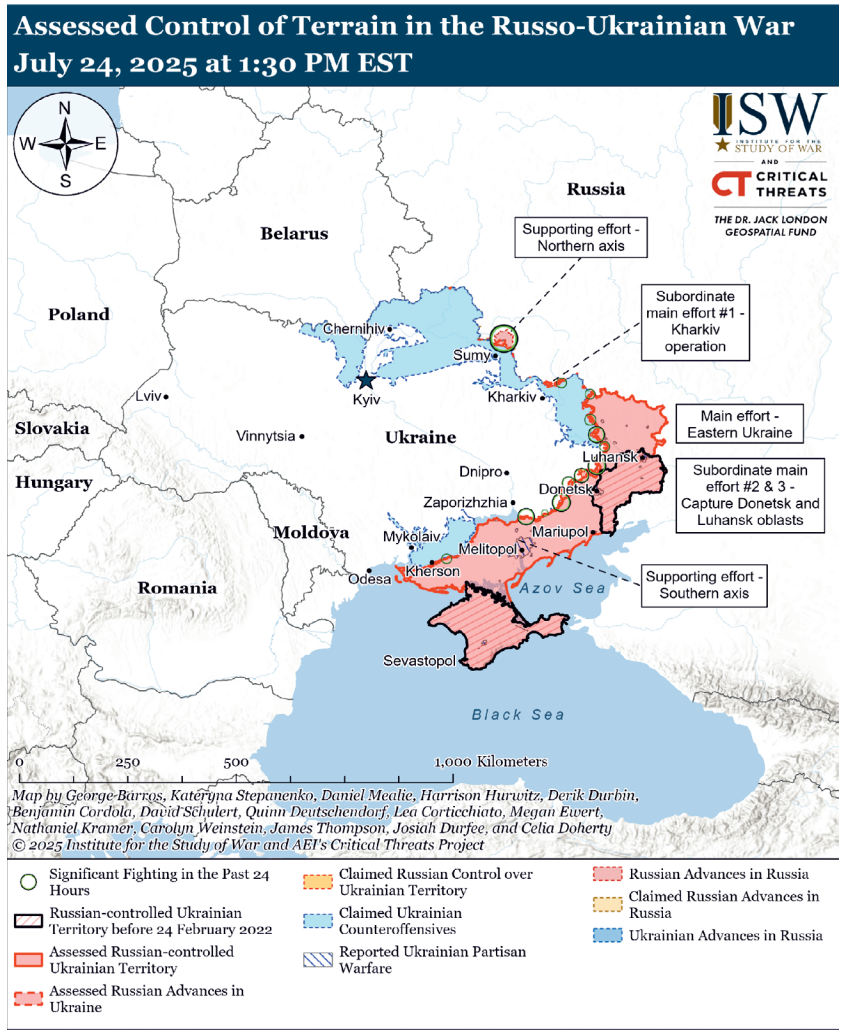
1 *Exercițiul militar anual 'Sea Shield' al NATO în Marea Neagră se încheie după 12 zile tumultoase*, Euronews, https://www.euronews.ro/articole/sea-shield-2024-peste-2-000-de-militari-vor-participa-la-cel-mai-mare-exercitiu-n.

2 *U.S. Warships Train to Survive Drones that Beat Russia's Black Sea Fleet*, Business Insider, https://www.businessinsider.com/us-navy-train-survive-drones-battered-russian-black-sea-fleet-2025-7?utm.

So, the Black Sea is today a space of strategic confrontation between Russia and the West (NATO/USA/EU), in the context of the war in Ukraine and the competition for the control of energy and trade routes. Militarization, geopolitical tensions and the lack of clear regulations on collective security in the area make it a hotbed of direct military competition.



Assessment of land control during the Russian-Ukrainian war (24 July 2025).
(Simeonova, 2025, https://ridl.io/wp-content//uploads/pdf/18257/black-sea-in-security-in-2025.pdf)

Russia is using this area as a platform for attacks on Ukrainian targets and military activities that have an impact on the transport of goods and supplies, especially on exports of Ukrainian grain from Black Sea ports. In this war, a determining factor was the use of various types of autonomous combat systems and anti-access technologies, in which maritime drones are the central element.

From this point of view, the Russian war against Ukraine has transformed the Black Sea into an experimental space for drones, electronic warfare and naval missiles. It is the first region where autonomous maritime drones (e.g.: Sea Baby, Magura V5) are used systematically in combat.

NEW PARADIGMS OF THE NAVAL WAR

Over the centuries, the evolution and technological innovation in the maritime domain have marked important transformations in the design of ships, armaments and communications, as well as complex propulsion and navigation systems, representing a powerful catalyst for strategic change. Ever since antiquity, when naval warfare was based on the tactics of striking and approach actions, and until contemporary times, when drones and other state-of-the-art technologies have penetrated significantly into the naval field, technological innovation has always overturned the strategies and tactics of war at sea, which determined their change/adaptation.

Early strategies of Antiquity were replaced by artillery-dominated strategies that emerged as a result of the invention of gunpowder at the end of the Middle Ages. This discovery revolutionised the tactics of naval engagement and laid the foundations for the sailing ship era, when European galleon and frigate fleets competed for global dominance, engaging in battles that were largely based on the on-board rifles and complex ship manoeuvres. Another major change came with the discovery of steam power in the Industrial Revolution era, which favoured the emergence of armoured warships and later steel-bodied battleships. These technological developments marked the entry into a new era of naval warfare, dominated by battleships, which represented national power and, by the middle of the 20th century, played the main role of strategic deterrence. The maritime strategies of that period, based on the principles of the maritime power

of Alfred Thayer Mahan, emphasized the concentration of fleets on the defence of domestic waters and the establishment of naval bases in the areas of interest.

The naval war went through a crucial moment in the Second World War, with the advent and development of aircraft carriers, which would become the main battleships of the military fleets, replacing traditional battleships. Air power created by carriers redefined naval engagements by facilitating long-distance attacks and introducing the concept of *air superiority* at sea. Innovations in submarine technology have also made them essential capabilities for reconnaissance and attack missions capable of sinking surface ships and blocking enemy trade.

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After the end of the Cold War, technological innovations in the naval field facilitated the adoption of maritime strategies based on attack groups of nuclear-powered aircraft carriers and submarines, whose main mission was the projection of power in the areas of interest. It was mainly the US strategy, which emerged as a dominant global naval power. Over time, this strategy has evolved to combine sea command, submarine warfare and power projection. But technologies have continued to evolve, and what we see today in the maritime conflicts in the Red Sea/Suez Canal and the Black Sea, we believe is the beginning of another radical change in the naval war. In April 2022, Ukrainians sank the Moskva cruiser *("the flagship of the Black Sea Fleet")*, the largest Russian warship sunk since the Second World War, using a combination of drones (for data collection and tracking) and cruise missiles. This combination of cruise missiles, aerial and maritime drones has proven to be lethal (A New Naval Warfare Paradigm). The success prompted the Ukrainians to plan other attacks of this kind, in which they managed to sink or damage about 1/3 of the pre-war Russian Black Sea fleet (Jucan, 2025).

In addition to the Russian-Ukrainian war, there are other dynamics highlighting that in a conflict situation, the use of unmanned technologies can be as effective against global maritime infrastructure as in the case of sunken or damaged Russian warships. Not only can global maritime routes be disrupted, as in the case of transport routes in the Suez Canal, but other types of infrastructure such as internet/telecommunications cables or submarine pipelines can also be targeted

with the use of unmanned technologies. Therefore, military systems based on unmanned technologies are increasingly being used at sea, and there is every reason to believe that these trends will continue and accelerate in the coming years.

THE ROLE OF AUTONOMOUS DRONES IN THE NAVAL CONFLICT IN THE BLACK SEA

Autonomous drones, both surface (USV) and underwater (UUV), have been used extensively by Ukraine to hit Russian Navy ships in the Black Sea. Notable examples include attacks on the Sevastopol naval base and damage to logistic ships. The key features of these drones are: low cost, ability to operate in swarms, lack of direct risks to personnel and the ability to circumvent traditional defence systems.

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Maritime drones, as the main elements of autonomous systems, are described in the literature as any remotely controlled or autonomous vehicle operating in the maritime domain: either on the surface (sometimes known as unmanned surface vehicles or USV), or underwater (unmanned underwater vehicles or UUV) or in the airspace above the sea (unmanned air vehicles or UAV). We must note, however, that not all maritime drones fall easily into one of these categories: for example, some glider drones can collect data at depth underwater, so that they then come to the surface to transmit them (Larter, 2021) to command centres, while other drones are able to operate in several areas, such as the amphibious C-Ray drone, which can operate on land or water[3], or the so-called sea glider *(Flying Sea Glider)*, developed by the U.S. Naval Research Center, which is intended to fly in water and then turn into an underwater vehicle (Trevithick, 2019). These systems can be operated remotely by a human controller or can operate autonomously via computerised control systems; they can also be operated in mixed mode, switching between human and autonomous operation depending on the role they play and the situation they are in.

[3] ***, *Prehistoric sea creature-like robot can navigate surf, crawl up onto the beach* (March 2023), in *Military Times*, https://dronewars.net/wp-content/uploads/2024/02/DW-Next-Wave-WEB.pdf.

The growing demand for enhanced surveillance, reconnaisance and precision attack capabilities in complex maritime environments has led to an unprecedented rise in these technologies in recent years. Since the use of smaller-scale naval drones in Yemen in the mid-2010s, the use of these technologies has steadily increased to a genuine Ukrainian naval program of functional USVs since 2023 (Cowen, 2025). At the heart of this change is the advent of naval drones, equipped with sensors and explosives, offering a cost-effective alternative to traditional naval forces. They allow naval forces to gather information and conduct operations more efficiently, often overtaking traditional platforms. The use of these unmanned systems goes beyond the traditional norms of naval warfare and is ready to revolutionize the theatre of maritime operations. In addition, future naval drones could support the protection of critical maritime infrastructures, providing highly effective deterrent against sabotage or direct attack. In asymmetric warfare, their use allows smaller but technologically advanced forces to effectively challenge larger adversaries. By the fact that sea drones are designed to operate autonomously or semi-autonomously, they facilitate various missions at sea without endangering human lives. With this, maritime drones are becoming a transformative element in modern warfare, and their integration into modern naval fleets marks a significant change in maritime strategy.

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History records that certain conflicts have become true *laboratories* for technological innovation materialized in new weapon systems and doctrines that have fundamentally altered the character of war. For the beginning of the 21st century, it seems that the Black Sea has become that laboratory of military innovation, and the catalyst of fundamental strategic transformations is represented by the unmanned autonomous systems widely used by Ukraine to defend its coastline and keep the Russian Black Sea Fleet away from its own shore. Thus, Ukraine has created and deployed in naval combat this new class of sea drones with which it successfully challenged the naval power, much superior, of Russia and rewrote the rules of coastal employment, offering a new vision for the future of maritime conflicts.

The use of drones in the naval war in the Black Sea began as a desperate measure of Ukraine's defence against Russia's asymmetric actions on the Ukrainian fleet and maritime infrastructures. Gradually,

sea drones have far surpassed their original role as *single-use kamikaze* systems, turning into a sophisticated and dynamic offensive capability. Thus, sea drones became versatile, multi-mission platforms that successfully attacked and destroyed high-value Russian warships, played a central role in breaking a paralyzing naval blockade and forced a strategic repositioning of the entire Russian Black Sea Fleet. All of this has fundamentally altered the regional balance of power, with Ukraine managing to position itself in a much more advantageous position without having a traditional navy of its own. We can say that this state of affairs is the result of not only a strategic adaptation of Ukraine, but also of a new paradigmatic approach to naval warfare, built on the principles of adaptability to technological developments, distributed lethality and cost efficiency[4]. That is why, for all maritime security specialists, both theorists and practitioners, the Ukrainian experience provides an extremely important case study on the potential of unmanned naval systems and the need to adapt the maritime strategy in order to exploit this potential with maximum efficiency.

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In 2022, at the beginning of the large-scale invasion of Russia, the strategic situation at the Black Sea was deeply unbalanced. Ukraine, overwhelmed by the conventional power of the Russian Black Sea Fleet, has faced the potential for a total naval blockade, supported by rocket attacks launched from the sea and the constant threat of an amphibious attack. In this situation, Ukraine realized that a traditional response based on an extremely small conventional fleet was impossible to achieve. In addition, shortly after the start of the invasion, the Ukrainian flagship, the frigate Hetman Sahaidachny, of the Krivak-III class, was sunk at its mooring in Mykolaiv (James, 2022), and as the Russian offensive advanced, ships in Ukrainian ports on the Sea of Azov were destroyed or captured (Kimr, 2022). Ukrainian ships that attacked the Russians directly did not succeed, and the Sloviansk patrol ship, despite having significant air defence, was quickly sunk in March 2022 by Russian aircraft. Thus, shortly after the invasion began, the Ukrainian fleet became almost non-existent, while the Russians

[4] ***, *The Naval Drone: How Ukraine Reinvented Maritime Warfare* (27 May 2025), in *Defence Ukraine*, https://www.defenceukraine.com/en/insights/ukrainian-naval-drones-reinventing-maritime-warfare/.

enjoyed complete freedom of navigation off the northern coast of the Black Sea.

But a month later, the situation would change with the sinking of the flagship of the Black Sea Fleet, the Moskva cruiser of the Slava class, being hit with two of the Neptune anti-ship missiles launched by the Ukrainians[5]. It was the first success of Ukraine, which marked the beginning of the change of the strategic situation in the Black Sea imposed by the Russians with the invasion. Thus, it turned out that the attacks with Ukrainian anti-ship missiles (both Neptune, manufactured in the country, and Harpoon, supplied by the West) forced the Russians to withdraw from the north-west of the Black Sea, losing control of the maritime districts in this area. But land-based missiles launched by Ukrainians, with limited range, could only threaten Russian ships up to a certain point, beyond which other means were needed. And from that moment on, Ukraine began to innovate, discovering that USVs could meet this requirement. Such type of unmanned means were considered the most handy solution, as they could be equipped with camera, satellite communications and an ogive at the top, and the technological manufacturing process was simple, USVs being the type of craft that can be built in a garage or in a small industrial facility.

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Once the issue of high-capacity communications and targeting were resolved throughout the mission, the actual use of USVs in military actions against the Russian Fleet was switched to. Missions using the USV intensified between spring and summer 2023, peaking when the Ropucha-class landing ship Olenegorsky Gornyak was hit in the port of Novorossiysk[6]. The ship was badly damaged, hardly avoiding sinking, being towed and taken to the port. Olenegorsky Gornyak survived the attack, but other ships had a less fortunate fate. Thus, another landing craft, a rocket-carrying corvette, a patrol ship, a mine dragger and several landing and smaller vessels were sunk or destroyed in attacks with USVs. These successes of the Ukrainians prompted the Russians to move almost all of their main maritime resources to the port of Novorossiysk, on the east coast of the Black Sea, and consistently

[5] ***, *Russian warship: Moskva sinks in Black Sea* (15 April 2022), in *BBC News*, https://www.bbc.com/news/world-europe-61114843.

[6] ***, *Ukraine says it has put Russian warship out of action in sea drone attack* (4 August 2023), in *The Guardian*, https://www.theguardian.com/world/2023/aug/04/ukraine-says-it-has-put-russian-warship-out-of-action-in-sea-drone-attack.

reduce their actions at sea. On the other hand, Ukraine has moved to the construction of a growing number of USV drones, the responsibility of their operation being assumed by the GUR (Defense Intelligence Service of Ukraine) and the SBU (Ukraine Security Service). GUR is known for Magura drones, while SBU is associated with Sea Baby drones.

Early models such as Magura V5 and Sea Baby proved to be the perfect response Ukraine could provide under the pressure of the direct threat of the Russian Fleet. Initially, these platforms were designed with one purpose: to deliver an explosive payload to a target. It can be said that it was a *David vs. Goliath* strategy, in which a platform of several hundred thousand dollars could threaten the ships of the Russian fleet worth hundreds of millions. And, perhaps in an unexpected way, this strategy proved to be extremely effective, which is why it was expanded and used throughout 2023 and 2024. But the ongoing pressure of the conflict has prompted Ukrainian specialists to look for solutions to perfect this concept through the rapid and iterative development of new models of USVs, adapted to the immediate demands on the battlefield. Thus, in the first half of 2025, Ukrainians tested a new type of USV, capable of performing several missions simultaneously and putting multiple problems to the opponent.

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The first innovation they resorted to was the integration into the USV platform of offensive missile systems, which led to the transformation of drones from contact detonation weapons into remote attack platforms. Basically, USVs become mobile rocket launchers, which can project danger at a significant distance. The solution to integrating offensive missile systems into the USV platform proved its effectiveness in January 2025, when naval drones of this type successfully destroyed Russian helicopters, posing a new and powerful threat to Russia's maritime resources at the Black Sea[7]. This evolution has enormously complicated the operational situation, causing the enemy to face a small platform, transformed into a real rocket launcher.

[7] ***, *Dronele navale înarmate cu rachete au distrus cu succes elicoptere rusești* (7 January 2025), Digi 24, Cum au reușit ucrainenii să doboare elicoptere rusești cu dronele navale. *„Am mers special să vânăm ținte aeriene"*, https://www.digi24.ro/stiri/externe/cum-au-reusit-ucrainenii-sa-doboare-elicoptere-rusesti-cu-dronele-navale-am-mers-special-sa-vanam-tinte-aeriene-3071143.

Another innovation introduced by Ukrainian specialists was to adapt USVs to act as launch platforms for smaller aerial drones. In this way, Ukraine has made true *miniature aircraft carriers*, with which it has managed to dramatically extend the range of air reconnaissance and attack capabilities (ib. note 4). Such a USV can carry a group of FPV[8] or UAV[9] drones reconnaissance deep into the enemy device, away from launch sites at the coast. Once in the enemy area, small drones are launched to conduct surveillance and provide data on certain targets, as well as to directly attack pre-established targets. It can create a complex, layered threat with extremely high operational effects.

Sea drones played a substantial role in Ukraine's strategy of blocking the actions of the Russian Fleet at the Black Sea and the destruction or damage of the means of combat and the infrastructure to support it. As response measures, Russia strengthened its physical defences around key naval bases and the Kerch Bridge employing signal jamming techniques to alter the drone guiding systems.

But perhaps the most daring innovation of Ukrainian specialists seems to have been the equipment of naval drones with anti-aircraft missile systems. The vulnerabilities of surface ships, especially small dominions, to airborne attacks by helicopters and fighter jets are well known, and this innovation turns vulnerability into a great advantage. Ukraine has achieved a highly effective means of combat for anti-aircraft defence of ships and coastline targets beyond their safe distance to air strikes. It was to be proven in May 2025, when Ukraine claimed a world premiere: the downing of two Russian fighter jets using naval drones equipped with these systems[10].

Thus, it is more than obvious that sea drones played a substantial role in Ukraine's strategy of blocking the actions of the Russian Fleet at the Black Sea and the destruction or damage of the means of combat and the infrastructure to support it. As response measures, Russia

[8] FPV (First Person View) drones are drones that allow you to view the situation in real time. They feature an on-board camera that transmits real-time video to FPV glasses or screens, providing an immersive experience. FPV drones are used for activities such as aerial photography, aerobatics and competitive flights, but can also be used for military purposes, having an important role in reconnaisance and surveillance.

[9] UAV (Unmanned Aerial Vehicle) drones are drones that can be used in various fields, including military, civilian and commercial. Drones are used for reconnaissance, surveillance, espionage, filming, topographic measurements and competitions. They can have payloads such as reconnaissance devices, sensors or other equipment.

[10] ***, *Demonstrație uimitoare de inovație în război: Lecția pe care Ucraina a predat-o doborând două avioane Su-30SM cu drone* (8 May 2025), Defense Romania, https://www.defenseromania.ro/doborarile-su-30sm-arata-ca-dronele-ucrainene-reprezinta-acum-o-amenintare-serioasa-la-adresa-avioanelor-de-lupta-rusesti_633651.html.

strengthened its physical defences around key naval bases and the Kerch Bridge employing signal jamming techniques to alter the drone guiding systems (Zafra, McClure, 2023). A decrease in reports on the activity of Ukrainian drones towards the end of 2023 could mean that such countermeasures have been a certain degree of success.

In addition to surface sea drones, Ukraine is also developing unmanned underwater vehicles/UUVs. As early as 2023, a prototype of a UUV called Toloka was presented. It is, in fact, a torpedo that is capable of carrying explosives and that would be built in three different versions, with different action beams and explosive payloads. At this point, it is not known whether the drone was approved or used operationally (Sutton-1, 2023). At the same time, it seems that the Ukrainian arms industry is developing a new autonomous underwater vehicle with larger dimensions, called Marichka. It is said that it was in the prototype phase in the summer of 2023, and Marichka was promoted as being intended for anti-ship and bridge attacks, information collection and transport (Sutton-2, 2023).

The strategic implications of Ukraine's innovations in the field of sea drones are huge. These advances illustrate a model to follow: identifying a successful technology and then rapidly developing it to expand its capabilities, thus maximizing its strategic impact. The technological successes registered by the Ukrainians have led to the significant expansion of the operational area of the USVs and to the maximization of their utility. Technological innovation and the adoption of an asymmetric strategy to exploit the vulnerabilities of the opponent was the only viable way forward and it produced the expected effects. For now, the Russian-Ukrainian war in the Black Sea has decreased in intensity, but it remains to be seen how things will evolve in the future.

The technological successes registered by the Ukrainians have led to the significant expansion of the operational area of the USVs and to the maximization of their utility. Technological innovation and the adoption of an asymmetric strategy to exploit the vulnerabilities of the opponent was the only viable way forward and it produced the expected effects.

TECHNOLOGICAL AND DOCTRINAL IMPLICATIONS

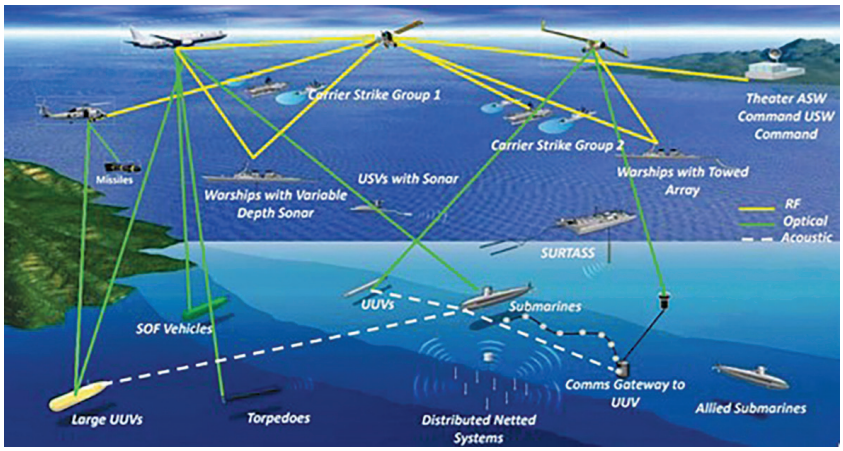
The technological and tactical innovations of Ukraine in the war against Russia on the Black Sea had a tremendous strategic effect. Ukraine's drone fleet has restored strategic balance at sea and has fundamentally altered the maritime operational environment. Under these conditions, Russia was forced to make decisions that,

before the war, would have been unthinkable. The lamentable withdrawal of most Black Sea Fleet ships from the abusively occupied port of Sevastopol in Crimea and their relocation in relative safety to the ports further east is evidence of a strategic victory for Ukraine, demonstrating how a state with an incomparably smaller maritime power manages to ban maritime control of a large naval power in its own area of responsibility. Unquestionably, Ukraine's fleet of sea drones was a key element in breaking the blockade of Russian ships and reopening vital sea routes for Ukrainian exports. Of course, this success is a real demonstration of capitalizing on the advantages of an asymmetric campaign led by a state forced to counter a superior conventional opponent. Moreover, it is true that it was not achieved by equalizing the Russian ship-by-ship fleet, but by prohibitively increasing the cost of maintaining a tight blockade.

Ukraine's success in blocking Russia's Fleet at the Black Sea can lead us to the conclusion that the use of unmanned means will profoundly change the strategy of naval warfare. It is clear that the emergence and development of autonomous systems and anti-access technologies are calling into question the traditional naval strategy, centred on large ships, missiles and artillery, and the physical control of the seas.

Undoubtedly, Ukraine's success in blocking Russia's Fleet at the Black Sea can lead us to the conclusion that the use of unmanned means *will profoundly change the strategy of naval warfare*. It is clear that the emergence and development of autonomous systems and anti-access technologies are calling into question the traditional naval strategy, centred on large ships, missiles and artillery, and the physical control of the seas. In the context of the Black Sea, where freedom of manoeuvre is restricted and surveillance is constant, the use of sea drones in combination with the Neptune and Harpoon coastal missiles allowed the neutralization of Russian ships and the constraint of their retreat from Sevastopol to more remote ports such as Novorossiysk. Thus, effective control over the western Black Sea held by Russia was lost in favour of Ukraine – *without Ukraine owning a classic fleet*. What conclusions can we draw from these events? First, Ukraine challenged Russian naval dominance without carriers, frigates or submarines. Instead, it used naval drones as a form of lethal asymmetric response with low cost and high efficiency. The fact that large ships are becoming vulnerable to swarms of drones, especially in narrow and near coastal districts, shows us that naval dominance is no longer guaranteed by mass and tonnage, and this is clearly at odds with the classical paradigm of classical naval warfare. The key to Ukrainian success was the coordination between aerial/naval drones, electronic

jamming and precision strikes, which marks a transition towards distributed and hybrid maritime operations (Distributed Maritime Operations/DMO). They involve the dispersion of the fleet in small and autonomous units, coordinated through AI and C4ISR networks. At the same time, challenges are emerging regarding human control, legal responsibility and vulnerabilities to electronic warfare.



Distributed maritime operations (https://sl.bing.net/h4iJEszz5s4)

These are undeniable advantages, which, however, could create the illusion that we are somehow witnessing the end of traditional fleets. But no, *we are not witnessing the end of traditional fleets, but a radical transformation of their role and composition, in which autonomous drones become a basic element of the new naval doctrine.*

The ships do not disappear, they will only redefine their role. For example, for *the global projection of power* (mobility on large oceans), *the transport of heavy troops and equipment, the launch of intercontinental missiles or aircraft, aircraft carriers, destroyers and nuclear submarines they will remain essential*. They will also serve as *command-and-control centres*, having complex infrastructure, which drones cannot replace (yet). At the same time, these vessels will be able to coordinate *swarms of autonomous drones* (air, naval, underwater) and will become communication, logistics and *decision hubs for autonomous platforms*, thus shifting from the concept of *heavy ship* to *distributed network*. Most likely, a balance will be

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reached between the piloted ship and the drone, the concept of a *fleet of ships* being replaced by that of an *ecosystem of autonomous and semi-autonomous platforms*. Given the vulnerability of classic ships to drones and the fact that small and fast drones can easily fool air/classical defence, some missions (recognition, rapid attack, and mining) could be attributed exclusively to drones as happened in the Black Sea, when large Russian ships were badly damaged or sunk by low-cost Ukrainian sea drones.

These transformations are briefly presented in *table 1*:

The fleet of the future will be more like a network of sensors, drones and interconnected units than a line of massive ships. Autonomous drones do not eliminate classic ships, but redefine their function – from weapons carriers to autonomous weapons command nodes.

Traditional naval model	New emerging model (hybrid)
Homogeneous, heavy fleet	Network of heterogeneous, autonomous platforms
Large ships + crew	Large ships + swarms of drones coordinated by AI
Visible permanent presence	Flexible, hidden, dynamic presence (stealth, mobility)
Linearity in action	Simultaneous strikes, from multiple angles, decided by AI

What is preserved from traditional fleets? *Nuclear submarines* are likely to survive because they are still hard to detect and impossible to replace for strategic dissuasion. Similarly, carriers, which, even if more vulnerable, will continue to play a major role in high-intensity conflicts. *Modern destroyers and frigates*, if equipped with lasers, anti-drone systems and AI, will certainly survive the transformation.

In conclusion, we are not witnessing *the end of traditional fleets*, but their *rebirth* in a mixed, intelligent and distributed form. The fleet of the future will be more like a *network of sensors, drones and interconnected units* than a line of massive ships. Autonomous drones do not eliminate classic ships, but *redefine their function* – from weapons carriers to autonomous weapons command nodes.

So, we can say that *the future of naval warfare will no longer be dominated by massive fleets, but by dispersed, autonomous, digitally coordinated forces capable of hitting the swarm and operating*

in contested environments. Therefore, this reality requires both *a redefinition of the maritime projection of power, and a doctrinal rewording*, simultaneously with resizing and redefining the role of warships.

STRATEGIC PERSPECTIVES: THE FUTURE OF NAVAL WAR IN THE BLACK SEA

Given the current trends, technological innovations and the regional geopolitical context of the Black Sea, we can say without reservation that the naval war is moving towards new *strategic perspectives*. Although the Black Sea is not regarded as one of the most disputed maritime regions globally, being defined as a closed strategic space, semi-closed geopolitically and militarily, with limited access through the Bosphorus Strait, controlled by Turkey, however, from the perspective of redefining the strategic paradigms of naval warfare, it occupies a central place. Geopolitically, the Black Sea is the eastern flank of NATO and a direct contact area between the Russian Federation and Western allies – Romania, Bulgaria and Turkey. The illegal war started by Russia against Ukraine transformed the Black Sea into an active naval combat theatre, with the involvement of modern military means, including autonomous maritime and air drones and precision weapons, and produced increased effects in the maritime space, giving the region an intense military dynamic. And as long as the war lasts, the Black Sea will remain in the attention of global actors whose interests in the region will be seriously affected.

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On the other hand, *Russia will not give up the Black Sea,* because it considers it essential for its projection of regional power and control. And, in order to understand what will happen in the near future in the naval war in the Black Sea, we need to analyse what Russia's reaction to the current operative situation in the maritime space could be. It is an essential and difficult strategic analysis, because Russia's reaction to the current situation in the Black Sea will depend on several factors – military, political, economic and, obviously, technological. However, from the analysis of recent developments and Russian naval doctrine, we can outline some probable directions of action.

Russia is developing a new strategy to increase security risks in the Black Sea in response to the defeat of the Black Sea Fleet, Part 4 (17 January 2025) (https://www.blackseanews.net/en/read/226500)

It is very likely that Russia will act to strengthen the A2/AD (anti-access/denial) strategy in order to turn the Black Sea into a zone denied for Western fleets, especially NATO.

First, taking into account the significant losses suffered since the early stages of the war (e.g. the Moskva cruiser), Russia will probably work to reduce the risk of losing large ships and preserve the asymmetric striking capacity. In this respect, it is very likely that Russia will proceed to a military recalibration of the Black Sea Fleet, reorienting its fleet to remote strike systems (Kalibr missiles, Onyx, Zircon missiles) on submarines and coastal platforms. At sea, it will bet on smaller, more mobile and harder to detect platforms, which is why it will most likely resort to the use of autonomous naval and underwater drones in response to Ukrainian tactics (Sabanadze, Dalay, 2025).

Secondly, it is very likely that Russia will act to strengthen the A2/AD (anti-access/denial) strategy in order to turn the Black Sea into a zone denied for Western fleets, especially NATO (https://www.blackseanews.net/en/read/226500). In this respect, it could strengthen its strategic points, especially the Crimean Peninsula, by deploying S-400, Bastion and Pantsir systems. Moreover, it will seek to control air and sea space by *integrating radar, anti-aircraft and electronic jamming*, and will continue to create threats on navigation

routes by *using marine mines and underwater drones* at key points such as the Danube mouths and even the Bosphorus.

Thirdly, in order to maintain an information advantage and create a climate of naval uncertainty, it is very likely that Russia will adapt its tactics to the realities of the new hybrid war. To do this, Russia will continue to carry out indirect attacks (using paramilitary groups, modified civilian ships, false flag operations), threaten naval communications and allied sensors through cyber and electronic warfare actions, and use kamikaze drones and reconnaissance drones for permanent surveillance (Bechev, 2025).

Fourthly, Russia can act to strategically isolate the Black Sea from the rest of NATO forces. Through *aggressive diplomacy*, Russia could persuade (or even press) Turkey to limit the access of NATO vessels through the Bosporus (according to the Montreux Convention) and could intensify political and economic pressure on pro-Western coastal countries (Romania, Bulgaria, Ukraine) (Sabanadze, Dalay, ib.). And last but not least, Russia could step up innovation and technological production in order to restore the strategic advantage over Ukraine, even if Ukrainians continue to receive Western support. To this end, Russia can develop and test new autonomous platforms (including unmanned submarines), accelerate stealth ship projects and hypersonic ships (type *"Gromkiy", "Karakurt"* or *"Laika*"), and increase the role of space forces and military satellites for maritime surveillance (https://www.blackseanews.net/en/read/226500).

In view of these considerations, *Russia will not give up the Black Sea*, on the contrary, its strategy will become *more asymmetric, more autonomous and more aggressive-dissuasive*. Instead of a large fleet, it will rely on a lethal combination of technology, denial of access and hybrid warfare.

In order to respond to such a scenario that Russia could follow, Ukraine has no solutions other than to continue to rely on *emerging technologies*. Therefore, the drone of the naval conflict at the Black Sea will continue through the use of *maritime drones* (e.g. Sea Baby, Magura V5), *autonomous and AI systems, precision weapons and remote strikes*, as well as through A2/AD strategies.

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CONCLUSIONS

The conflict in the Black Sea will evolve, in large part, taking into account technological trends, especially the evolution of unmanned, AI and high-precision striking systems. It will have a major impact on future naval strategies. Consequently, the process of *transformation of naval fleets will continue*. We will see a decline in traditional fleets and the birth of *distributed fleets*, based on small, mobile and autonomous units, capable of operating in the network without human presence. The sea thus becomes more *transparent*, and satellites, drones and ISR networks (Intelligence, Surveillance, and Reconnaissance) will make the enemy easier to detect and attack.

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The rapid evolution of Ukrainian naval drones is more than just a series of technological fixes; it points to an emerging doctrine of distributed and adaptable lethality. This new doctrine emphasizes agility and innovation as supreme strategic assets, proving that a decentralized network of intelligent systems can overcome a traditional, centralized naval hierarchy. It is a model that will be studied by navies around the world, especially those of smaller nations that want to discourage larger and more powerful aggressors.

The development of the Ukrainian USV is far from over. Future developments will likely focus on integrating more sophisticated sensor suites, increasing autonomy and coordination for complex swarm operations, and integrating a wider diversity of weapon systems. However, the lessons are already clear. The defence technology sector in Ukraine has demonstrated an unparalleled ability to iterate and rapidly implement solutions in direct response to the needs of the battlefield, presenting a unique and powerful paradigm in the development of modern defence.

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