CMSN REPORTS

Asymmetric Enabler

An Overview of Global USV and UUV Developments

David Thomas

February 2025

Asymmetric Enabler

An Overview of Global USV and UUV Developments

David Thomas | March 2025

Executive Summary

This paper is an in-depth environment scan of global uncrewed surface vehicle (USV) and uncrewed underwater vehicle (UUV) developments, specifically focusing on armed platforms that can supplement the fires of the RCN fleet. It summarizes different platforms that are now being deployed globally to understand mission sets and the vehicles' intended roles within proposed fleet architectures. These USV capabilities have been categorized based on size and role. The five USV categories include large USVs, medium USVs, small USVs, one-way-attack (OWA) USVs, and USV carriers of uncrewed aerial vehicles (UAVs). Due to the immature nature of armed UUV technology, these systems are presented together.

From this overview, this paper offers impressions on why NATO allies are investing in uncrewed platforms and how a future RCN fleet architecture could integrate these assets with traditional warships.

Uncrewed Platform Investment

The War in Ukraine has initiated a new revolution in military affairs. Drones, long an expensive auxiliary service, have become both cheap and plentiful and, in the process, are increasingly dominating the battlefield. Maritime drones have seen extraordinary success, moving from concept designs at the outbreak of the war to now effectively sidelining the Russian Black Sea Fleet.

These radical shifts have, naturally, provoked a reaction in NATO countries, as research and development is expedited. Adversaries, too, are beginning new programs to enhance naval forces with the sorts of reconnaissance and strike capabilities that have proven their utility in Europe. Canada is no exception to this trend. Indeed, given the small size of the RCN, the loss of a major combatant would be devastating, and the force may, therefore, become even more reliant on expendable assets than its partners or adversaries.

The cost of drones also opens new opportunities for the RCN. With a constrained budget and high shipbuilding costs, uncrewed systems represent the only affordable avenue for generating both the

mass and firepower needed to fight in modern high-intensity warfare. In a threat environment that is intensifying daily, there is, as the US Chief of Naval Operations (CNO) declares, "a need for more munitions on more platforms in more places."[1]

Maritime drones also offer speed-of-build advantages. While the RCN's recapitalization is well underway, it will take at least 20 years to complete. In an immediate threat environment, Canada needs assets that could be built in weeks, not decades. As Ukraine has shown, quantity has a quality all of its own, and the ability to scale up industrial production lines in a crisis is critical.

Ukraine has also shown the need for a greater dispersal of forces – for surveillance and attack. Drones offer radical new potential for such distributed fleet architectures.[2] Intelligence, surveillance, and reconnaissance (ISR) are the essential facilitators of modern combat operations across domains,[3] and ISR-based USVs/UUVs can form resilient mesh networks to enhance over-the-horizon targeting (OTH-T) operations, maximize fires potential, and create increasingly accurate understandings of battlespaces.[4] With kill chains established, USVs can also engage from a range that would be hazardous for crewed vessels.

This need for mass and innovation is magnified by China's rapidly expanding military-industrial infrastructure.[5] As of September 2023, China's shipbuilding capacity was 232 times greater than that of the United States.[6] Canada and its NATO allies cannot outbuild China in a conventional shipbuilding race. Of great concern, China's industrial base is also, by some indications, gearing up for conflict – with a declared intent for the People's Liberation Army (PLA) to be ready to invade Taiwan by 2027.[7] With colossal industrial capability and the world's largest shipbuilding capacity, the PLA services are intent on developing a "warfighting ecosystem" intended to triumph over Taiwan and its allies.[8]

In this rapidly evolving world, the RCN needs to adapt. In practice, this means generating more mass, more dispersed capabilities, more sensors, and greater fires potential.[9] USVs and UUVs must be a part of the solution.[10] These are cheap force multipliers that can be produced en masse and deployed into dangerous situations by a country (rightly) averse to battle casualties.[11]

This report is an in-depth environment scan of the maritime drone ecosystem. It provides an overview of global developments and priorities to offer the RCN and the Government of Canada a snapshot of what is available today and what may be needed tomorrow.

Guiding Principles and Operational Conceptualization

Fundamental to a realistic future fleet design – which efficiently employs available resources – is the procurement of platforms that coincide with a clear operational concept.[12] This mandates a systems-level approach to define required capabilities, their mission sets, and how they integrate into the fleet's Standard Operating Procedures (SOPs) and tactics, techniques, and procedures (TTPs).[13] As the Ukrainian Navy has shown, this could even include abandoning or transforming traditional roles and mission sets to ensure that a fleet is ready for the future fight.[14]

To draw lessons from allies for such a plan, Canada should consider German naval policy. In March 2023, the Deutsche Marine published *Das Zielbild für die Marine ab 2035* (*The Target Picture for the Navy of 2035*).[15] Here, the Germans have identified four primary guiding principles for their

future fleet. These are resiliency, a future-oriented force, multi-domain operations, as well as mass and combat capability.[16] Similar principles should guide the RCN in its procurement of USV/UUV assets as Canada once again looks to punch above its weight.[17]

Owing to the extensive range and diversity of platforms and programs, this overview will present systems in an order that takes their specifications, intended roles, mission sets, and armaments into account. Measurements have been converted to metric when possible.

The Maritime Drone Ecosystem

Large Uncrewed Surface Vehicles (LUSVs)

The United States

The United States has the most developed LUSV programs. Future US Navy LUSVs are envisioned to be between 60 and 90 metres (m) long and have a displacement of between 1,000 and 2,000 tons.[18] They will be the size of corvettes: smaller than frigates but larger than patrol craft.[19] The US Navy has directed that upcoming LUSV platforms include certain specifications. Firstly, the primary mission set of US Navy LUSVs will be anti-surface warfare (ASuW), and thus, they are to be armed with strike payloads in the form of anti-ship and land-attack missiles.[20] To carry their intended armaments, LUSVs may be equipped with vertical launch systems (VLSs) with 16 to 32 missile tubes.[21] At least initially, these LUSVs may be considered optionally or lightly crewed ships. Small onboard crews will assist the US Navy as it develops, trials, and incorporates new USV-applicable technologies and operating concepts.[22]

LUSVs will be a key enabler to take Distributed Maritime Operations (DMO) from conceptualization to practice. LUSVs are planned to forward deploy with individual crewed combatants or to augment the firepower of larger task forces.[23] The first LUSV will be procured in fiscal year (FY) 2027 at a cost of US$497.6 million.[24] Two LUSVs in FY2028 will have a combined estimated cost of US$652.8 million – or US$326.4 million each.[25] FY 2029 will see the addition of three LUSVs, each with a cost of US$331.4 million, for a total of US$994.3 million.[26]

In addition to the new LUSV procurement program, the US Navy currently operates a set of existing prototype LUSVs, which form part of the US Navy Strategic Capabilities Office's Ghost Fleet Overlord program.[27] This program was initiated in 2018 to accelerate the integration of LUSVs into the fleet.[28] The initial phase of development concluded in 2019 when the first two platforms, USV *Ranger* and USV *Nomad*, executed standard operating procedures in compliance with the Convention on the International Regulations for Preventing Collisions at Sea, with over 600 hours of autonomous testing and several long-range voyages in navigationally complex environments.[29] The last two platforms are USV *Mariner* and USV *Vanguard*, the former of which is equipped with the Aegis Combat System.[30] *Ranger* and *Mariner* are also optionally crewed.[31]

Australia

With the release of the *Enhanced Lethality Surface Combatant Fleet Analysis*, the Australian Government has agreed for the Royal Australian Navy to procure large optionally crewed surface vessels (LOSVs).[32] LOSVs are intended to supplement fires, increase joint force durability, and reduce naval crewing requirements.[33] Six LOSVs are intended to be built in western Australia's Henderson Shipyard and will increase the Tier 1 surface combatant fleet's VLS cell capacity through their inclusion of an undesignated number of VLS cells.[34]

Germany

Like Australia, Germany's Deutsche Marine plans on having 18 supplementary Future Combat Surface Systems (uncrewed corvettes) to augment the 21 to 24 crewed frigates and corvettes of its 2035 fleet.[35]

China

China has arguably built the largest uncrewed surface combatant to date.[36] While US Navy Ghost Fleet Overlord vessels have a larger displacement of 673 tons, they have multi-role functions.[37] The JARI-USV-A Orca, or possibly "Killer Tiger," features a trimaran hull, VLS cells, and a stern-mounted helipad for vertical take-off and landing (VTOL) UAVs such as the WZ-5B.[38] Covert Shores notes that its integrated mast and multiple radar arrays distinguish it from other large USVs.[39] The JARI-USV-A Orca features a displacement of 420 tons, a length of 58m to 60m, a width of 23m, and a draft of 2m.[40] Its maximum speed is 40 knots (kn), with a range of 4,000 nautical miles (nm).[41] It features dual diesel-electric propulsion, four to 12 VLS cells, two lightweight torpedo tubes, and one remote weapon station, and it has been seen with HQ-10 surface-to-air missiles (SAMs).[42] It is additionally fitted with an active electronically scanned array (AESA) radar and the capacity to carry UUVs onboard.[43]

Medium Uncrewed Surface Vehicles (MUSVs)

The United States

The US Navy defines MUSVs as USVs that are less than 60m in length and that have displacements of under 500 tons, thus being generally comparable to patrol craft.[44] Similar to their LUSV counterparts, American uncrewed platforms must be high endurance, low cost, and equipped with reconfigurable modules and payloads. According to a recent Congressional Research Service report, future US Navy MUSVs will concentrate on ISR and targeting (ISR-&T), counter ISR-&T, and information operations (IO) missions.[45] MUSVs will add sufficient mass to gain the benefits of these capabilities at scale and thus will greatly improve distributed situational awareness.[46] While US MUSVs are mainly ISR platforms, the upcoming MUSV program is included here due to its sizeable impact and necessity for the implementation of future US Navy DMO.

However, between FY2025 and FY2029, there are no planned MUSV procurements. Yet, in July 2020, L3Harris Technologies was awarded a contract to build a single MUSV prototype for US$34,999,948.[47] The contract included options for an additional eight MUSVs, for a combined total of US$281,425,446. L3Harris will utilize its ASView autonomous technology in a

commercially derived, yet purpose-built, 59.5m-long platform. L3Harris will provide systems integration and autonomous mission technologies; however, Gibbs & Cox and Incat Crowther will provide the ship design, and Swiftships will complete the construction.[48]

In addition to the upcoming MUSV program, the US Navy presently operates a set of currently experimental MUSVs. These platforms were established through the Anti-Submarine Warfare Continuous Trail Uncrewed Vessel (ACTUV) program of the Defense Advanced Research Projects Agency (DARPA).[49] Both of these ships feature a compact bridge with no crew quarters and are intended for anti-submarine warfare (ASW). USV *Sea Hunter* and USV *Sea Hawk* are classified as Class III USVs by the US Navy.[50] USV *Sea Hunter* is 40.23m long and 15.24m wide, displacing 140 tons, while *Sea Hawk* displaces 145 tons.[51] In 2017, the contract awarded to Leidos to build *Sea Hawk* was for $US35.5 million.[52] According to the US Naval Institute, it adopted and integrated 300 lessons from *Sea Hunter*.[53]

The Netherlands

The Royal Netherlands Navy plans on procuring two lightly crewed support platforms that will assist its air-defence frigates.[54] For a proposed investment ranging from US$279 million to US$1.1 billion, these platforms will be armed with SAM missiles to counter incoming anti-ship missiles and drones.[55] It is important to note that it is unclear what is included in this wide-ranging price estimation. Nevertheless, these two proposed air-defence USVs are 53m long with 9.8m beams. Notably, they will displace 550 tons, slightly larger than the US Navy's definition of a MUSV.[56]

In comparison, the De Zeven Provinciën–class air-defence frigates that these USVs will assist are 144.2m long and 17.5m wide and displace 6,000 tons.[57] Crewed by eight sailors, the lightly crewed support ship will be built by the Dutch shipyard Damen, and Israel Aerospace Industries will be providing combat capabilities. Its primary weapon will be the Barak extended-range interceptor SAM missile, with an interception range of 150 kilometres (km) and a maximum altitude of 30km. The manufacturer states that this missile is capable of low-signature and 360° vertical launch, with a high immunity to electronic counter-measures with swift and reliable target acquisition.[58] Additionally, Israel Aerospace Industries will provide HAROP long-range munitions and electronic warfare suites for the platforms.[59]

China

The People's Liberation Army Navy (PLA-N) and Chinese research programs have been experimenting with MUSVs. In February 2024, at the World Defense Show Exhibition in Saudi Arabia, the China State Shipbuilding Corporation (CSSC) unveiled the "Thunderer" A2000 USV.[60] This uncrewed surface combatant – 45m long and displacing 280 tonnes – is equipped with twin diesel engines and two controllable-pitch propellers, allowing for a top speed of 35kn.[61] A trimaran hull that decreases its radar cross-section further highlights the necessity of stealth for survivability in the modern naval battlespace. The Thunderer A2000's primary capabilities are eight VLS cells.[62] Depending on the source, these VLS cells may be equipped with HQ-10 short-range SAMs, FM-3000N medium SAMs, or CM-802B short-range SAMs, all focused on incoming missile and drone interception.[63]

To compliment the eight VLS cells, an additional total 24 port- and starboard-mounted cell launchers can deploy loitering munitions alongside a single 30-millimetre (mm) cannon. While the platform does not itself carry ASuW or ASW armaments, the Chinese have asserted that its command and control (C2) features allow it to direct smaller USVs – with such mission sets – within its zone of influence and air defence cover. ISR and OWA-strike-capable VTOL UAVs are deployable via a designated launchpad.[64] An AESA radar for surface and air surveillance is present, a capability shared with the larger JARI-USV-A Orca.[65] The Chinese MUSV is controlled from a land-based station, with increased operational range provided through satellites. Chinese CSSC employees at a Malaysian exhibition insisted that simulations have displayed a 600km C2 range.[66] The Thunderer A2000 is intended to be deployed in littoral waters and is capable of operating independently or within a networked fleet.[67] In peace, this ship can still provide ISR functions, and in war, it promises air defence and uncrewed C2 and range extension for strike-capable UAVs.[68]

USV/UAV Carriers

China

In May 2024, Naval News reported on the PLA-N's upcoming fourth operational aircraft carrier.[69] However, this carrier, unlike the others, is dramatically smaller and believed to be the world's first dedicated fixed-wing UAV carrier.[70] Silently launched in December 2022, the flight deck is one-third the length and half the width of a US Navy or PLA-N super carrier, making it slightly shorter and wider than the average escort carrier of the Second World War.[71] While crewed fixed-wing aircraft could operate from the platform, the inclusion of a straight deck would be seemingly anachronistic, as aircraft cannot simultaneously land and take off. Satellite imagery indicates that the flight deck is very low, making it even less likely that a full-sized hangar exists, further suggesting its use as a dedicated drone carrier.[72] The carrier's island superstructure is on the starboard side, with the marked runway along the vessel's port.[73] The runway is large enough to accommodate platforms equivalent to the General Atomics MQ-9 series.[74] Additionally, the existence of a runway and not simply a launch rail or catapult suggests that the UAVs operating from the vessel are not just OWA UAVs. The broad catamaran hull is also unique, as it has never left the pages of aerial vehicle carrier concept design.[75]

UAV carriers are highly cost effective compared to conventional super carriers and require little to no onboard crew.[76] While they do not contain the same capabilities, their mass production via Chinese shipbuilding can ensure a strong, prolific, and dangerous adversarial UAV presence in the South China Sea's littoral waters.[77] Additionally, such carriers compliment the Thunderer A2000 by carrying more offensive and ISR-capable UAVs, while benefiting from the latter's air defence cover. Consequently, it was believed important to include USV or lightly crewed dedicated drone carriers in this report. These USVs can be argued to be offensively armed through their carrying of UAVs with either missile, torpedo, or OWA armaments. They provide unique aerial and loitering capabilities at mass for a fraction of the cost of conventional carriers and aircraft.[78]

Open-source intelligence (OSINT) imagery spotted the carrier at a shipyard along the largest river in Eurasia, the Yangtze, and distantly located from the bustling shipyards of Shanghai. Alongside the large UAV carrier, the image shows two smaller UAV carriers and barges.[79] Independent naval analyst H.I. Sutton claims these platforms are used in training to represent PLA-N adversaries and

are known as the "Electronic Blue Force."[80] Subsequently, it is possible that the large UAV carrier may serve in a similar capacity, in addition to further testing and developing PLA-N UAV carrier operations.[81]

Iran

Alongside the PLA-N, China's co-enabler of the Russian invasion of Ukraine, Iran, has taken an interest in translating the UAV carrier concept into a hard capability. Iran chose to convert the container ship *Perarin* into a UAV carrier. While the carrier is thus not purpose-built, this approach often is cost effective and allows for the faster deployment of new capabilities.[82] Work is believed to have begun in May 2022 near Bandar Abbas by the Iran Shipbuilding & Offshore Industries Complex Company.[83] The conversion was commissioned for the Iranian Revolutionary Guard Corps (IRGC) Navy, not to be mistaken with Iran's other maritime service, the Islamic Republic of Iran Navy (IRIN).[84]

The ship, named *Shahid Bagheri*, seemingly left port for its first excursion on June 8, 2024, according to an unofficial Iranian naval force social media account.[85] Satellite photos from BlackSky later confirmed that during December 2024, at the latest, the carrier was seaworthy and had left port.[86] The 240.8m-long UAV carrier accommodates an angled flight deck and ski-jump for takeoff on the port side.[87] The original superstructure of *Perarin* is retained, spanning the entire width of the deck.[88] Resultantly, a mandatory angled deck was required, as opposed to the PLA-N UAV carrier's straight deck design.[89] Further, the old starboard superstructure necessitated the construction of a significant overhang on port to incorporate the flight deck.[90] Questions regarding the practicality of landing due to the narrow angled deck and its proximity to the remaining original superstructure have been raised.[91] This leads to speculation for the probable inclusion of arresting wires.[92]

It is currently unclear what UAVs will comprise the carrier's air wing, yet it can be assumed that it will likely include platforms from the extensive array of OWA UAVs that Iran currently fields.[93] Even behind the superstructure, the aft deck provides ample space for additional VTOL or small catapult-launched systems.[94] For example, it would easily accommodate a HESA Shahed 136 launch system. This UAV loitering munition, mass-produced by the Iranian Shahed Aviation Industries, is believed to have a 30kg to 50kg warhead, a 2,500km operational range, and an estimated domestic production cost of only US$10,000 to US$20,000 per unit.[95] Additionally, alongside China and others, Iran has already successfully test-fired containerized ballistic missiles.[96] These ballistic missiles, disguised and encased in standard shipping container exteriors, have reportedly been fired by one of two other IRGC carriers. Two other warships, *Shahid Mahdavi* and *Shahid Roudaki*, were also designed to carry UAVs, helicopters, and missile launchers and were originally converted from container ships.[97]

Turkey

The Turkish Naval Forces (TDK) have also taken seriously the potential force multiplier effects of UAVs for naval warfare.[98] The largest warship in the Turkish fleet is also claimed to be the world's first dedicated carrier for combat-capable UAVs.[99] Originally conceived as a helicopter carrier in 2013, TCG *Anadolu* is now designated as a UAV- and helicopter-carrying amphibious assault ship. The final specifications in 2015 dictated a price of US$1 billion, and the warship was delivered to

the TDK in April 2023.[100] The warship displaces 24,660 tons in an UAV carrier configuration and 27,436 tons while in an amphibious assault ship configuration.[101] A length of 231m, a beam of 32m, and a height of 58m create a flight deck of 5,550m^2 with six landing points.[102] Fully loaded, TCG *Anadolu*'s maximum speed is 21kn, and it can carry 11 UAVs and/or ten helicopters on the flight deck and 30 UAVs and/or 19 helicopters in the hanger.

Armed Turkish UAVs, including the Bayraktar TB3 and the upcoming stealth jet-powered Kizilelma, will be operable from TCG *Anadolu*.[103] This ship thus offers the Turkish Naval Forces capabilities such as UAVs loitering with air-to-air, anti-tank guided, anti-radiation, anti-ship, air-to-surface, and cruise missiles.[104] The small, light attack aircraft Hurjet, under development by Turkish Aerospace Industries, can also operate from the vessel.[105] TCG *Anadolu* features an onboard hospital with two operating rooms and the ability to carry 93 armoured vehicles, including main battle tanks and amphibious infantry fighting vehicles, as well as a compliment of 1,223 personnel.[106]

Why UAV Carriers Are Included

While TCG *Anadolu* is a large, crewed vessel, its inclusion within this report was deemed worthy for two reasons. Firstly, while the multi-purpose carrier is not itself a method to economically supplement the fires potential of the Turkish Naval Forces, the diverse array of capabilities that onboard UAVs and their munitions provide certainly are. They significantly bolster fires capacity through their perceived threat, loitering potential, and extensive range, which is provided through their deployment from a mobile seagoing platform.[107]

Secondly, and more broadly for all carriers, UAV carriers have been included in this report to highlight the diverse methods by which even non-water-based uncrewed assets can unconventionally enable capabilities that have become out of reach for smaller seafaring navies as traditional carriers have become larger and more expensive.[108] Supplementing traditional thinking with experimentation enables the creation of new platform combinations and operating concepts that are dramatically reducing the capability gap between asymmetric forces.[109] The carrier example was highlighted to show the serious foreign implementation of one such idea. It illustrates the need to explore what is currently being done, even if it is somewhat divergent from perceived desires, as it can inspire further propositions. For example, further experimentation could seek naval UAV capabilities through more economic and smaller repurposed carriers.[110]

New and Upcoming Small UAV Carriers

Indeed, recent news articles as of January 2025 are further reporting that Ukraine is deploying first-person-view (FPV) OWA UAVs to attack Russian warships from small Ukrainian USVs.[111] Moreover, the Royal Netherlands Navy (RNLN) is experimenting with a small surface mothership currently known as the USV90.[112] It is 9m long and will carry a host of smaller uncrewed vehicles for a variety of purposes, though it is currently focusing on mine countermeasures (MCM).[113] However, the USV90 is more of an exception than the rule as a multi-purpose carrier. Generally, the smaller an uncrewed surface vehicle becomes, the more likely it is to have a specific and distinct function. While that is not to say that multi-role and ISR-capable vehicles will not play important roles in future warfare, this report will focus on the rapidly expanding list of smaller armed USVs.

Small USVs

China

The previously mentioned PLA-N JARI-USV-A Orca "Killer Tiger" is not the first model of Chinese armed USV to be developed. Another smaller design was first developed by the No.716 Research Institute or Jiangsu Automation Research Institute (JARI).[114] This original JARI USV had a length of 15m, a breadth of 4.8m, a depth of 1.8m, and a displacement of 20 tons, and it was propelled by a single water jet.[115] With a maximum speed of 42kn, a range of 500nm, and a sensor suite featuring Active Phased Array Radar (APAR) with four fixed panels, the USV design is also heavily armed and can be fitted with sonar for ASW.[116] It features potentially a 30mm remote weapon system (RWS) or a 57mm gun, optional pod-guided or unguided rockets, and 2x4 VLS cells that can deploy surface-to-air missiles and SeRAM missile defence.[117] Additionally, two optional single torpedo launchers (lightweight armaments like the single-propeller electric-driven ET-52C, based on the Italian A.224S and components from the Mk 46 torpedo) could be added on either side of the superstructure.[118]

Turkey

While the 15m-long JARI USV demonstrates China's investment in developing small, armed, uncrewed platforms, Turkey has the most diverse and developed small USV program. Its extensive research and development has resulted in small USVs specializing in long-range anti-surface warfare (LR-ASuW), ASuW, anti-air warfare (AAW), ASW, MCM, ISR, electronic warfare (EW), firefighting and search and rescue (SAR), scientific research, and OWA swarm USVs and seaborne targets.[119] The ULAQ, a series of drones produced by Turkish companies ARES Shipyard and Meteksan Defence Inc., has a variety of capabilities and roles.[120] The base platform has a length of 11m, top speed of 35kn, and range of 400km.[121] It can be piloted via ground or vessel-based stations. The ULAQ ASuW G/M is armed with four 150km ÇAKIR anti-ship/cruise missiles or 220+km Atmaca anti-ship and one 12.7mm RWS (Remote Weapon System).[122]

There are four other shorter-range ASuW warfare variants, with armaments containing either eight Cirit guided rockets or four L-UMTAS anti-tank guided missiles (ATGMs) and/or a single 12.7mm RWS.[123] The ULAQ AAW is armed with four SUNGUR man-portable air-defence systems (MANPADS) and the ULAQ mine countermeasure vehicle (MCMV) with one mine-hunting remotely operated vehicle (ROV), two Roketsan ASW rocket launchers, and a single 12.7mm RWS. There are five ASW ULAQ variants. The first two, LT 1 and 2, are armed with two 25+km, 324mm ORKA torpedoes, as well as either 12 sonobuoys or one sonar and one 12.7 RWS. ASW LT 3 and the secondary configuration of the ULAQ MCMV feature one Roketsan ASW rocket launcher and one 12.7mm RWS or one 50+km, 533mm AKYA torpedo, two Roketsan ASW rocket launchers, and one 12.7mm RWS, respectively. The ISR and SAR variants feature EW, jamming payloads, chaff launchers, water pumps, and inflatable life rafts.[124] An official of the Turkish Secretariat of Defence Industries claimed that the ULAQ unit price average was a "few million US dollars, depending on configuration."[125]

Sefine Shipyard's redesignated Constellation class (previously RD09 and NB57) has been cited as the first multi-role USV, asserting that the platform's two outrigger hulls each provide space for an additional weapon station.[126] The three weapon stations have been used to create four variants.

When in a trimaran configuration and armed with four 25+km, 324mm ORKA torpedoes, a Roketsan ASW rocket launcher, 20 sonobuoys, and a single 12.7mm RWS, it is deployed for ASW missions.[127] The patrol variant features one 12.7mm RWS and sonar, while the coastguard subvariant features no sonar.[128] Lastly, the more heavily armed ASuW trimaran variant has eight L-UMTAS ATGMs or 16 Cirit guided rockets, anti-ship missiles, KUZGUN guided missiles/rockets/long-range ATGMs, a single 12.7mm RWS, and 20 sonobuoys.[129]

Dearsan Shipyard, operating out of Istanbul, contributes two platforms to this extensive collection, the USV 11 and USV 15. Like their names suggest, they are 11m and 14.79m long, respectively.[130] The USV 11 comes in two ASuW variants. The first features a Yalman weapon station with either eight Cirit guided rockets or four L-UMTAS ATGMs, while the second boasts one 12.7mm RWS.[131] The USV 15 ASuW is armed with eight Cirit guided rockets or four L-UMTAS ATGMs and one 12.7mm RWS.[132] The C2 station includes a wideband transceiver for line-of-sight data/image transfer and satellite communications (SATCOM) for over-the-horizon communications (OTH-C).[133] Additionally, featuring a composite hull, a 300nm range, a beam of 3.83m, a draft of 0.75m, two diesel engines, two water jets, and one diesel generator, USV 15 is capable of reaching 60kn.[134] Another small ASuW USV named the SANCAR SIDA has been designed by Yonca-Onuk Shipyard.[135] It and other similar Turkish small ASuW USVs feature the same armament as the USV 15 and some ULAQs.[136]

It is important to note that small USVs can be transported by land, air, and ship, including landing platform docks (LPDs) and landing helicopter docks (LHDs). Specifically, the Turkish Naval Forces' TCG *Anadolu* UAV carrier/assault ship has been cited as one such example.[137] While small USVs are easily air and ground transportable and are able to rapidly deploy to protect a nation's littoral waters, the ability for navies to deploy them in blue waters via motherships or carriers allows smaller seafaring navies a chance to bring sizeable armaments with them that would otherwise be more costly and difficult to transport.

Warships like frigates and destroyers are often outfitted with helicopter hangers. These spaces and other modules should be investigated and possibly retrofitted to transport smaller armed or OWA USVs. If the future River-class destroyers of the RCN were able to install a USV transport module, it would dramatically increase their potential fires capability and their perceived ASuW/ASW/AAW threat and deterrence.

Essential Lessons from Ukraine: The Advantages of Smaller Platforms for Threatened Middling Powers

Ukraine

While Turkey has shown extensive development in small USVs, the nation that has shown the greatest innovation in the field and whose navy has far exceeded expectations in the largest conventional conflict since the Second World War is the free and democratic Ukraine.[138] The Ukrainian Navy has proven that USVs are an important asset for naval warfare and anti-access/area denial (A2AD) in littoral waters. The Ukrainian Navy's use of non-traditional assets, lack of large warships, and successful attacks in the Black Sea and Sevastopol stand testament to this fact.[139] Moreover, and importantly, Ukraine's USV and UUV programs are products of necessity during a

21st-century conventional war of attrition.[140] Therefore, if Canada is to ensure its ability to deter and potentially sustain combat operations in an increasingly likely scenario, it would be judicious to incorporate the lessons Ukraine has learned into its own operating procedures and platform specifications.

Firstly, current naval requirements have been created in a peacetime or a "Global War on Terror" mindset, and naval analyst H.I. Sutton argues that this is why many navies have chosen not to focus on integrating one-way-attack (OWA) platforms into their current or future capabilities and requirements.[141] Secondly, Ukraine has leveraged its civilian commercial industry to supplement purpose-built military platforms.[142] Arguably, the simplest platforms that can be created by civilian industry, without the need for extensive conversion and expensive equipment, are small OWA USVs. In Ukraine, small communities and organizations have formed to build OWA USVs, even using their personal home garages in Kyiv.[143] This further highlights the importance of practical, easily serviceable, expendable platforms. These clearly have a role on the battlefield and can supplement more purpose-built systems. Commentators have long argued that bureaucratic debates during peacetime on multi-role potential – and the desire to ensure long service lives – have resulted in overly engineered and expensive platforms.[144]

Thus, the third lesson from Ukraine is to understand that militaries and civilization itself are facing a time of rapid technological innovation.[145] Canada is procuring large warships in the upcoming River-class guided-missile destroyers (DDGs), as well as crewed diesel-electric, air-independent propulsion, or fully electric submarines. However, neither will be operational in any meaningful form for over a decade.[146] As over-quoted as it is, the musing of Prussian military strategist Helmuth von Moltke the Elder "that no plan survives contact with the enemy" is prudent advice here.[147] As the impacts of new technologies only accelerate, we are unable to predict what future war will look like. Larger, more expensive platforms require vast monetary and time investments, while possibly being outdated or quickly destroyed in a coming large conventional war.[148] Quality is important, but it cannot make up for a lack of quantity. In a future conflict, the current small size of the RCN ensures that any ship not in active service, due to damage or maintenance, is a massive loss to the RCN's operational capability. Therefore, this report would suggest diversification through a focus on supplementing our crewed fleet with smaller USVs/UUVs/OWAs. These, as shown previously, can even operate from warships for blue-water operations. Large USVs/UUVs are exponentially more expensive than smaller counterparts, and Ukraine has already proven these economic platforms to be combat effective and logistically easier to deploy and operate. For example, in future Canadian Arctic A2AD missions, River-Class destroyers and submarines could be supplemented with loitering OWA UUVs with 1,000km ranges – like the Ukrainian Marichka OWA UUV – and pose threats to surface and under-ice subsea threats.

In addition, due to the more attritable nature of smaller uncrewed platforms, it is then economically viable to consistently replace aging or destroyed platforms and to integrate decisive design improvements and new technologies into following production. Such platforms are meant to be used without worrying extensively about their longevity, diverging from the sunk time and cost fallacy that evolved as a symptom of the fascination with overly expensive bespoke designs during the Global War on Terror. This sunk time/cost fallacy is a misconception that must be discarded to prepare for the next serious conflict. Furthermore, a related point specifically regarding OWA USVs must be made to provide reasoning for why Western navies must not specifically avoid them. If OWA USVs are deployed, they should not be considered wasted due to their likely inherent

non-reusable nature. If they defeat an adversary through their loitering deterrent presence or the destruction of their target, then they successfully achieved their objective. In this regard, it is rational and more prudent to consider them munitions whose follow-on replenishments may even include further improvements.

The last consideration and fourth lesson from Ukraine surfaces from the multiple advantages of the production infrastructure for small USVs/UUVs. Firstly, their production does not require nor need to impact existing military-industrial infrastructure that is designed for the construction of larger platforms.[149] Secondly, in case of potential attacks and strikes on Canadian territory, more dispersed, smaller, and possibly hidden infrastructure is harder for an adversary to target and destroy, as seen in Ukraine. Thirdly, investment in this uncrewed platform category supports the diversification of industry and potential smaller future startup Canadian defence companies, only benefiting Canadian resiliency and even sovereignty, as Canada would rely even more on indigenous designs. As of 2018, 90% of Canadian defence firms were small to medium sized, according to the Senate of Canada.[150] This is keeping in mind that OWA designs can be ingenious quality products even with their intended expiration on use, as will now be highlighted.

One-Way-Attack (OWA) USVs

Ukraine

The Maritime Autonomous Guard Uncrewed Robotic Apparatus (Magura) Series is manufactured by the Ukrainian state-owned SFTE SpetsTechnoExport. It is used by the Main Directorate of Intelligence (GUR) of Ukraine's Ministry of Defence.[151] As of September 2024, the Magura V-Type is the latest known model in the series.[152] Ivan Sybyriakov, the Uncrewed Systems Manager at SFTE SpetsTechnoExport, stated that the Magura V-Type is capable of housing more weapon modules than are publicly known.[153] The export model, the Magura V5, has multiple missions, including ISR, SAR, mine warfare (MIW), fleet security and patrol, OWA, and AAW. The AAW "FrankenSam" is armed with AA-11 Archer (R-73) air-defence missiles that are taken from Su-27 Flanker and MiG-29 Fulcrum fighter aircraft.[154] As of November 11, 2022, the Armed Forces of Ukraine stated that a Magura USV costs 10 million hryvnias or, converted to 2025, CAD$342,000 or US$238,000 per unit.[155]

The Mykola was the first Ukrainian OWA USV revealed, and it was used in the attack on the Black Sea Fleet in Sevastopol on October 29, 2022.[156] The Mykola's estimated price according to Ukrainian sources is US$250,000, and it has been created from commercial/recreational boating parts.[157] The USV features a length of 5.5m, a 1,000-kilogram (kg) maximum weight, a 200kg payload, a 430nm range, 60 hours of autonomous operation, and a top speed of 43kn.[158] It can navigate via automatic global navigation satellite system (GNSS), inertial, and visual methods, and it has three high-definition (HD) video streams and 256-bit encryption.[159]

The Mamai OWA is a reliable and battle-tested design used by the Security Service of Ukraine (SBU) in its attacks on the Russian Ropucha-class landing ship *Olenegorsky Gornyak* and tanker *Sig*.[160] Both ships were significantly damaged far from Ukrainian-controlled territory. It is known that the Mamai is larger than the Magura, but an analyst notes that the overall dimensions are compact.[161] This increased volume can either be used for fuel for long-range operations or for a larger payload.[162] With a top speed of 60kn, it is significantly faster than the Mykola. It features

up to two satellite communications antennas and an electro-optical camera ball. The Mamai OWA's warhead is detonated when one of the three impact sensors protruding on the bow contacts the target.[163]

The Sea Baby series, operated by the SBU, was reportedly the USV used on July 17, 2023, to attack the Kerch Bridge.[164] It is 6m long, 2m wide, stands 0.6m above the waterline, is propelled by twin water jets driven by 2x200-horsepower (hp) inboard motors, and has a 49kn maximum speed, a 540nm range with additional fuel tanks, a payload of 850kg, and satellite communications.[165] The main payload is an OWA charge, but the Sea Baby can additionally carry RPV-16 thermobaric rockets. Two/four/six rocket tube configurations have been seen. The RPV-16's range is 1,000m, and it is thus summarized to have three different uses. It could be used as the primary weapon in an attack or even as a standoff defence weapon against surface threats. However, it may also be used in the OWA ram, where the rocket launch is used to bewilder the enemy and prevent it from mounting an effective defence. During the Second World War, this third option was the desired operating procedure of the Imperial Japanese Navy's Shinyo Type 1 and Type 5 explosive suicide boats.[166] They were armed with two 119mm rockets and an optional 13.2mm heavy machine gun (HMG), in addition to their 250–300kg explosive charges.[167] The Sea Baby rockets can additionally be modified to launch 6x122mm rockets.

The Sea Baby II "Avdiivka" was a further development that the SBU unveiled in March 2024. As an alternative to two smaller jet ski motors, the "Avdiivka" has one 400hp engine. The payload is apparently smaller at 400kg, though sometimes it is reported as being higher.[168] The range and speed are similar at 500nm and 48kn. A reinforced hull can traverse waves of 1.5m with a draft of 1m and a height above water – an important aspect of OWA – of 1m. A Kymeta satellite link and directional Starlink antenna provide communication with the USV. It is unconfirmed but probable that it, too, can be armed with rockets.[169]

At the Black Sea Security Forum 2024 in Odesa, Ukraine's Stalker 5.0 multifunctional USV was revealed.[170] It is 5m long and 1.2m wide, and it has a 150kg maximum payload for OWA, a 600km maximum range, and a top speed of 40kn with its 60hp outboard motor.[171] The Stalker 5.0's main function is reconnaissance and patrol. It also has a special compartment for transporting weapons, equipment, and provisions.[172] However, the payload makes it multi-purpose and able to engage targets of opportunity on patrol.[173]

Whether the Toloka TLK-150 from the Ukrainian government's Brave1 initiative has been operational is not fully clear. It comes in multiple variants: one is 4m long and may have a 400km or 1,200km operating radius, depending on its configuration.[174] The Riverine Resupply USV is a prototype logistics USV primarily made to ship ammunition (120mm and 155m) through dangerous environments.[175] Its small stature at 1.5m fixes it to a maximum 30kg payload. Similar platforms could even be considered to resupply other operational USVs/UUVs.

The Ukrainians have also outfitted small commercial jet skis and rigid-hulled inflatable boats (RHIBs) into OWA USVs. They have weaponized Yamaha WaveRunner FXs (Generations 1 and 2) and assumedly AM800 RHIBs (high-speed manoeuvring surface target (HSMST) vessels).[176] The 8.2m-long RHIB USV was found floating in Romanian waters on April 3, 2024, and the warhead was from a Styx anti-ship missile.[177] Although not formally attributed, analysts have claimed that it is Ukrainian.[178] The Yamaha WaveRunner FX's pricing starts at US$16,399.[179]

Silver Ships, which produces the AM-800 RHIB (HSMST), won a contract for US$6.1million to create 246 platforms, amounting to – when produced at that number in that specific contract – US$24,797 per unit.[180]

Turkey

The Turkish Naval Forces are also investing in OWA USVs to be used in swarms. The Albatros-S program was initiated by the Defense Industry Agency (SSB).[181] The contract was given to Aselsan, which has proven the concept with a swarm of the 7m-long and 2m-wide Albatros-S and the 15m-long and 3.85m-wide MIR USVs operating together.[182] In June 2023, eight platforms were coordinated together in a demonstrated attack.[183] The Albatros-S has ten hours of endurance, a 40kn top speed, radio frequency (RF) communication, and SATCOM control, but it is capable of autonomous-synced USV swarm navigation and operations.[184] The MIR USV is primarily designed for ASW but has been featured in Aselsan's swarm demonstrations and has a top speed of 35kn and a 72-hour endurance.[185] MIR USV payloads include ASW sonar systems – either dipping sonar or a diver detection sonar – and also a sonobuoy system, lightweight torpedoes, ASW rockets, a STAMP-2L stabilized weapon station (a 12.7mm or 7.62mm RWS turret), and a KIRLANGIÇ electro-optical/infra-red (EO/IR) camera.[186]

Russia

Since the illegal full-scale invasion of Ukraine by the Russian Federation, the Russian Navy has invested in and deployed OWA USVs. The Murena 300 from the LLC KB Centre for Uncrewed Systems is similar in size to the Magura V5.[187] It is marketed for MCM, MIW, patrol, reconnaissance, and port defence.[188] On September 19, 2024, President Putin watched a display of a Murena 300 firing dummy UMT 220mm lightweight torpedoes.[189] The outboard motor is attached to a simple metal semi-planing powerboat hull, and a Starlink antenna is hidden under camouflage netting.[190] Another small Russian USV, the Sargan, is self-righting, 4–5m long, and heavily inspired by Ukrainian designs.[191] Another variant appears to be only 2.12m long and 0.53m wide, with a speed of 33kn and total weight of 20kg. The Russian-appointed governor of Sevastopol, Mikhail Razvozhayev, posted on Telegram that these USVs were to protect convoys. Most notable is that these OWA USVs are very small, on average weighing 50 times less than their Ukrainian counterparts and measuring half their length.[192] The Russian USV that is most similar in specifications to Ukraine's is the BBKN Dandelion by Kingisepp Machine-Building Plant in St. Petersburg.[193] It must be stated that it appears to be very similar to the RK-700 Vizir, which may be the same platform through either a marketing mistake or change in name.[194] It can reportedly reach 43kn with its 600kg payload.[195] It has a 108nm range.[196] While the Russian Federation has arguably spent less time developing and innovating new USVs even with its illegal invasion of Ukraine, it has arguably spent more time and energy promoting its much-hyped UUV programs.

The Asymmetric Advantages of UUVs

The specifications, operating concepts, and varieties of UUVs are rapidly advancing. H.I. Sutton notes that "armed UUVs are the next major asymmetrical must-have for smaller navies. Along with their surface drone cousins, they promise a way to stand up to much larger and more powerful conventional navies."[197] New developments in lithium-ion submersible battery technology only increase the stealth potential of smaller armed UUVs and their ability to act as sentient hunters via

active search and loitering via target of opportunity attacks and long-range missions.[198] If one imagines a small OWA UUV, encapsulated in a Hammerhead-style mine (similar to the old Mark 60 CAPTOR mines that contain torpedoes), they could be deployed for A2AD.

UUVs

The United States

The US Navy's XLUUV research and development is currently focused on MIW.[199] The current XLUUV Orca program was established to address a Joint Emergent Operational Need (JEON).[200] The US considers XLUUVs as UUVS with a diameter of 84+ inches and that are correspondingly too large to launch from crewed submarines.[201] They thus generally need to be transported to forward operating ports and launched from piers.[202] US XLUUVs will be designed to utilize an array of armaments. In 2021 and 2022, the US Navy asserted that mines will be the first payloads of XLUUVs and will be housed in 10.4m payload modules.[203] The US Navy is keen to have XLUUVs as active MIW platforms through the covert deployment of Hammerhead mines.[204] The US Navy plans on procuring one per year. In FY2023, prototypes underwent tests. The FY2026 XLUUV procurement cost is US$113.3 million, the FY2027 is US$115.6 million, the FY208 is US$117.9 million, and the FY2029 is US$120.4 million.[205] Contracts for additional Orcas are planned for FY2026 and thereafter, with the ramping up of quantities to be dependent on the progress and success of the first five platforms.[206]

The Orca's specifications incorporated significant changes to support its military mission requirements but borrowed heavily from the Boeing Echo Voyager. Therefore, to get a general understanding of the Orca's specifications, one can examine the Echo Voyager. For visual reference, it is the size of a subway car, 15.5m long and 2.6m in diameter with a range of 6,500nm when one fuel module is installed.[207] When in the air, it weighs 50 US (assumedly) tons.[208] It can equip the same size of payload module (10.4m) as the Orca, with 56.6m^3 of internal payload volume and a total platform length of 25.9m.[209] The Echo Voyager can instead install a 4.3m modular payload with 25.5m^3 of internal space.[210] It can include additional external payloads, and it is able to conduct multiple-month deployments with a fully autonomous capability. Its maximum depth is 3,000m, minimum speed 2.5kn, maximum speed 8kn, and optimal speed 2.5–3kn. The range of this experimental platform is arguably its limiting factor, at only 150nm. Finally, the Echo Voyager can equip a Raytheon PROSAS PS60-6000 Synthetic Aperture Sonar to enhance ocean-bottom mapping capability.[211] The sonar specs include a swath of 1900m, resolution of ten centimetres (cm), and altitude of 100m.[212]

China

Now the world's largest navy, China's PLA-N is heavily investing in XLUUVs. According to Naval News, as of February 23, 2023, the PLA-N had five XLUUV designs in the water.[213] H.I. Sutton declares that Chinese XLUUVs are leading the world in the field or are at least leading in its attempts to scale up their use when combined with China's strategy of aggressive arms export.[214] The PLA-N UUV-300 series was possibly designed from a prototype that the PLA-N chose not to pursue and which Chinese defence exporter Poly Technology is now selling.[215] The UUV-300CB is 11.5m long, with a hull width and height of 1.6m and total width of 2m. A range of 450nm can be achieved at 5kn, with a maximum speed of 12kn. The large internal volume is dedicated to

weapons. Sealed tubes can swing out to launch four lightweight torpedoes, EM-12 bottom mines, smaller UUVs, or potentially land-attack missiles.[216] Two torpedo tubes may be exchanged for flank array sonar, which is possibly the stock configuration.[217] Weighing 50 tonnes, the UUV-300CB's operating depth is 300m, and its acoustic emissions are less than 140 decibels (dB).[218] Communications are available through ultra-high frequency (UHF)/SATCOM/acoustic means.[219]

The UUV-300CB's counterpart, the UUV-300CD, is larger at 28m long and 2.5m in diameter, with a weight of 50 tons.[220] The CD's dive depth is less than that of the CB, at 200m, and its maximum speed is 10kn.[221] It shares a cruising speed of 5kn, which provides it with a 325nm range. Intended for ISR and offensive operations, the CD can carry four torpedoes.[222]

The HSU-001, the first large UUV, was unveiled at the 70th anniversary parade of the People's Republic of China (PRC) in 2019.[223] It may be large enough to carry sensors, mines, or smaller UUVs.[224] It could be used for ISR, and/as the twin-screw back propellers could point towards an intent for slow, near-surface cruising.[225] Vertical and horizontal thrusts are present in the fore and aft, while there appear to be external hard points on either side of the hull.[226] Small spikes on the hull top for launch and recovery can be seen. It is believed to be 5m long and 1m in diameter and weigh 3 tons. It may be used to cut, jam, or eavesdrop on adversarial submarine cables, and thus, it could in engage in acts of grey-zone warfare.[227]

Russia

The Russian XLUUV program previously alluded to is one of the oldest military UUV designs and one of the most publicized.[228] Putin's much-touted maritime doomsday posterchild is a nuclear XLUUV OWA, known as the Poseidon (North Atlantic Treaty Organization (NATO) Reporting Name Kanyon, GRAU Index 2M39).[229] Previously the Status-6, the Poseidon is estimated to be 24m long, with a diameter of 2m.[230] H.I. Sutton asserts that its maximum speed is 70kn, and its proposed super-cavitation and extreme speeds have been debunked.[231] Its operating depth is reportedly greater than 1,000m.[232] The Poseidon is nuclear powered, and its warhead may be two megatons.[233] According to TASS, the Russian news agency, it will be carried by two operational submarines by 2027.[234] The first submarine is a modified OSCAR II class (Project 09852 Belgorod) and the other the purpose-built Project 09851 Khabarovsk.[235]

TASS has also reported that the first batch of Poseidons for Project 09852 Belgorod's arsenal were built as of January 15, 2023.[236] It further declares the Russian Navy's plans to have 32 active-duty nuclear-capable Poseidon UUVs.[237] There is a rumoured "Skif" deployment (seabed launch) option, allowing the UUV to infinitely loiter on the seafloor in a specialized container until its desired deployment.[238] If placed beyond the 12-mile territorial limit, it would contravene the 1972 Seabed Arms Control Treaty.[239] This would most likely not be a concern for revanchist Russia, as it has already suspended participation in the nuclear New START Treaty.[240] The Russian Ministry of Defence released a digitally rendered video of a Poseidon destroying an aircraft carrier.[241] This is fairly improbable, and such a weapon would more likely be used against a more manageable and stationary target like port infrastructure or an anchored warship.[242]

Alongside the "leaked" existence of the Poseidon in 2015 was the Cephalopod. The smaller UUV was also designed by the largest of Russia's three submarine design centres, the Rubin Central Design Bureau for Marine Engineering.[243] Analysis has alluded that a seemingly large sonar dome

in the bow, combined with retractable torpedo launchers and a submarine-like screw, could imply an ASW role.[244] Around 10m in length, the armament is anticipated to be similar to the standard Russian 324mm MTT lightweight torpedoes.[245]

The Russian Project 7P22 Garymoniya-GUIDE autonomous underwater vehicle (AUV) may have been cancelled in 2018. It featured a screw propeller and large vertical rudder with a communication pod, alluding to a potential for near-surface, long-endurance operations.[246] A unique concept is the Russian Nerpa anti-diver UUV. Its purpose is to patrol harbours to ensure adversarial divers have extreme difficulty attaching limpet mines.[247] One of its primary advantages over routine diver patrols is the ability to operate in cold water and during long nights without tiring. Development costs exceeded ten million rubles. The UUV is not intended to replace Naval Spetsnaz divers but rather to compliment them.[248] The Nerpa is armed with an APS underwater rifle.[249] While the 5.66mm-calibre steel bolts are effective against underwater human targets, they would suffer against SEAL Delivery Vehicles (SDVs) or other UUVs.

Ukraine

On August 22, 2023, Ukrainian social media accounts released videos of a new OWA UUV called the Marichka.[250] The footage indicates that the Marichka is a 6m-long UUV with a range of 1,000km.[251] It is 1m in diameter, and the unit price as of posting in 2023 was 16 million hryvnia or US$433,000.[252] It features full metal construction, with either the majority or entirety of the hull being a pressure vessel.[253] Along the bottom of the OWA UUV, a keel and towing loops can be seen.[254] A.M.M.O УКРАЇНА, the Marichka's manufacturer, promotes the platform for anti-ship, anti-bridge, ISR, and transport roles.[255]

Hamas

Lastly, the existence of Hamas's Al-Asef, a torpedo-like OWA UUV, was known by May 2021.[256] It was created using a rear screw and shroud from an old diver propulsion vehicle (DPV).[257] It may rely on a snorkel, as a hollow hose suggests a possible combustion engine, implying a shallow dive limit. A GoPro camera may supplement possible positioning data to assist the remote human pilot.[258]

Conclusion

Ultimately, uncrewed platforms will play an ever more important role in naval operations. Technological developments are increasing the threats to conventional warships and their personnel and demand more attritable systems to compensate. Uncrewed platforms provide an economic means of acquiring capabilities and will be necessary to sustain combat operations in the next large attritional conflict. Moreover, the asymmetric advantages of uncrewed platforms allow smaller nations and actors the ability to negate the dominance of larger conventional forces.

Adversarial nations have implemented wartime economies to mass-produce platforms, and the rules-based international order is facing an alarming and ever-growing number of threats. Therefore, this report suggests that the RCN should consider integrating USVs and UUVs to supplement the fires potential of the crewed fleet. Specifically, the advantages of smaller armed and OWA USV/UUVs may provide the most effective and even most capable means of doing so.

From their proven combat effectiveness in the Black Sea to their distributed means of production, which complements – rather than infringes upon – traditional naval shipbuilding infrastructure, there are a variety of benefits to USV/UUVs. Due to the required operational ranges of the RCN, USVs and UUVs will have to integrate into RCN task forces. Resultantly, small, uncrewed platforms can be carried by larger crewed warships for blue-water operations. The inherently affordable pricing of small platforms enables the relatively easy procurement of follow-on models with vital enhancements. It is of vital importance that Canada acquires uncrewed platforms for coming conflicts. Since February 2022, in the Black Sea, the Russian Navy has lost 11 submarines and surface combatants, with another five heavily damaged.[259] The Ukrainian Navy has suffered 17 crewed ships captured, one damaged, and nine lost.[260] During the Second World War, the RCN lost 31 ships and destroyed 42 enemy warships and 33 submarines.[261] By the end of war, the RCN had over 400 warships in service.[262] The RCN's proposed 15 destroyers and estimated 12 submarines will need support to increase their lethality and survivability. With long procurement times and the potential scale of future wars, the RCN cannot afford unnecessary losses and must insulate and protect its crewed fleet. The RCN will only survive and be an effective navy if it adopts the lesson that mass and sustaining power are the keys to effectively fighting modern war. Canada does not have the shipbuilding capacity for additional complex warships, but it can leverage its ability to produce effective small supplementary platforms. Although Canada faces numerous threats, never has technology enabled it to make a better stand for its own right to national sovereignty, the democratic values it wishes to uphold, and the NATO and Ukrainian allies it wishes to protect.

Notes

[1] Naval Sea Systems Command, "Navy Makes Significant Investment in Munitions Capability, Awards Kongsberg Defence Multi-Year Over the Horizon – Weapons System Contract" (November 12, 2024).
[2] Sebastian Sprenger, "German Navy Tests BlueWhale Underwater Drone for Covert Ship Tracking," Defense News, December 16, 2024, https://www.defensenews.com/global/europe/2024/12/16/german-navy-tests-bluewhale-underwater-drone-for-covert-ship-tracking/; Congressional Research Service, "Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress," US Congress, September 24, 2024, https://sgp.fas.org/crs/weapons/RL32665.pdf.
[3] Deutsche Marine, "German Navy Objectives for 2035 and Beyond," Bundeswehr, April 20, 2023, https://www.bundeswehr.de/en/organization/navy/news/german-navy-objectices-2035-plus-5625058; Franchetti, "Chief of Naval Operations."
[4] Seapower Staff, "Commandant: Long-Range USV Will Be Primarily an ISR Platform That Launches Unmanned Assets," Seapower, September 15, 2022, https://seapowermagazine.org/commandant-long-range-usv-will-be-primarily-an-isr-platform-that-launches-unmanned-assets/.
[5] US Department of Defense, "Military and Security Developments Involving the People's Republic of China 2024: Annual Report to Congress," 2024, 128, https://media.defense.gov/2024/Dec/18/2003615520/-1/-1/0/MILITARY-AND-SECURITY-DEVELOPMENTS-INVOLVING-THE-PEOPLES-REPUBLIC-OF-CHINA-2024.PDF.
[6] Cathalijne Adams, "China's Shipbuilding Capacity Is 232 Times Greater than that of the United States," Alliance for American Manufacturing, September 18, 2023, https://www.americanmanufacturing.org/blog/chinas-shipbuilding-capacity-is-232-times-greater-than-that-of-the-united-states/.
[7] Franchetti, "Chief of Naval Operations," 6; Kyle Amonson and Dane Egli, "The Ambitious Dragon: Beijing's Calculus for Invading Taiwan by 2030," *Journal of Indo-Pacific Affairs* (March–April 2023).
[8] Franchetti, "Chief of Naval Operations," 6; Rush Doshi, "The Long Game: China's Grand Strategy to Displace American Order," Brookings Institution, August 2, 2021, https://www.brookings.edu/articles/the-long-game-chinas-grand-strategy-to-displace-american-order/.

[9] Franchetti, "Chief of Naval Operations," 10; Federico Borsari and Gordon B. Davis Jr., "An Urgent Matter of Drones," CEPA, September 27, 2023, https://cepa.org/comprehensive-reports/an-urgent-matter-of-drones/.
[10] Caleb Bailey, "Stones for Shepherds: UAS as a Force Multiplier and Deterrent Model in Ukraine," Center for Air & Space Law, August 2024, https://airandspacelaw.olemiss.edu/2024/08/22/stones-for-shepherds-uas-as-a-force-multiplier-and-deterrent-model-in-ukraine/.
[11] H.I. Sutton, "World First: Ukraine's Newest Naval Drone in Unique Attack on Russian Positions," Naval News, December 18, 2024, https://www.navalnews.com/naval-news/2024/12/world-first-ukraines-newest-naval-drone-in-unique-attack-on-russian-positions/.
[12] Mark Llewellyn et al., "Future War Project: What Can We Afford?," John Hopkins Applied Physics Laboratory, 2016.
[13] WSP Australia, "The Systems Approach to Solving Complex Problems," WSP, June 1, 2019, https://www.wsp.com/en-ca/insights/the-systems-approach-to-solving-complex-problems.
[14] Benjamin Jensen, "How US Forces Can Adopt Ukraine's Unconventional Multidomain Approach," Defense News, March 22, 2024, https://www.defensenews.com/opinion/2024/03/22/how-us-forces-can-adopt-ukraines-unconventional-multidomain-approach/.
[15] Alex Luck, "German Navy Mulling Drone-Heavy Force Structure Looking Towards 2035 and Beyond," Naval News, March 10, 2023, https://www.navalnews.com/naval-news/2023/03/german-navy-mulling-drone-heavy-force-structure-looking-towards-2035-and-beyond/.
[16] Deutsche Marine, "German Navy Objectives."
[17] E.D. Deneau, "Uncrewed Aerial Systems Proliferation: What Does It Mean to Military Planners?," Canadian Armed Forces, 2016, https://www.cfc.forces.gc.ca/259/290/318/305/deneau.pdf.
[18] Program Executive Office Uncrewed and Small Combatants, "U.S. Navy Achieves Significant Engine Testing Milestones for Large Unmanned Surface Vessel Program," US Naval Sea Systems Command, March 22, 2024, https://www.navsea.navy.mil/Media/News/Article-View/Article/3716370/us-navy-achieves-significant-engine-testing-milestones-for-large-unmanned-surfa/.
[19] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress," August 24, 2023, 4, https://crsreports.congress.gov/product/pdf/R/R45757/65.
[20] Naval Gazing, "Distributed Maritime Operations and the LUSV," June 9, 2024, https://www.navalgazing.net/Distributed-Maritime-Operations.
[21] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 50.
[22] Swiftships, "Ghost Fleet: The Unmanned Surface Vessel Nomad (aka Riley Claire)," July 2022, https://swiftships.com/autonomous-solutions/riley-claire-aka-nomad/.
[23] Sam LaGrone, "CNO: Navy to Finalize Large Unmanned Surface Vessel Requirements Later This Year," USNI News, April 5, 2023, https://news.usni.org/2023/04/05/cno-navy-to-finalize-large-unmanned-surface-vessel-requirements-later-this-year.
[24] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 5.
[25] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 5.
[26] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 6.
[27] Megan Eckstein, "US Navy's Four Unmanned Ships Return from Pacific Deployment," Defense News, January 16, 2024, https://www.defensenews.com/naval/2024/01/16/us-navys-four-unmanned-ships-return-from-pacific-deployment/.
[28] Naval Technology, "Ghost Fleet Overlord Unmanned Surface Vessels, USA," March 23, 2023, https://www.naval-technology.com/projects/ghost-fleet-overlord-unmanned-surface-vessels-usa/.
[29] Naval Technology, "Ghost Fleet Overlord Unmanned Surface Vessels."
[30] Mallory Shelbourne, "Unmanned Surface Vehicle Mariner Next Ghost Fleet Vessel to Join the Navy," USNI News, August 23, 2022, https://news.usni.org/2022/08/23/unmanned-surface-vehicle-mariner-next-ghost-fleet-vessel-to-join-the-navy.
[31] Naval Technology, "Ghost Fleet Overlord Unmanned Surface Vessels."
[32] Australian Department of Defence, "Enhanced Lethality Surface Combatant Fleet: Independent Analysis of Navy's Surface Combatant Fleet," Government of Australia, 2024, 8, https://www.wa.gov.au/system/files/2024-08/enhanced_lethality_surface_combatant_fleet_web.pdf.
[33] Australian Department of Defence, "Enhanced Lethality Surface Combatant Fleet," 8–9.
[34] Australian Department of Defence, "Enhanced Lethality Surface Combatant Fleet," 8–9.
[35] Deutsche Marine, "German Navy Objectives."
[36] H.I. Sutton, "China Builds World's Largest Uncrewed Warship," Covert Shores, November 12, 2024, http://www.hisutton.com/Chinese-JARI-USV-A.html.

[37] Peter Suciu, "Forget Aircraft Carriers: China's Navy Has ORCA 'Drone' Combat Warships," The National Interest, November 13, 2024, https://nationalinterest.org/blog/buzz/forget-aircraft-carriers-chinas-navy-has-orca-drone-combat-warships-213696.
[38] Sutton, "China Builds World's Largest Uncrewed Warship."
[39] Sutton, "China Builds World's Largest Uncrewed Warship."
[40] Sutton, "China Builds World's Largest Uncrewed Warship."
[41] Ridzwan Rahmat, "Airshow China 2024: China Debuts 500 Tonne Unmanned Surface Vessel," JANES, November 12, 2024, https://www.janes.com/osint-insights/defence-news/security/airshow-china-2024-china-debuts-500-tonne-unmanned-surface-vessel.
[42] Sutton, "China Builds World's Largest Uncrewed Warship."
[43] Army Recognition, "China's JARI USV A Orca Unmanned Vessel with VLS Revealed at Zhuhai," November 12, 2024, https://armyrecognition.com/news/navy-news/2024/chinas-jari-usv-a-orca-unmanned-vessel-with-vls-revealed-at-zhuhai.
[44] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 10.
[45] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 10.
[46] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 10.
[47] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 10.
[48] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 11.
[49] Defense Advanced Research Projects Agency, "ACTUV: Anti-Submarine Warfare (ASW) Continuous Trail Uncrewed Vessel," 2024, https://www.darpa.mil/research/programs/anti-submarine-warfare.
[50] Julian Turner, "Sea Hunter: Inside the US Navy's Autonomous Submarine Tracking Vessel," Naval Technology, May 3, 2018, https://www.naval-technology.com/features/sea-hunter-inside-us-navys-autonomous-submarine-tracking-vessel/.
[51] H.I. Sutton, "Chinese-Sea-Hunter-USV-Update," Covert Shores, April 7, 2021, http://www.hisutton.com/Chinese-Sea-Hunter-USV-Update.html.
[52] Joseph Trevithick, "Navy's Sea Hunter Drone Ship is Getting a New Owner, New Abilities, and a Sister," The War Zone, June 30, 2019, https://www.twz.com/18264/navys-sea-hunter-drone-ship-is-getting-a-new-owner-new-abilities-and-a-sister.
[53] Sam LaGrone, "Navy Takes Delivery of Sea Hawk Unmanned Vessel," USNI News, April 8, 2021, https://news.usni.org/2021/04/08/navy-takes-delivery-of-sea-hawk-unmanned-vessel.
[54] Rudy Ruitenberg, "Dutch Navy to Buy Armed Sidekick Ships for Its Air-Defense Frigates," Defense News, September 25, 2024, https://www.defensenews.com/global/europe/2024/09/25/dutch-navy-to-buy-armed-sidekick-ships-for-its-air-defense-frigates/.
[55] Ruitenberg, "Dutch Navy to Buy Armed Sidekick Ships."
[56] Ruitenberg, "Dutch Navy to Buy Armed Sidekick Ships."
[57] Seaforces, "De Zeven Provinciën Class Guided Missile Frigate," 2024, https://www.seaforces.org/marint/Netherlands-Navy/Frigate/De-Zeven-Provincien-class.htm.
[58] Israel Aerospace Industries, "BARAK ER Extended Range Interceptor," 2024, https://www.iai.co.il/p/barak-er.
[59] Ruitenberg, "Dutch Navy to Buy Armed Sidekick Ships."
[60] Tayfun Ozberk, "China Unveils Next-Gen Attack USV 'Thunderer A2000' at WDS 2024," Naval News, February 8, 2024, https://www.navalnews.com/event-news/wds-2024/2024/02/china-unveils-next-gen-attack-usv-thunderer-a2000-at-wds-2024/.
[61] Ozberk, "China Unveils Next-Gen Attack USV 'Thunderer A2000.'"
[62] Peter Suciu, "China Is Building a Missile Carrying Unmanned Surface Vessel," The National Interest, May 13, 2024, https://nationalinterest.org/blog/buzz/china-building-missile-carrying-unmanned-surface-vessel-210995.
[63] Army Recognition, "DSA 2024: China Unveils New Thunder of Seas Named A2000 Thunderer USV," May 6, 2024, https://armyrecognition.com/news/navy-news/2024/dsa-2024-china-unveils-details-on-news-thunder-of-the-seas.
[64] Suciu, "China Is Building a Missile Carrying Unmanned Surface Vessel."
[65] Ozberk, "China Unveils Next-Gen Attack USV."
[66] Army Recognition, "DSA 2024."
[67] Suciu, "China Is Building a Missile Carrying Unmanned Surface Vessel."
[68] Army Recognition, "DSA 2024."
[69] H.I. Sutton, "China Builds World's First Dedicated Drone Carrier," Naval News, May 15, 2024, https://www.navalnews.com/naval-news/2024/05/china-builds-worlds-first-dedicated-drone-carrier/.
[70] Sutton, "China Builds World's First Dedicated Drone Carrier."

[71] Sutton, "China Builds World's First Dedicated Drone Carrier."
[72] Sutton, "China Builds World's First Dedicated Drone Carrier."
[73] Sutton, "China Builds World's First Dedicated Drone Carrier."
[74] Sutton, "China Builds World's First Dedicated Drone Carrier."
[75] Sutton, "China Builds World's First Dedicated Drone Carrier."
[76] Maya Carlin, "China's 'Drone' Aircraft Carrier: What You Need to Know and Why It Matters," The National Interest, May 20, 2024, https://nationalinterest.org/blog/buzz/chinas-drone-aircraft-carrier-what-you-need-know-and-why-it-matters-211085.
[77] Alexander Palmer, Henry H. Carroll, and Nicholas Velazquez, "Unpacking China's Naval Buildup," Centre for Strategic and International Studies, June 5, 2024, https://www.csis.org/analysis/unpacking-chinas-naval-buildup.
[78] Joseph Trevithick, "Long-Range Kamikaze Drones Offer 'Cheap' Strike Opportunities for U.S., Allies: USAF General," The War Zone, July 31, 2024, https://www.twz.com/air/long-range-kamikaze-drones-offer-cheap-strike-opportunities-for-u-s-allies-usaf-general.
[79] Sutton, "China Builds World's First Dedicated Drone Carrier."
[80] Sutton, "China Builds World's First Dedicated Drone Carrier."
[81] Jake Epstein, "Satellite Images Show Iran's New Drone Carrier Has Set Sail, Leaving Its Home Port for the First Time," Business Insider, December 5, 2024.
[82] Joe Saballa, "US Navy to Turn Pacific Oil Rigs into Mobile Military Bases to Counter China," The Defense Post, April 23, 2024, https://thedefensepost.com/2024/04/23/us-navy-mobile-bases/.
[83] H.I. Sutton, "Iran's First Carrier Expected to Be Launched in 2023," Covert Shores, December 30, 2022, http://www.hisutton.com/Iran-IRGC-Drone-Carrier-Update.html.
[84] Military Watch Magazine Editorial Staff, "A Look at Iran's First Ever Aircraft Carrier: Shahid Bagheri Promises to Expand Reach of Stealth Drone Fleet," Military Watch Magazine, August 21, 2024, https://militarywatchmagazine.com/article/iran-carrier-shahid-bagheri-drone.
[85] Defense Express, "Iran Completes Building Its First Drone Carrier Called Shahid Bagheri," August 23, 2024, https://en.defence-ua.com/news/iran_completes_building_its_first_drone_carrier_called_shahid_bagheri-11610.html.
[86] Epstein, "Satellite Images Show Iran's New Drone Carrier."
[87] Thomas Newdick, "Iran's Bizarre 'Aircraft Carrier' Seen in New Detail," The War Zone, August 21, 2024, https://www.twz.com/sea/irans-bizarre-aircraft-carrier-seen-in-new-detail.
[88] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[89] Sutton, "China Builds World's First Dedicated Drone Carrier."
[90] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[91] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[92] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[93] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[94] Newdick, "Iran's Bizarre 'Aircraft Carrier.'"
[95] Daniel Boffey, "Financial Toll on Ukraine of Downing Drones 'Vastly Exceeds Russian Costs,'" The Guardian, October 19, 2022, https://www.theguardian.com/world/2022/oct/19/financial-toll-ukraine-downing-drones-vastly-exceeds-russia-costs; Thomas Newdick, "Russia Bombards Ukraine with Iranian 'Kamikaze Drones,'" The War Zone, October 17, 2022, https://www.twz.com/russia-bombards-ukraine-with-iranian-kamikaze-drones; Chris Gordon, "Cheap UAVs Exact High Costs," Air & Space Forces Magazine, January 20, 2023, https://www.airandspaceforces.com/article/cheap-uavs-exact-high-costs/; Jeremy Binnie, "IRGC Confirms Specs for Shahed-136 Attack UAV," JANES, May 17, 2023, https://www.janes.com/osint-insights/defence-news/air/irgc-confirms-specs-for-shahed-136-attack-uav.
[96] Oliver Parken, "Iran Fires Ballistic Missile from a Shipping Container at Sea," The War Zone, February 14, 2024, https://www.twz.com/news-features/iran-fires-ballistic-missile-from-a-shipping-container-at-sea.
[97] H.I. Sutton, "Guide to Iran's Navy & IRGC's Drone Carriers, Forward Base Ships, and Covert Intelligence Ships," Covert Shores, December 14, 2024, http://www.hisutton.com/Iran-Navy-IRGC-Forward-Base-Ships.html.
[98] Army Recognition, "Turkish Navy Adopts TAI Aksungur UAV as Newest Surveillance Asset," December 18, 2023, https://armyrecognition.com/news/navy-news/2023/turkish-navy-adopts-tai-aksungur-uav-as-newest-surveillance-asset; Burak Ege Bekdil, "Turkey Selects Local Shipyard for LPD Contract," Defense News, December 29, 2013.
[99] Gokhan Ergocun, "Turkish Navy Receives Türkiye's Largest Warship TCG Anadolu," AA, April 10, 2023, https://www.aa.com.tr/en/turkiye/turkish-navy-receives-turkiyes-largest-warship-tcg-anadolu/2868488.

[100] University of Plymouth, “Turkey Signs Contract with NAVANTIA-SEDEF for the Construction of a Light Aircraft Carrier,” May 11, 2015, https://blogs.plymouth.ac.uk/dcss/2015/05/11/turkey-signs-contract-with-navantia-sedef-for-the-construction-of-a-light-aircraft-carrier/.
[101] SavunmaSanayiST, “TCG Anadolu Amphibious Assault Ship Entered the Inventory,” April 10, 2023; University of Plymouth, “Turkey Signs Contract.”
[102] Ergocun, “Turkish Navy Receives Türkiye’s Largest Warship.”
[103] Ergocun, “Turkish Navy Receives Türkiye’s Largest Warship.”
[104] Naval News Staff, “Turkish Roketsan Introduces New Antiship Missile Family ‘ÇAKIR,’” Naval News, March 31, 2022, https://www.navalnews.com/naval-news/2022/03/turkish-roketsan-introduces-new-antiship-missile-family-cakir/; SavunmaSanayiST, “National Penguin from TÜBİTAK-SAGE: KUZGUN-ER,” March 20, 2022, https://www.savunmasanayist.com/tubitak-sageden-milli-penguin-kuzgun-er/; Shephard Media, “IDEF 2021: ‘Turkish DARPA’ Targets Live Tests for Kuzgun,” August 19, 2021, https://www.shephardmedia.com/news/air-warfare/idef-2021-turkish-darpa-targets-live-tests-kuzgun/.
[105] Tayfun Ozberk, “Turkey Plans to Deploy Indigenous Aircraft ‘Hürjet’ on LHD Anadolu,” Naval News, April 20, 2021, https://www.navalnews.com/naval-news/2021/04/turkey-plans-to-deploy-indigenous-aircraft-hurjet-on-lhd-anadolu/.
[106] Ergocun, “Turkish Navy Receives Türkiye’s Largest Warship.”
[107] Michael Peck, “The US Navy Needs Drone Aircraft Carriers, Naval Analysts Argue,” Business Insider, January 25, 2025, https://www.businessinsider.com/us-navy-needs-drone-aircraft-carriers-rand-2025-1.
[108] John Grady, “Battles in the Black Sea Changing the Character of Naval Warfare, Experts Say,” USNI News, June 13, 2024, https://news.usni.org/2024/06/13/battles-in-the-black-sea-changing-the-character-of-naval-warfare-experts-say.
[109] Jon Hemler and Derek Bisaccio, “Ukraine’s USVs Write New Rules for Asymmetric Naval Warfare,” Defense and Security Monitor: Insights from Forecast International, June 13, 2024, https://dsm.forecastinternational.com/2024/06/13/ukraines-usvs-write-new-rules-for-asymmetric-naval-warfare/.
[110] Peter Ong, “Op-Ed: Is It Time for the U.S. Navy to Build the Drone Carrier Warship?,” Naval News, April 26, 2021, https://www.navalnews.com/naval-news/2021/04/op-ed-is-it-time-for-the-u-s-navy-to-build-the-drone-carrier-warship/.
[111] Thomas Newdick, “Ukraine Claims Its Drone Boats Are Now Launching Kamikaze FPV Drones at Russian Shore Targets,” The War Zone, January 7, 2025, https://www.twz.com/news-features/ukraine-claims-its-drone-boats-are-now-launching-kamikaze-fpv-drones-at-russian-shore-targets.
[112] Andrew Salerno-Garthwaite, “In De-Mining Efforts, RNLN Test First Uncrewed Surface Vessel,” Naval Technology, July 18, 2024, https://www.naval-technology.com/news/in-de-mining-efforts-rnln-test-first-uncrewed-surface-vessel/.
[113] Salerno-Garthwaite, “In De-Mining Efforts, RNLN Test First Uncrewed Surface Vessel.”
[114] Army Recognition, “AAD 2018: China’s CSOC Unveils ‘JARI’ Unmanned Surface Combatant - USV,” September 23, 2018, https://armyrecognition.com/news/navy-news/2018/aad-2018-china-s-csoc-unveils-jari-unmanned-surface-combatant-usv.
[115] Sutton, “China Builds World’s Largest Uncrewed Warship.”
[116] Suciu, “Forget Aircraft Carriers.”
[117] Suciu, “Forget Aircraft Carriers.”
[118] Weapon Systems, “ET-52,” WeaponSystems.net, 2024, https://weaponsystems.net/system/447-ET-52.
[119] Ares Shipyard and Meteksan Defence, “ULAQ,” 2024.
[120] Tayfun Ozberk, “Here Are the Four USV Programs Turkiye Is Working On,” Naval News, August 7, 2022, https://www.navalnews.com/naval-news/2022/08/here-are-the-four-usv-programs-turkiye-is-working-on/.
[121] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels,” October 26, 2022, https://www.oryxspioenkop.com/2022/10/meet-turkiyes-indigenous-unmanned.html.
[122] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[123] Roketsan, “Tactical Missile Weapon System,” 2024, https://www.roketsan.com.tr/uploads/docs/kataloglar/ENG/1628389274_tactiacal-missile-weapon-system.pdf.
[124] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[125] Burak Ege Bekdil, “Turkey Orders ULAQ Naval Drone from Shipyard Ares,” Defense News, January 5, 2023, https://www.defensenews.com/unmanned/2023/01/05/turkey-orders-ulaq-naval-drone-from-shipyard-ares/.
[126] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[127] Roketsan, “Anti-Submarine Warfare [ASW] Rocket and Launcher System,” 2024, https://www.roketsan.com.tr/en/products/anti-submarine-warfare-asw-rocket-and-launcher-system.

[128] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[129] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[130] Luca Peruzzi, “Dearsan Unveils Its New F 142 Frigate Concept and USV 15 Models,” European Defence Review Magazine Online, March 28, 2022, https://www.edrmagazine.eu/dearsan-unveils-its-new-f-142-frigate-concept-and-usv-15-models.
[131] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[132] Dearsan Shipyard, “Unmanned Surface Vehicle,” 2025, https://www.dearsan.com/en/products/naval-vessels/unmanned-surface-vehicle.
[133] Peruzzi, “Dearsan Unveils Its New F 142 Frigate Concept and USV 15 Models.”
[134] Dearsan Shipyard, “DEARSAN USV (Unmanned Surface Vehicle) Has Been Launched,” 2025, https://www.dearsan.com/en/news/dearsan-usv-unmanned-surface-vehicle-has-been-launched-.
[135] Railly News, “A New Power Is Coming to the Blue Homeland Defense: SANCAR SİDA,” June 7, 2022, https://raillynews.com/2022/06/mavi-vatan-savunmasina-yeni-guc-geliyor-sancar-sida/.
[136] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[137] Oryx, “Meet Türkiye’s Indigenous Uncrewed Surface Vessels.”
[138] Ashish Dangwal, “Devastating! Ukraine’s Satellite-Controlled ‘Drone-Launched Drone’ Emerges Big Threat to Russian Navy,” The EurAsian Times, January 25, 2025, https://www.eurasiantimes.com/devastating-ukraines-satellite-controlled-drone-launched-drone-emerges-big-threat-to-russian-navy/.
[139] Michal Baranowski, “Ukraine’s Path Forward: Clearing Away the ‘Gloom and Doom’ Scenarios,” The German Marshall Fund of the United States, February 23, 2024, https://www.gmfus.org/news/ukraines-path-forward-clearing-away-gloom-and-doom-scenarios.
[140] Ulrike Franke, “Drones in Ukraine: Four Lessons for the West,” European Council on Foreign Relations, January 10, 2025, https://ecfr.eu/article/drones-in-ukraine-four-lessons-for-the-west/.
[141] H.I. Sutton, “Ukraine’s Maritime Drones (USV) What You Need to Know,” Covert Shores, November 11, 2022, http://www.hisutton.com/Ukraine-Maritime-Drones.html.
[142] David Kirichenko, “Ukraine’s Innovative Drone Industry Helps Counter Putin’s War Machine,” Atlantic Council UkraineAlert, June 26, 2024, https://www.atlanticcouncil.org/blogs/ukrainealert/ukraines-innovative-drone-industry-helps-counter-putins-war-machine/.
[143] Simon Shuster, “The Drone Wars: How Ukraine Beat Russia in the Battle of the Black Sea,” *Time*, August 26, 2024, https://time.com/7013531/sea-drones-how-ukraine-beat-russia-in-the-black-sea/.
[144] Ralf Bosen, “German Military: Strangled by Bureaucracy,” DW, July 6, 2022, https://www.dw.com/en/germanys-military-upgrade-hampered-by-bureaucracy/a-62046032.
[145] Kateryna Bondar, “How Ukraine Rebuilt Its Military Acquisition System Around Commercial Technology,” Centre for Strategic and International Studies, January 13, 2025, https://www.csis.org/analysis/how-ukraine-rebuilt-its-military-acquisition-system-around-commercial-technology.
[146] David Pugliese, “First Submarine in New Canadian Fleet Won’t Be Operational Until 2037, Navy Confirms,” *Ottawa Citizen*, September 23, 2024, https://ottawacitizen.com/news/national/defence-watch/first-submarine-in-new-canadian-fleet-wont-be-operational-until-2037-navy-confirms.
[147] “Helmuth von Moltke 1800–91 Prussian Military Commander,” Oxford Reference, 2025, https://www.oxfordreference.com/display/10.1093/acref/9780191826719.001.0001/q-oro-ed4-00007547.
[148] Michael T. Hackett and John A. Nagl, “A Long, Hard Year: Russia-Ukraine War Lessons Learned 2023,” *US Army War College Quarterly: Parameters* 54, no. 3 (August 29, 2024), https://press.armywarcollege.edu/parameters/vol54/iss3/6/.
[149] Shuster, “The Drone Wars.”
[150] “Canada’s Defence and Security Industry,” The Senate of Canada, 2018, https://sencanada.ca/content/sen/committee/421/AEFA/Briefs/2018-11-28_Brief_CADSI_e.pdf.
[151] 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.
[152] Naval News, “Ukraine’s Kamikaze Drone Magura v5 in Details,” September 14, 2024.
[153] Naval News, “Ukraine’s Kamikaze Drone.”
[154] H.I. Sutton, “Ukrainian Magura USV Armed with R-73/AA-11 ARCHER FrankenSAM,” Covert Shores, May 6, 2024, http://www.hisutton.com/Ukraine-USV-FrankenSAM.html.
[155] Armed Forces of Ukraine, “Ukraine Reveals Details about Naval Strike Aircraft,” November 11, 2022.
[156] 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.

[157] H.I. Sutton, “Suspected Ukrainian Explosive Sea Drone Made from Recreational Watercraft Parts,” USNI News, October 11, 2022, https://news.usni.org/2022/10/11/suspected-ukrainian-explosive-sea-drone-made-from-jet-ski-parts.
[158] Sutton, “Suspected Ukrainian Explosive Sea Drone.”
[159] H.I. Sutton, “Overview of Maritime Drones (USVs) of the Russo-Ukrainian War, 2022-24,” Covert Shores, December 20, 2024, http://www.hisutton.com/Russia-Ukraine-USVs-2024.html.
[160] Danylo Kramarenko, Daria Shekina, and Volodymyr Zablotskyi, “Magura vs. Sea Baby: Closer Look at Ukrainian Drone Warfare Against Russian Ships,” RBC-Ukraine, March 7, 2024, https://newsukraine.rbc.ua/news/magura-vs-sea-baby-closer-look-at-ukrainian-1709831518.html; Army Recognition, “Ukrainian Military Intelligence SBU Unveils New Drone USV Mamai,” December 28, 2023, https://armyrecognition.com/news/navy-news/2023/ukrainian-military-intelligence-sbu-unveils-new-drone-usv-mamai.
[161] Sutton, “Overview of Maritime Drones.”
[162] Sutton, “Overview of Maritime Drones.”
[163] Sutton, “Overview of Maritime Drones.”
[164] 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/.
[165] Sutton, “Overview of Maritime Drones.”
[166] Combined Fleet, “IJN Shinyo Types 1 and 5 Explosive Motorboats,” 2024, http://www.combinedfleet.com/shinyo_c.htm.
[167] Sutton, “Overview of Maritime Drones.”
[168] Sutton, “Overview of Maritime Drones.”
[169] Sutton, “Overview of Maritime Drones.”
[170] Armed Forces of Ukraine, “Ukraine Unveils Stalker 5.0 Naval Drone with Kamikaze Capability,” June 16, 2024, https://mil.in.ua/en/news/ukraine-unveils-stalker-5-0-naval-drone-with-kamikaze-capability/.
[171] Armed Forces of Ukraine, “Ukraine Unveils Stalker.”
[172] Armed Forces of Ukraine, “Ukraine Unveils Stalker.”
[173] Armed Forces of Ukraine, “Ukraine Unveils Stalker.”
[174] Sutton, “Overview of Maritime Drones.”
[175] Sutton, “Overview of Maritime Drones.”
[176] Sutton, “Overview of Maritime Drones.”
[177] Sea Technology, “Silver Ships AM800 RHIBs for US Navy,” June 23, 2023, https://sea-technology.com/silver-ships-navy-contract-am800-rhib.
[178] Sutton, “Overview of Maritime Drones.”
[179] Yamaha Wave Runners, “Luxury Series 2025 FX SERIES,” 2025, https://www.yamahawaverunners.com/waverunner/series/luxury/.
[180] Business Alabama, “Silver Ships Awarded Its Largest Contract Ever,” June 15, 2023, https://businessalabama.com/silver-ships-awarded-its-largest-contract-ever/.
[181] Defence Turkey, “For the First Time in the World, a Swarm Attack Concept Was Carried out in a Joint USV-UAV Operation!,” October 9, 2023, https://www.defenceturkey.com/en/content/for-the-first-time-in-the-world-a-swarm-attack-concept-was-carried-out-in-a-joint-usv-uav-operation-5716.
[182] Defence Turkey, “For the First Time.”
[183] Defence Turkey, “For the First Time.”
[184] Aselsan, “ALBATROS S Uncrewed Surface Vessel Swarm,” 2024, https://wwwcdn.aselsan.com/api/file/ALBATROS-S_ENG.pdf.
[185] Aselsan, “MIR Uncrewed Surface Vessel,” 2024.
[186] Aselsan, “MIR Uncrewed Surface Vessel.”
[187]Army Recognition, “Did Ukraine’s Magura V5 Inspire Russia’s New Murena 300 S Unmanned Surface Vessel?,” August 16, 2024, https://armyrecognition.com/news/navy-news/2024/did-ukraines-magura-v5-inspire-russias-new-murena-300-s-unmanned-surface-vessel.
[188] Sutton, “Overview of Maritime Drones.”
[189] Sutton, “Overview of Maritime Drones.”
[190] Sutton, “Overview of Maritime Drones.”
[191] Ukraine Armed Forces, “Strike Naval Drones in the War Against Russia,” June 20, 2023, https://mil.in.ua/en/articles/strike-naval-drones-in-the-war-against-russia/.
[192] Sutton, “Overview of Maritime Drones.”

[193] Sutton, "Overview of Maritime Drones."
[194] Sutton, "Overview of Maritime Drones."
[195] Army Recognition, "Russia Delivers First Kamikaze Naval Drone BBKN Dandelion for Deployment in Ukraine," December 15, 2023, https://armyrecognition.com/news/navy-news/2023/russia-delivers-first-kamikaze-naval-drone-bbkn-dandelion-for-deployment-in-ukraine.
[196] Army Recognition, "Russia Delivers First Kamikaze Naval Drone."
[197] H.I. Sutton, "China Reveals Another New Armed XLUUV: UUV-300," Covert Shores, May 9, 2024, http://www.hisutton.com/China-UUV-300.html.
[198] L3Harris, "A Major Milestone in Unmanned Systems Technology: The Delivery of Lithium-Ion Batteries for Submarine Use," November 12, 2024, https://www.l3harris.com/newsroom/editorial/2024/11/major-milestone-unmanned-systems-technology-delivery-lithium-ion.
[199] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 12.
[200] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 12.
[201] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 12.
[202] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 12.
[203] Richard R. Burgess, "Navy's Orca XLUUV to Have Mine-Laying Mission, Adm. Kilby Says," Seapower, March 18, 2021, https://seapowermagazine.org/navys-orca-xluuv-to-have-mine-laying-mission/; Richard R. Burgess, "Navy's Orca XLUUV Will Carry 34-Foot Payload Module for Mine Laying," Seapower, May 26, 2022, https://seapowermagazine.org/navys-orca-xluuv-will-carry-34-foot-payload-module-for-mine-laying/.
[204] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 13.
[205] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 15.
[206] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 15.
[207] Boeing, "Echo Voyager Extra Large Uncrewed Undersea Vehicle," 2017, https://www.boeing.com/content/dam/boeing/boeingdotcom/defense/autonomous-systems/echo-voyager/echo_voyager_product_sheet.pdf.
[208] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 15.
[209] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 15.
[210] Congressional Research Service, "Navy Large Unmanned Surface and Undersea Vehicles," 15.
[211] Boeing, "Echo Voyager Extra Large Uncrewed Undersea Vehicle."
[212] Boeing, "Echo Voyager Extra Large Uncrewed Undersea Vehicle."
[213] H.I. Sutton, "China Reveals New Heavily Armed Extra-Large Uncrewed Submarine," Naval News, February 23, 2023, https://www.navalnews.com/event-news/navdex-2023/2023/02/china-reveals-new-heavily-armed-extra-large-uncrewed-submarine/.
[214] Sutton, "China Reveals Another New Armed XLUUV."
[215] Sutton, "China Reveals Another New Armed XLUUV."
[216] Sutton, "China Reveals Another New Armed XLUUV."
[217] Sutton, "China Reveals Another New Armed XLUUV."
[218] Tayfun Ozberk, "DSA 2024: New Torpedo-Launching UUV from China," Naval News, May 7, 2024, https://www.navalnews.com/naval-news/2024/05/dsa-2024-new-torpedo-launching-uuv-from-china/.
[219] Ozberk, "DSA 2024."
[220] Ozberk, "DSA 2024."
[221] Ozberk, "DSA 2024."
[222] Ozberk, "DSA 2024."
[223] Centre for Joint Warfare Studies, "Chinese Autonomous Underwater Vehicle: HSU-001," 2019, https://cenjows.in/wp-content/uploads/2022/05/Chinese-Autonomous-Underwater-Vehicles-HSU-001-09-Oct-2019.pdf.
[224] H.I. Sutton, "Chinese LDUUV," Covert Shores, October 2, 2019, http://www.hisutton.com/Chinese_LDUUV.html.
[225] Sutton, "Chinese LDUUV."
[226] Sutton, "Chinese LDUUV."
[227] China's 163 Domain, "Uncrewed Underwater Vehicles: China's Newest Recruit," February 1, 2021.
[228] Silky Kaur, "One Nuclear-Armed Poseidon Torpedo Could Decimate a Coastal City. Russia Wants 30 of Them," Bulletin of the Atomic Scientists, June 14, 2023, https://thebulletin.org/2023/06/one-nuclear-armed-poseidon-torpedo-could-decimate-a-coastal-city-russia-wants-30-of-them/.
[229] Kaur, "One Nuclear-Armed Poseidon Torpedo Could Decimate a Coastal City."

[230] H.I. Sutton, “Poseidon Torpedo,” Covert Shores, February 22, 2019, http://www.hisutton.com/Poseidon_Torpedo.html.
[231] H.I. Sutton, “Poseidon Demystified,” Covert Shores, January 21, 2019, http://www.hisutton.com/Poseidon_demystified.html.
[232] Sutton, “Poseidon Demystified.”
[233] Sutton, “Poseidon Demystified.”
[234] TASS Russian News Agency, “Russian Navy to Get Poseidon Nuclear Underwater Drones by 2027 - Source,” May 12, 2018, https://tass.com/defense/1003964.
[235] H.I. Sutton, “Analysis - Russian Status-6 Aka KANYON Nuclear Deterrence and Pr 09851 Submarine,” Covert Shores, December 19, 2016, http://www.hisutton.com/Analysis%20-%20Russian%20Status-6%20aka%20KANYON%20nuclear%20deterrence%20and%20Pr%2009851%20submarine.html.
[236] TASS Russian News Agency, “First Batch of Nuclear-Armed Drones Poseidon Manufactured for Special-Purpose Sub Belgorod,” January 15, 2023, https://tass.com/emergencies/1562553.
[237] TASS Russian News Agency, “First Batch of Nuclear-Armed Drones.”
[238] United States Army Training and Doctrine Command, “Poseidon Class (Kanyon Class) Russian Uncrewed Underwater Vehicle,” 2024.
[239] United States Army Training and Doctrine Command, “Poseidon Class (Kanyon Class) Russian Uncrewed Underwater Vehicle.”
[240] Heather Williams, “Russia Suspends New START and Increases Nuclear Risks,” Centre for Strategic and International Studies, February 23, 2023, https://www.csis.org/analysis/russia-suspends-new-start-and-increases-nuclear-risks.
[241] Sutton, “Poseidon Demystified.”
[242] Sutton, “Poseidon Torpedo.”
[243] H.I. Sutton, “Cephalopod,” Covert Shores, July 27, 2018, http://www.hisutton.com/Cephalopod.html.
[244] Sutton, “Cephalopod.”
[245] Sutton, “Cephalopod.”
[246] H.I. Sutton, “Ru Garmoniya-GID AUV,” Covert Shores, September 12, 2019, http://www.hisutton.com/Ru_Garmoniya-GID_AUV.html.
[247] H.I. Sutton, “Nerpa Armed-UUV,” Covert Shores, August 25, 2018, http://www.hisutton.com/Nerpa_Armed-UUV.html.
[248] Sutton, “Nerpa Armed-UUV.”
[249] Overt Defense, “Russia Unveils the NERPA Armed Unmanned Underwater Vehicle,” OVD, August 22, 2018, https://www.overtdefense.com/2018/08/22/russia-unveils-the-nerpa-armed-unmanned-underwater-vehicle/.
[250] Tayfun Ozberk, “Ukraine’s New Underwater Drone Marichka Breaks Cover,” Naval News, August 23, 2023, https://www.navalnews.com/naval-news/2023/08/ukraines-new-underwater-drone-marichka-breaks-cover/.
[251] Мисягін, “Testing of the Underwater Drone ‘Marichka,’” August 22, 2023.
[252] Мисягін, “Testing of the Underwater Drone ‘Marichka.’”
[253] H.I. Sutton, “Ukraine’s Marichka Underwater Drone (AUV),” Covert Shores, August 23, 2023, http://www.hisutton.com/Ukraine-Marichka-AUV.html.
[254] Sutton, “Ukraine’s Marichka Underwater Drone.”
[255] A.M.M.O. UKRAINE, “Marichka,” 2025.
[256] H.I. Sutton, “World Survey of Underwater Attack Drones (OWA-AUVs),” Covert Shores, January 3, 2024, http://www.hisutton.com/Guide-To-Underwater-Attack-Drones.html.
[257] H.I. Sutton, “First Details of Hamas’ New Submarine Drone Weapon,” Naval News, November 1, 2023, https://www.navalnews.com/naval-news/2023/11/first-details-of-hamas-new-submarine-drone-weapon/.
[258] Sutton, “First Details of Hamas.”
[259] Oryx, “Attack on Europe: Documenting Russian Equipment Losses During the Russian Invasion of Ukraine,” February 24, 2022, https://www.oryxspioenkop.com/2022/02/attack-on-europe-documenting-equipment.html.
[260] Oryx, “Attack on Europe.”
[261] Encyclopaedia Britannica, “Second World War in Royal Canadian Navy,” January 31, 2025, https://www.britannica.com/topic/Royal-Canadian-Navy/Second-World-War.
[262] Encyclopaedia Britannica, “Second World War.”