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A War of Attrition

Assessing the Impact of Equipment Shortages on Russian Military Operations in Ukraine

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A Report of the CSIS Europe, Russia, and Eurasia Program

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Contents

Executive Summary

This report examines the impact of Russia's growing military equipment and ammunition shortages on the Kremlin's ability to prosecute the war in Ukraine and to carry out operations in other areas. In doing so, it focuses on availability of artillery ammunition,[1] as well as five weapons categories of central importance for Russia's ability to sustain operations: tanks, artillery, uncrewed aerial vehicles, electronic warfare systems, and long-range precision strike weapons. For each category, the report examines how the size and composition of Russian weapons portfolios in Ukraine are changing under the twin influences of attrition and sanctions, while taking account of Russian efforts to increase defense production and otherwise replenish its forces. It concludes by assessing the impact of Russia's declining weapons portfolios in Ukraine on its ability to carry out future operations against Kyiv, as well as in other regions of interest such as Central Asia, the Middle East and North Africa, and the Caucasus.

The report finds that the magnitude of Russian equipment losses and ammunition usage in Ukraine is having a major negative effect on the Kremlin's ability to prosecute the war. In each of the five categories, Russian defense production is struggling to keep pace with its growing losses on the battlefield due to sanctions and capacity limitations, although they have been offset to some extent by various stopgap measures. The resulting decline in the size and quality of Russian weapons portfolio in Ukraine are further undermining Russia's ability to sustain operations. Growing signs of an impending ammunition shortage are particularly problematic since Russian forces in Ukraine rely so heavily on artillery to sustain operations. By contrast, the Ukrainian military has been able to rely on a steady influx of Western military equipment to replenish its forces and preserve its combat power.

Resulting shifts in the balance of forces are creating a window of opportunity for Ukraine to renew its counteroffensive and recover additional territory. It is not clear, however, whether conditions are ripe enough yet for Kyiv to make enough gains to decisively seize the initiative and escape the current cycle of attrition

altogether. So far, equipment and ammunition shortages have tended to undermine Russia's offensive capabilities more than they have its defensive capabilities. Moreover, the Kremlin is making a concerted effort to mobilize defense production. Given its enormous prewar equipment stockpiles, remaining defense production capabilities, and continuing support from countries still willing to do business with Russia, the Kremlin likely still retains the capacity to reverse recent declines in its weapons portfolio and replenish its forces in Ukraine at levels sufficient to continue the war effort, albeit with some limitations. However, the prolonged invasion coupled with heavy manpower and equipment losses will likely limit Moscow's ability to engage in high-intensity conventional military operations in other areas, at least in the near future.

This report, which was drafted in May 2023, is the second report in a series exploring Russia's defense industry under the allied sanctions and export controls. The first report examined the impact of sanctions on the Kremlin's ability to manufacture and sustain advanced weapons systems without direct access to higher-end Western components.[2]

Introduction

Russia's armed forces entered the war in Ukraine with formidable advantages in military equipment and technology over the Armed Forces of Ukraine (AFU). On paper at least, the Russian military was particularly well equipped for the task, with ample armor, artillery, and precision strike weapons, as well as an impressive array of combat support systems, including uncrewed aerial vehicles (UAVs) and electronic warfare (EW). During the initial invasion, however, Russian forces significantly underperformed while their ambitious multi-axis strategy intended to rapidly dislocate Ukrainian forces, seize major cities in the east, surround Kyiv, and install a pro-Kremlin regime quickly faltered, leaving Moscow embroiled in a long and brutal war of attrition centered primarily on southeastern Ukraine but encompassing missile strikes across the country. After more than a year of high-intensity combat, Russian forces in Ukraine have incurred enormous losses in troops and matériel and have been significantly attrited.

The Kremlin is urgently seeking to replace its equipment losses by mobilizing its defense base and ramping up production. Russian leaders are also pursuing a variety of stopgap measures, withdrawing Soviet-era equipment from storage, and purchasing matériel from Iran and North Korea.[3] Thus far, however, such measures have fallen short of what is needed to replenish Russia's equipment stocks. Consequently, Russian forces in Ukraine are now trapped in a cycle of attrition and are facing shortages of equipment and ammunition, at least over the near term.

This report assesses the extent to which Moscow's growing equipment and ammunition shortages from sustained attrition are affecting its ability to prosecute the war in Ukraine, as well as conduct military operations in other areas. It starts by examining the extent to which Russian losses are changing the composition of its forces in Ukraine—and their weapons portfolios—while also taking account of Russian efforts to replace those losses. These findings are then used to assess how reductions in the size, quality, and composition of Russian equipment stocks are affecting the military's ability to prosecute the war in Ukraine

and conduct potential future operations in other regions of interest, including Central Asia, the Middle East and North Africa, and the South Caucasus.

After more than a year of war, the magnitude of Russia's equipment losses in Ukraine is hurting its ability to prosecute the war. Growing artillery ammunition shortages, in particular, are casting doubt on coming operations. Defense production rates are failing to keep pace with losses on the battlefield. Moscow is attempting to boost production, but such efforts are being undermined by Western sanctions and enduring capacity constraints. Efforts at import substitution are facing difficulties as well due to the country's enduring technological deficiencies and its lack of access to advanced machine tools. Stopgap measures (e.g., fielding legacy tanks taken from storage) are undermining the quality of Russian equipment in Ukraine. While Russian leaders continue to struggle with reconstituting their forces, military commanders on the ground are having to make do with a significantly degraded fighting force.

The resulting equipment and ammunition shortages are clearly undermining Russia's ability to sustain operations in Ukraine. However, the impact is uneven, affecting some capabilities more than others. Thus far, they have tended to undermine Russia's offensive capabilities more than they have its defensive capabilities. Unusually high tank losses have further reduced the military's ability to maneuver. Russian artillery losses and growing ammunition shortages have the potential to be even more consequential, as this could substantially undercut Russia's ability to sustain mass fires during coming operations. By contrast, Moscow has thus far been able to maintain a relatively high tempo of drone and EW operations despite substantial losses since it has been able to tap into external sources in the first case and to maintain adequate inventories in the second. Moscow has also been able to sustain its long-range precision strike campaign despite having drawn down its initial missile stocks by shifting to a lower-cost and more sustainable mix of missiles and one-way attack drones. It is important to remember, however, that each weapons category is to some extent dependent on the others, such that degrading capability in one area can also affect others. This is the case with Russian drone losses, which provide essential targeting data for Russian artillery. On the other hand, maintaining strength in one area can often help compensate for weaknesses in other areas. Russian advantages in artillery have been used to compensate for deficiencies in Russian maneuver units, for example.

It is important to remember, however, that each weapons category is to some extent dependent on the others, such that degrading capability in one area can also affect others.

Collectively, Russia's growing losses in troops and matériel have left it increasingly vulnerable to a potential AFU counteroffensive. However, it is unclear how long this situation will endure. As the first report in this series noted:

> Available evidence indicates that the Kremlin will still be able to maintain its war efforts in Ukraine. Sanctions and export controls are not a silver bullet that will force Russia to bring the war to an end. Russia's large prewar equipment stockpiles, its massive military industrial complex, and the prioritization of defense production . . . as part of Moscow's wartime mobilization are likely to enable the Kremlin to continue to wage war in Ukraine, albeit with limitations.[4]

Over time, therefore, Russian leaders are likely to find ways to reconstitute their forces, as discussed further below. In the meantime, despite heavy losses, the Russian military still has significant troops and equipment in Ukraine that it can call upon to defend its gains. Thus, it is not clear how long this window will remain open and whether conditions are ripe enough yet for Ukraine to break the cycle of its attrition.

This report will examine these issues in greater detail, focusing on the evolving state of Russian equipment inventories in five key weapons categories: main battle tanks (MBTs), artillery, UAVs, EW, and theater precision strike weapons. The report will commence by examining changes in inventory levels for each weapons category due to attrition and the resulting impact on the size, quality, and character of the force, taking account of Russian efforts at replenishment. These findings are then used to gauge the impact of resulting shortages on Russia's ability to prosecute the war in Ukraine. Next, the report will examine the broader implications of Russian ammunition and equipment shortages on the military's ability to conduct operations in other areas, including Central Asia (the case of Kazakhstan), the Middle East and North Africa (the case of Syria), and the Caucasus (the case of Georgia). The report concludes with a summary of its key findings, followed by recommendations for policymakers to help prioritize future equipment transfers for Ukraine and refine sanctions efforts in ways that will help shift the balance of forces more in Ukraine's favor.

Impact of Shortages on Principal Weapons Categories

Main Battle Tanks

CHANGES IN FORCE POSTURE

Maneuver warfare has long been a pillar of Russia's way of war, with Russian tank groupings playing a central role in such operations. On paper at least, Russia's tank and motorized infantry units are particularly well equipped for the mission with large numbers of tanks and other armored vehicles, as well as organic artillery. During the initial invasion, however, Russia's attempts at armored maneuver warfare were largely unsuccessful, except in the south. Instead, Ukrainian forces were able to make effective use of an array of anti-tank and related weapons to exact a heavy toll on Russian tanks and armored vehicles, while helping blunt Russia's offensive.[5] Since then, Russian tank losses have continued to mount, leading military commanders to adjust their tactics and use tanks in different roles, but with mixed results.

Russia entered the war in Ukraine with a frontline force of around 2,927 main battle tanks according to the *Military Balance 2022*.[6] This was comprised of a combination of Russian frontline tanks, including approximately 2,030 T-72s, 480 T-80s, and 417 T-90s of various kinds.[7] Russian tanks in Ukraine are based on Soviet-era designs that have been incrementally upgraded over the last thirty years. The most advanced models employed by Russia during the initial invasion included the T-72B3M, T-90M, and T-80BVM; however, Russia's invasion force also included many earlier versions as well.[8]

By February 2023, Russia had lost at least 1,900 MBTs according to Oryx (abandoned, captured, or destroyed)—around two-thirds of its original total.[9] Since Oryx only reports on tank losses that it is able to verify, Russia's actual tank losses likely exceed this amount by a significant margin. This means at a minimum Russia has been losing, on average, around 150 tanks per month. According to anecdotal evidence provided by Ukrainian colleagues from CACDS consulted for this report, the shortage of tanks and armored vehicles in

some Russian ground force units is reaching upwards of 60–70 percent.[10]

While Russia's actual tank production capacity is a matter of significant debate, thus far, Russian tank factories are falling well short of producing enough tanks to replace its losses in Ukraine. In recent years, Russian tank factories were able to produce on average around 250 new and modernized T-72B3, T-80BVM, and T-90M main battle tanks each year.[11] In December 2022, Russian minister of defense Sergei Shoigu reported that the defense industry had achieved a 30 percent increase in production of basic weapons over the previous year. Assuming this also applies to main battle tanks, that would bring annual production up to 325 tanks per year.[12] According to another recent report, Russia can likely restore another 600 old Soviet-era tanks taken from storage per year. Even when these two figures are added, the total still falls well short of the 1,900 tanks needed to replace its losses in Ukraine.[13]

Although Russia's tank industry is striving to increase production, it currently lacks the capacity to produce enough new or upgraded tanks to replace its losses. It will take months and in many cases years to add new plants and equipment, hire skilled workers, and establish supply chains. Moreover, expanding capacity is likely to be complicated to some extent by loss of access to high-end Western machine tools currently blocked by sanctions, even though Russia is finding ways to maintain access to some Western machinery in spite of sanctions.[14]

Sanctions are complicating Russian tank production in other ways, as well. As mentioned in the first report in this series, in some cases, Russian tanks are being delivered without some of their most advanced subsystems, such as the SOSNA-U targeting system, which relies on a French thermal imager. Imports of these components are now banned due to sanctions, leading Russia to install less capable legacy gun sights on replacement tanks.[15] Sanctions are likely to further complicate Russian defense production given the continuing presence of Western components and electronics in Russian MBTs.[16] Shifting to import substitution or finding workable replacements will be difficult and will likely drive up costs and/or lead to reductions in quality.

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In light of such production problems, starting in May 2022, Russia began pulling older Soviet-era tanks out of storage, refurbishing them, and sending them to Ukraine. These include various legacy models, such as the T-62, T-55, and T-54, the latter first introduced in the 1950s.[17] Most of these tanks have subpar capabilities, which will reduce their effectiveness on the modern battlefield. Yet, as noted above, Russian forces are only projected to receive around 600 of these refurbished Soviet-era tanks per year. Moreover, sustaining even this total may prove challenging for Russia, since those tanks remaining in storage will likely require even more extensive refurbishment. Yet, even when combined with the 240–325 additional tanks currently produced

each year by Uralvagonzavod, the monthly total of around 80–90 tanks per month still falls well short of the 150 tanks needed to replace its losses.[18] It should be noted, however, that Moscow appears to be holding several hundred of its most advanced T-90 tanks in reserve, possibly to support a future NATO contingency, and could potentially draw upon these if needed in Ukraine.[19]

Overall, the Russian defense industry is likely to eventually find ways to increase tank production, including drawing upon thousands of older tanks in storage to sustain its forces, although the remaining tanks will likely require more extensive refurbishment. Yet, over the near term at least, Russian forces will continue to face shortages and will have to make do with a markedly diminished tank force, one with substantially fewer tanks and declining quality levels as the proportion of legacy tanks taken from storage increases.

OPERATIONAL IMPACT

At the tactical level, the decline in the quality of Russian tanks used in Ukraine has reduced their effectiveness to some extent.[20] Without the SOSNA-U targeting system, for example, Russian tanks are facing greater difficulties in detecting and targeting Ukrainian forces at long range, especially at night. As a result, these tanks have lost their first fire advantage, leaving them vulnerable to strikes by Ukrainian forces who spot them first. Likewise, Russia's thin-skinned legacy tanks, such as the T-62, which the Russians have been fielding in Ukraine, have less than half the frontal armor protection of today's main battle tanks and their turret roof armor is especially thin, leaving them even more susceptible to Ukrainian anti-tank weapons ranging from rocket-propelled grenades to artillery.[21] Moreover, the legacy guns on older Russian tanks will be less able to penetrate thicker armor on the latest Western tanks used by Ukraine.[22]

At the tactical-operational level, reductions in the size and quality of Russia's tank forces in Ukraine are having a more pronounced effect on Russia's ability to prosecute the war. For one, Russia's ability to conduct armored maneuver warfare has been markedly diminished by the reductions (along with Russian troop losses, shortages of artillery ammunition, and other factors). That said, Russian forces have struggled with combined arms maneuver even when they had a full complement of their best frontline tanks, indicating more fundamental failings in operational planning, training, and leadership. At the outset of the campaign, Russian attempts to defeat Ukraine in a lightning campaign using concentrated armor were largely unsuccessful (except in the south). Although they made advances in some areas, they also incurred heavy tank losses from Ukrainian units supported by a dense network of artillery and anti-tank weapons.[23]

A Russian tank destroyed by Ukrainian forces in Luhansk Oblast on February 26, 2022.

Photo: ANATOLII STEPANOV/AFP via Getty Images

As the campaign progressed, and as tank and personnel losses mounted, Russian forces have had even less success with armored maneuver warfare, even on a smaller scale. For example, during the Donbas campaign in April–May 2022, Russian forces attempted to break through AFU lines around Izyum with

the apparent objective of enveloping Ukrainian forces in the Donbas. Ultimately, they incurred heavy tank losses while making only limited gains.[24] Once the campaign transitioned to a war of attrition, Russia's ability to maneuver declined even further, though troop shortages, poor training, and tactical deficiencies have also played a role.[25] Given the diminished size and quality of Russia's tank force, persistent tactical deficiencies, and the heavy attrition incurred by the force as a whole, Russia's ability to conduct armored maneuver is likely to remain limited until it can replenish its forces and improve combat proficiency, condemning Russia for now to an attrition strategy.

On the other hand, Russian armor has retained the ability to operate effectively when used with infantry in an assault role. Russian ground forces enjoyed local tactical successes when using tanks in this manner, as demonstrated during the grinding, large-scale Russian offensives carried out in the Donbas in mid-2022 and more recently in Bakhmut.[26] Under this approach, concentrated Russian infantry backed by tanks, armored vehicles, and massed artillery have had success at times in conducting sustained frontal assaults against entrenched Ukrainian forces. In some cases, tanks were used in combination with infantry to conduct armored assaults on AFU defensive positions, while in others they were used in a standoff role to provide mobile fire support.[27] In several cases, Russian forces were able to make steady incremental gains over time by wearing down Ukrainian defenders, exploiting weak points within their front lines and compelling them to retreat.

It is worth noting that for operations such as this, reductions in the quality of Russian tank forces are less important, so long as a sufficient number of tanks are available to support the operation. Moreover, even legacy Soviet-era tanks will generally suffice for such assaults since mobility, firepower, and protection are what matter most in such cases. Nevertheless, the Russian army has incurred serious tank losses during such operations, and they were not always successful.[28] Given the continuing high attrition rates experienced during such operations, the ability and willingness of Russian commanders to undertake them is likely to diminish as well, at least over the near term.[29] According to recent testimony by U.S. intelligence officials, Russian forces will be increasingly challenged to conduct even modest offensive operations absent further mobilization and additional ammunition supplies.[30]

Artillery and Ammunition

CHANGES IN FORCE POSTURE

Artillery has traditionally held a central place in Russian military doctrine. Russian maneuver brigades and dedicated artillery and rocket brigades are particularly well equipped with towed and self-propelled artillery and multiple launch rocket systems (MLRS). Russian forces in Ukraine have relied heavily on their artillery and MLRS to support offensive and defensive operations and to degrade Ukrainian forces.

As the war has progressed, however, Russian artillery losses have continued to mount while ammunition stockpiles have exhibited growing signs of depletion due to exceptionally high ammunition usage rates. Russia's declining ammunition stockpiles are particularly problematic for Russian forces since the Kremlin's strategy of attrition is critically dependent on artillery.

Russian artillery and rocket forces had over 4,894 artillery platforms in active service in 2022 according to *The Military Balance 2022*.[31] These included 2,118 self-propelled and towed howitzers, 1,056 MLRS, and 1,720 heavy mortars.[32] Moreover, Russia also maintains thousands of artillery and MLRS platforms in storage.[33] This was sufficient to provide Russia with an enormous advantage in firepower over Ukraine at the start of the war.[34]

Since then, Russian forces have lost a substantial number of artillery, including at least 486 artillery systems and 191 MLRS (captured, abandoned, or destroyed), as of February 2023.[35] Even more importantly, they have expended enormous amounts of both tubed and rocket artillery ammunition during the war, on average using around 20,000 shells per day throughout last year, and as many as 40,000 shells per day during peak periods of the spring and summer offensives in 2022.[36] Despite its large prewar ammunition stockpiles, such intensive rates of fire are proving unsustainable, even for Russia.[37]

This photo, taken on December 7, 2022, shows collected remnants of shells and missiles used by Russian forces in their attack against the second-largest Ukrainian city of Kharkiv.

Photo: ALEKSEY FILIPPOV/AFP via Getty Images

Faced with such issues, Russia is pursuing a range of measures to sustain its artillery and rocket forces in Ukraine. Russian defense firms continue to deliver new and upgraded artillery systems for the front.[38] Yet current production rates are insufficient to replace Russia's losses in Ukraine.[39] The defense industry is also taking measures to increase artillery production, working extra shifts, and rallying the artillery sector to improve efficiencies.[40] Efforts to ramp up production have been hindered by sanctions, however, which are restricting Russia's ability to obtain high-end Western machine tools and high-quality gun steel.[41]

Russia faces even greater challenges in maintaining ammunition supply for its artillery and rocket forces. Ammunition shortages are much more of a limiting factor for Russia than are its artillery losses, since Russia still has enough guns to bring mass firepower to bear when needed.[42] At first glance, it appears that Russian defense firms continue to deliver substantial amounts of artillery and MLRS ammunition. According to the Russian defense conglomerate Rostec, ammunition production has now reached a new 10-year high.[43] However, current production rates for 122-millimeter and 152-millimeter artillery shells—both Soviet-standard ammunition—appear wholly inadequate to replenish existing stockpiles given current expenditure levels. The same is true of production of rocket ammunition for Russian MLRS.[44]

More recently, the Kremlin has been turning to North Korea and Iran for additional artillery ammunition.[45] Although not insignificant, the amounts involved so far are unlikely to materially improve Russia's supply situation.[46] Consequently, Russia continues to dig deeply into its existing munition stocks to sustain operations, amid growing signs of depletion. One U.S. official reported that Russia is now using 40-year-old artillery shells.[47]

Given the foregoing factors, the Russian military is liable to face a serious shortage of artillery ammunition during the next phase of the war and will likely have to operate with a partially depleted artillery force. For much of the war, Russian artillery and rocket forces have been able to operate at a high tempo while

maintaining fire superiority over Ukrainian forces.[48] In December, however, U.S. officials reported that Russian artillery fires had declined by 75 percent, fueling speculation that Russia may be running dangerously low on artillery ammunition or attempting to conserve ammunition.[49] In April 2023, the Russian private military company Wagner Group's chief, Yevgeny Prighozin, admitted as much, threatening to withdraw his forces from the front due to ongoing ammunition shortages.[50] Yet Russian forces have been able for the most part to sustain a high tempo of artillery fire during recent ground offensives in Bakhmut and Avdiyivka. Given Russia's growing signs of shell hunger, however, its forces may soon find themselves forced to ration artillery usage even further.

OPERATIONAL IMPACT

Russia's declining artillery and munition stocks are likely to have a major impact on Russian military operations in Ukraine, if not properly addressed. An inability to sustain artillery fires at previous levels would seriously undermine Russia's ability to effectively prosecute the war. Russian forces continue to rely heavily on artillery to offset deficiencies in other areas, including infantry, armor, and close air support.[51] Artillery also plays a central role in Russia's attrition strategy, with mass artillery used to pound Ukrainian positions and urban population centers, both to degrade their forces and weaken their resolve.[52] A shortage of artillery would erode these capabilities.[53]

Russian artillery has played a crucial role in Russian defensive operations as well. Artillery was instrumental in helping stem the Kherson counteroffensive in late 2022.[54] At the same time, defensive use of artillery has been able to inflict "frightful losses" on Ukrainian forces during recent counteroffensives in Kharkiv and Kherson.[55] When used defensively, Russia's approach is to bring mass firepower to bear to break up Ukrainian troop concentrations, disrupt attacks, interdict supply chains, and attrite their forces. However, defensive use of artillery consumes large amounts of ammunition. Acute ammunition shortages would thus weaken Russian defensive capabilities, opening up additional opportunities for Ukrainian counteroffensives.

Artillery has also been critically important for Russian offensive operations. Russia has been using mass fires, for example, to support the grinding, methodical advances taking place at Bakhmut. In this case, Russian forces are using artillery to keep Ukrainian forces in place, prevent them from concentrating, destroy strong points, and deliver suppressing fires during Russian ground assaults.[56] In the Donbas, Russian artillery inflicted thousands of casualties, while at times creating a paralyzing effect on Ukrainian forces. In the process, however, Russian artillery units are using enormous amounts of ammunition. Growing ammunition shortages would thus further weaken Russia's ability to conduct offensive operations as well.

Defensive use of artillery consumes large amounts of ammunition. Acute ammunition shortages would thus weaken Russian defensive capabilities, opening up additional opportunities for Ukrainian counteroffensives.

To address this problem, Russia is attempting to make greater use of precision artillery, which is far more efficient than unguided shells. Being properly supported with quality targeting data and reconnaissance strike complexes designed to link sensors with fires through battlespace networks would help Russia

enormously to conserve artillery ammunition, while also reducing its logistical footprint.[57] To date, however, Russian forces have faced challenges in scaling up the use of precision artillery due to poor training; limited intelligence, surveillance, and reconnaissance (ISR) capabilities; and, most importantly, insufficient precision munition stocks.[58]

Uncrewed Aerial Vehicles

CHANGES IN FORCE POSTURE

Russia was a latecomer in adopting UAVs, but over the last 15 years, it has made a concerted effort to catch up, developing a series of ISR and combat drones, and loitering munitions. According to the Kremlin, Russia entered the war with approximately 2,000 military drones of various kinds, distributed across the different services.[59] These included hundreds of Orlan-10 ISR UAVs; Orion combat drones; Lancet-3 and KUB-BLA loitering munitions; and special purpose drones, such as the Leer-3, which is designed to hijack and disrupt cellular phone traffic.[60]

Although exact numbers are hard to come by, since the war began, Russia has likely lost hundreds of UAVs to Ukrainian air defense, electronic attack, system failure, and pilot error.[61] To replenish its stocks, Russia's defense industry has promised to ramp up production of ISR drones, combat drones, and loitering munitions. To this end, Putin recently announced a new national import substitution program for the development of UAVs in Russia with up to 1 trillion rubles in new funding.[62] However, the defense industry is grappling with supply chain issues due to shortages of navigation, radio communication, avionics, and information technology (IT) components, as well as capacity problems.[63] Although there is evidence of some improvement, the industry is still having difficulty producing enough drones to meet demand.[64] For example, production of Orion UAVs was recently estimated at a mere 45 units per year.[65]

Sanctions are also contributing to Russia's production problems. Russia's Orlan-10 and Lancet UAVs rely on Western components—including cameras, engines, and electronics—some of which are placed on the sanctions list. Likewise, production of Russia's Orion, which is comparable to Turkey's Bayrakter, remains restricted due to sanctions and capacity limitations, while Moscow's use of the Forpost-R combat drone in Ukraine has thus far been negligible.[66] Russian officials recently announced a new program to shift over more fully to import substitution, but this is unlikely to lead to major increases in output over the near term.[67]

Due to such issues, Russian forces in Ukraine faced a serious drone shortage several months into the war.[68] To compensate, Russia has been purchasing commercial UAVs made by Chinese companies, such as Da-Jiang Innovations (DJI), through online retailers and other channels. Chinese DJI quadcopters, designed for civilian use, have become particularly prevalent on the battlefield after repurposing for military use.[69]

At the same time, the Russian military is seeking to acquire a large number of "first-person view" (FPV) drones from China (or components to build them) for use as small, high-speed kamikaze drones. These are already being used by the AFU to good effect in Ukraine.[70] Russia is also turning to Iran for UAVs, including the Mojaher-6 combat drone.[71] Evidence also suggests that Moscow has been able to increase production for certain systems, such as the Lancet-3, based on a sharp increase in attacks in Ukraine since November 2022.[72]

Thus far, Russian drone supplies have been sufficient to sustain a reasonably high tempo of drone operations despite persistent gaps in coverage due to the sheer size of the battlespace. Collectively, however, high UAV loss rates due to Ukrainian air defense and EW are driving Russia to import large numbers of foreign UAVs to

replenish its stocks.[73] Given domestic production limitations, Moscow remains highly dependent on Chinese civilian drones. According to Russian customs data, China has sold more than $12 million in drones and drone parts to Russia since the start of the war, although that likely understates actual volumes by a significant margin, given the prevalence of private drone purchases by Russian civilian volunteer groups.[74] If Russia's access to Chinese drones were to diminish due to sanctions, or if Russian drone losses significantly increased due to the AFU's rising counter-UAV capabilities, growing shortages would start to erode the many advantages accruing for Russian forces from concentrated use of UAVs.

If Russia's access to Chinese drones were to diminish due to sanctions, or if Russian drone losses significantly increased due to the AFU's rising counter-UAV capabilities, growing shortages would start to erode the many advantages accruing for Russian forces from concentrated use of UAVs.

OPERATIONAL IMPACT

Surveillance drones have been critical for Russia in maintaining battlespace awareness in Ukraine. ISR drones, such as Orlan-10, are serving effectively as forward-based artillery spotters, relaying data on Ukrainian positions to waiting Russian artillery batteries. When used effectively, ISR drones have reportedly helped to compress the time between target detection and strike to just three to five minutes.[75] They have also helped artillery units conserve ammunition by reducing the need for blind shelling.[76] Disruption of Russia's ISR drone supply would therefore diminish a key component of Russia's artillery kill chain, further undermining Russia's ability to sustain effective artillery fires.

A critical power infrastructure burning after a Russian drone attack against Kyiv on December 19, 2022.

Photo: SERGEI SUPINSKY/AFP via Getty Images

The prevalence of Russian surveillance drones linked to artillery has restricted the AFU's freedom of action across the battlespace. When used in combination with Russian combat drones and loitering munitions, their pervasive presence has compelled AFU ground force commanders at times to disperse their forces and conceal weapons and troop movements in tactically limiting or unsound ways.[77] A reduction in Russian drone supply would help loosen these strictures, allowing Ukrainian forces to concentrate

their efforts more effectively while potentially restoring the element of surprise at selected points of attack.

Russia's small fleet of combat drones and loitering munitions is also providing its forces with additional strike capability. Russian Lancet and KUB loitering munitions are able to hold Ukrainian targets at risk across the battlefront to a depth of up to 40 kilometers.[78] They can effectively penetrate Ukrainian airspace and operate in AFU rear areas to conduct ground strikes and aerial interdiction while Russian combat aircraft remain largely sidelined due to Ukraine's potent air defense network. A decline in Russian drone supplies would likewise hinder such operations.

Russian drone operations in Ukraine are also limited by deficiencies in UAV capabilities. For one, Chinese civilian drones suffer from limited range and durability. They remain vulnerable to jamming and spoofing as well, reducing their utility and survivability.[79] Russian drone operations have also been hindered by persistent shortages of Russia's Orion combat drone, which has sufficient range, payload capacity, and endurance to strike targets at operational depth. Having more of these platforms would help Russian forces further degrade Ukraine's air defense networks, precision artillery, and logistics nodes in AFU rear areas—though these drones are themselves vulnerable to Ukrainian EW and air defense.[80]

Electronic Warfare

CHANGES IN FORCE POSTURE

The Russian military has invested heavily in electronic warfare in an effort to maximize its control of the electromagnetic spectrum (EMS) on the battlefield. Building upon its impressive Soviet legacy in "radio-electronic battle," Russia has developed a wide array of sophisticated EW systems in recent years. These include jammers and spoofers, electronic intelligence, advanced radars, electro-optical and infrared sensors, direction finders, and electronic countermeasures of various kinds. Russia has used EW to good effect in Ukraine to disrupt navigation signals and cellular communications, down drones, jam radars, and disrupt AFU operations.[81]

Although data on current inventory levels of Russian EW platforms are difficult to obtain, Russia has been able to maintain a sufficient number of EW assets to pervasively impact the EMS across broad areas of the battlefront, albeit with some limitations. Russia has also been able, at times, to mass its EW assets with paralyzing effect to support offensive ground operations.[82] In May 2022, after the campaign shifted to the Donbas, Russia reportedly deployed around 10 EW complexes for every 20 kilometers of frontage. Collectively, these assets were used to disrupt navigation along the entire front, geolocate Ukrainian artillery, and conduct effective electronic attacks against Ukrainian aircraft and UAVs.[83]

Russian forces in Ukraine have lost a significant number of EW platforms, however, including several dozen platforms dedicated to jamming and spoofing, electronic intelligence, aerial surveillance, target designation, direction finding, fire control, reconnaissance, and counter-unmanned aircraft systems (UAS).[84] Faced with such losses, Russian defense minister Sergei Shoigu met with defense industry leaders recently to increase the production of EW equipment used in Ukraine.[85] Russia's Rostec also announced recently that it will begin mass production of a new generation of EW and counter-UAS platforms.[86]

Over time, however, such efforts are likely to be increasingly challenged by sanctions on Western advanced microchips used in Russian EW systems. According to a recent report from the Royal United Services Institute (RUSI), Russia's Borisoglebsk-2, an advanced broadband jammer, relies on a range of chips produced by

Western companies, which it uses to process signals over a wide frequency range.[87] Analysts also found Western chips in a Russian Torn-MDM signals intelligence (SIGINT) radio direction finder and a Fara radar system recently captured in Ukraine.[88] Russian EW platforms are particularly dependent on specialized Western microchips, for which there are fewer external sources, so this is an area where sanctions are likely to be more effective.[89]

Moreover, there are significant gaps in Russian EW coverage, due to low production rates of certain EW platforms. Thus, in some areas, Russia simply does not have enough EW systems to cover the entire battlefront in Ukraine. This has left gaps in coverage in Russia's air defense network, which Ukrainian forces have exploited, using drones to strike Russian ground forces or to cue artillery strikes.[90] EW fratricide has also been a persistent problem, with Russian EW systems often jamming their own sensors and networks, forcing them to be taken offline.[91]

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In many cases, Russian EW platforms also suffer from limited reach since their effects are often restricted to their line of sight. At the same time, Russia does not have enough long-range drones (such as Orion) capable of hosting onboard EW systems to extend their reach. This, in turn, is curbing Russia's ability to penetrate Ukrainian airspace at sufficient depth to jam air defense radars, collect intelligence, and disrupt communications networks at the tactical-operational level.[92]

OPERATIONAL IMPACT

Despite these shortcomings, Russian forces have thus far been able to maintain sufficient EW platforms to create pervasive effects, at times, across broad areas of the battlefront. Russian forces are using EW to degrade Ukraine's communications, navigation, and ISR capabilities and to repeatedly deny Ukrainian forces access to significant portions of the EMS. Moreover, despite sanctions, Russia's EW capabilities have continued to advance, as its defense industry is finding new ways to achieve greater effects on the battlefield. For example, Russian EW systems were reportedly modified recently to take down Ukrainian DJI drones that were previously less susceptible to Russian electronic attack.[93] Russia has also refined the use of its EW systems, allowing them to jam Ukrainian military communications without affecting its own.[94]

Yet Moscow's growing supply chain problems and increasing losses on the battlefield, coupled with more effective Ukrainian countermeasures, are helping to perpetuate persistent EW shortages. Should this trend continue, this could materially erode Russia's ability to maintain tactically significant EW effects, thereby leaving Russian forces more vulnerable to Ukrainian strikes. As this unfolds, it would create further gaps in coverage and new opportunities for Ukraine to deploy its drone force into Russian-controlled airspace and to expand precision strikes.

As an example, Russia has been using its EW and air defense systems to effectively counter Ukraine's UAV fleet,

thereby reducing its situational awareness and disrupting kill chains. Russian EW, when combined with air defense, has been highly effective at this mission, reportedly eliminating up to 90 percent of Ukrainian drones after just a few flights.[95] Russia has also been using EW systems, such as Palantin, to jam Ukrainian drones and prevent them from transmitting the coordinates of Russian ground targets to Ukrainian artillery.[96] Other EW assets are being used to dazzle UAV sensors and disrupt flight control transmissions from their remote operators.[97] The lack of quality target data from ISR drones has, at times, effectively sidelined Ukrainian precision strike weapons. Dense EW and air defense networks have likewise been effective in countering Ukrainian combat drones and loitering munitions.[98] Although targeting data provided by Western intelligence sources has likely helped offset such effects, suppression of Russian EW platforms would allow Ukrainian UAVs to operate more freely in what is currently denied airspace.[99]

A Russian drone-detecting radar station spotted at the Russian military base in Syria in September 2019.

Photo: MAXIME POPOV/AFP via Getty Images

Russian EW assets are also playing a key role in Russian air defense networks, effectively limiting the role of Ukrainian ground attack aircraft by helping deny them access to airspace over Russian-controlled territories. Russia's radio-technical forces have successfully maintained dense air defense radar coverage over the entire battlefront to facilitate surface-to-air missile strikes. Russian radar operators have also used EW to counter Ukrainian efforts to suppress these radars.[100] Russian EW systems are also used routinely to jam airborne radars on Ukrainian combat aircraft and to disrupt their navigation and communications signals, to some effect, at times disabling them.[101] Likewise, systems such as Russia's Krasukha-4 are being utilized in an attempt to jam Western airborne and satellite-based radar signals and to disrupt communications.[102] Suppressing these Russian EW assets would contribute significantly to efforts in hampering Russia's air defense networks, providing more opportunities for the Ukrainian air force to access airspace over Russian-occupied territories.

Long-Range Precision Strike

CHANGES IN FORCE POSTURE

Russia's long-range precision strike systems, especially its best frontline theater cruise and ballistic missiles (Kalibr, Kh-101, and Iskander), have played a major role since the 2022 invasion. These systems have been used extensively throughout the campaign to strike high-value civilian and military targets in Ukraine at operational and strategic depth. At the start of the campaign, Russia relied primarily on the Kalibr, Kh-101, and Iskander missiles, which were expressly designed for the theater land attack mission, though it later incorporated other missiles.

Although the sizes of Russia's initial and current missile stockpiles remain unknown, Russia has reportedly

launched several hundred of their best frontline missiles since the war began, and more than 5,000 missiles in total, as of April 2023.[103] Missiles are typically employed using mass salvo attacks to stress Ukraine's air defense network and ensure that a larger percentage of them reach their targets.

Over time, the rates of fire associated with Russia's best frontline precision missiles have declined significantly. Accordingly, the Russians have likely been using their Kalibr, Kh-101, and Iskander missiles at faster rates than they can produce them, and this has significantly depleted their stockpiles over time.[104] Estimates vary, but according to Ukraine's defense minister, by November 2022, Russia had used 24 percent of its high-precision missiles, including 37 percent of its Kalibrs and 50 percent of its Kh-101 missiles—though the research team has been unable to confirm these numbers.[105] The growing effectiveness of Ukrainian air defense systems is also taking an increasing toll on Russia's missile stockpiles.[106]

As its theater missile campaign has continued, Moscow has been integrating other missiles into its long-range strike packages. These include the Russian Oniks, S-300, Tornado-S, Kh-55, and Kh-32 missiles, among others.[107] However, many of these missiles were designed for other missions and were essentially repurposed for the theater land attack mission. More recently, Russia has been purchasing Iranian Shahed-136 one-way attack (OWA) drones, which have also been integrated into its long-range strike packages.[108] At a price of as little as $20,000 per system, the Shahed-136 provides Russia a low-cost option to bolster its theater strike capability.[109] Russia is reportedly acquiring another 6,000 of these systems, potentially for licensed production. Most recently, Moscow has renewed use of the Kh-47 Kinzhal hypersonic missile, which had been used sparingly earlier in the war. In this case, however, the Kinzhal represents an upgrade in capability based on its hypersonic speeds and its superior ability to penetrate Ukrainian air defense systems.[110] This system is not invulnerable, however, as demonstrated by the recent downing of a Kinzhal missile by the Ukrainian Air Force using a Patriot air defense system.[111]

In parallel with this, the defense ministry has been making efforts to increase production, with Russia's missile manufacturers working three shifts per day. In May 2022, Votkinsk—manufacturer of the Iskander missile—announced plans to hire 500 workers to increase production.[112] It is unclear as of yet whether production volumes are increasing, but Russia has had some success in sustaining production in spite of sanctions. For example, a recent inspection of Kh-101 missiles recovered in Ukraine found that they contained Western microchips that were produced during the previous two months, indicating that the missiles themselves were also assembled within this two-month period.[113]

Dmitry Medvedev, deputy chairman of Russia's security council, visited the Raduga missile manufacturer near Moscow on February 2, 2023.

Photo: YEKATERINA SHTUKINA/SPUTNIK/AFP via Getty Images

Efforts to boost production could increasingly be hindered by sanctions, however, given that

production of these advanced missiles relies extensively on Western electronics.[114] Sanctions are also liable to limit Russia's ability to add capacity, which is dependent on advanced Western machine tools. Production of Kalibr missiles was reportedly halted temporarily due to a breakdown in Western manufacturing equipment used in its production.[115]

OPERATIONAL IMPACT

The shift to a broader mix of precision strike weaponry has significantly helped to sustain the Kremlin's long-range precision strike campaign. However, the growing use of missiles built for other missions, such as the S-300 air defense missile, has reduced the campaign's effectiveness. Such missiles are not designed for the land attack mission and are poorly suited for it. Many lack the accuracy needed to hit their designated targets, with some missing them by a wide margin. Although they cause damage to whatever they hit, they are inevitably less effective in destroying critical infrastructure targets.

Fluctuations in operating tempo characterized by changes in the frequency and size of Russia's strike packages have likewise impeded the theater missile campaign, resulting in a reduced operating tempo on occasion, giving Ukraine more time to recover. Moreover, the growing share of lower quality missiles in recent strike packages is also reducing their effectiveness, due to their limited reach and ability to circumvent Ukrainian air defense systems.

One of the key goals of Russia's theater precision strike campaign is to support Russia's ground campaign by destroying critical infrastructure targets directly supporting Ukraine's war effort. This includes command and control nodes, defense plants, military training centers, air force bases, logistics depots, and similar targets. Further reductions in the volume of Russian long-range missile strikes—due to sanctions or production problems—would limit Russia's ability to carry out this mission. At the same time, using less accurate missiles against such targets is likely to lead to lower success rates and more civilian damage.

Another key goal of Russia's theater strike campaign is to help degrade and eventually suppress Ukraine's integrated air and missile defense systems.[116] This is achieved both directly by striking Ukrainian air bases and air defense nodes and indirectly by compelling Ukraine to deplete its remaining inventory of surface-to-air missiles. Notably, the latter mission is far less dependent on Russia's most capable precision strike missiles (e.g., Kh-101). If the goal is compelling Ukraine to expend its air defense missiles, virtually any missile with sufficient reach will suffice. The Iranian Shahed-136 UAVs have been used to good effect for this mission, causing Ukraine to expend its limited supply of expensive surface-to-air missiles to destroy drones purchased at a fraction of the cost.[117]

The Kremlin's theater strike campaign is also designed to impose costs on the Ukrainian populace, disrupt the economy, and shape leadership decisionmaking by striking (or holding at risk) critical civilian infrastructure targets throughout the country. Russian missile strikes against Ukrainian energy plants, oil refineries, and other civilian infrastructure have been a key component of this effort, raising costs on the entire populace. This mission is intended to undermine the economy, as well as the will of the Ukrainian people, while sending a message to them that there are no sanctuaries in the country. Unfortunately, for this purpose, use of less accurate missiles, such as the S-300, can still be quite effective since an errant missile strike in a residential area nevertheless contributes to the objective. A sustained reduction in the volume of Russian missile strikes would further impair Russia's ability to carry out this mission, reducing the threat to Ukraine's economy while helping contain the effects of the war.

The Kremlin's theater strike campaign is also designed to impose costs on the Ukrainian populace, disrupt the economy, and shape leadership decisionmaking by striking (or holding at risk) critical civilian infrastructure targets throughout the country.

To date, Ukraine's air defense network has been surprisingly effective at intercepting Russian long-range missiles. It is important to recognize, however, that it will be difficult to fully mitigate this threat given Russia's ability to produce or acquire additional systems. Russia's best missiles can maneuver, use decoys, and take other measures to avoid interception. Inevitably, a certain number of missiles are likely to get through. By the same token, using expensive surface-to-air missiles to intercept Iranian drones acquired at a fraction of the price is not a cost-effective tradeoff.

Impact of Equipment Shortages on Russia's Ability to Operate in Other Areas

This section of the report assesses the impact of Russia's cumulative equipment and munition shortages on its ability to carry out operations in other areas, even if the war in Ukraine is ongoing. This assessment is obviously preliminary in nature and limited to three potential conflict scenarios, including a potential intervention in Central Asia to restore stability, an expeditionary operation in the Middle East and North Africa, and a conventional military operation in the Caucasus, all of which take place in the next few years. The section concludes with a preliminary discussion on the prospects and timing for Russia to reconstitute its forces. All such assessments are, out of necessity, highly speculative and highly contingent on the circumstances at the time. Thus, the outcome could be quite different depending on the timing, the context, the stakes involved, the geopolitical conditions, and many other factors.[118]

Stability Operations in Central Asia

Scenario: Russia is a member of the Collective Security Treaty Organization (CSTO), a military alliance comprised of Russia and five former Soviet states: Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Tajikistan. The CSTO is a true military alliance with mutual defense commitments. In January 2022, just prior to the Ukraine invasion, Kazakhstan's president requested CSTO assistance after armed anti-government protesters took control of parts of Almaty, the country's largest city. In response, a Russia-led force made up of 2,300 troops from Russia and other CSTO member states was quickly dispatched to Kazakhstan. This included over 1,000 Russian regulars and airborne troops, as well as several armored vehicles. Their mission was to provide security, guard key facilities, and free up Kazakh security forces, who were then able to quell the protests and restore order. The mission was completed within a week and Russian forces were then withdrawn.[119]

Assessment: The Russian military should have little difficulty in carrying out a similar operation in Central Asia in the next few years, its losses in Ukraine notwithstanding. Given the small size of the mission, its limited

scope, and the permissive environment, Russia retains the ability to carry out such operations whether or not the war in Ukraine is ongoing. It also retains the military airlift capability to transport and sustain a force of this size.

Expeditionary Operations in the Middle East and North Africa

Scenario: In 2015, Russia dispatched an expeditionary force to Syria to support Syrian government forces facing a wide array of armed rebel groups which had been receiving substantial external support. The initial contingent of the Russian military in Syria reportedly comprised roughly 4,100 military personnel, including one to two squadrons of Russian combat aircraft, several ground force and artillery units, a naval contingent, and a military transport unit.[120] Russian forces established a forward-operating base at Khmeimen in Syria and commenced air strikes. Russian specialists also provided advisory support and combat support services for the Syrian army. This mission was sustained for several years, during which the composition of the force changed considerably, but this assessment is restricted to the initial deployment.

Assessment: Despite recent losses in Ukraine, Russia's armed forces likely still retain the capacity to carry out an expeditionary operation of similar scope and character in the Middle East and North Africa, so long as they have access to suitable basing and a port on the eastern Mediterranean. Russian operations in Syria were centered primarily on an air campaign and took place in a relatively permissive environment. Russian ground forces were assigned to protect Russian bases in Syria, though they also operated in the field to provide advisory support, as well as limited combat and combat support services, for the Syrian army. Despite recent losses in Ukraine, Russian ground forces likely still retain sufficient capacity to carry out such a mission given the limited requirements. Likewise, the Russian navy and aerospace forces also maintain the capacity to complete this kind of operation, since their losses in Ukraine remain limited relative to the ground forces. Russia also retains sufficient military airlift and naval transport capacity, which—together with access to commercial shipping—should be sufficient to sustain such an operation, provided Turkey reopens the Bosporus.

Conventional Military Operations in the Caucasus

Scenario: In 2008, the Russian military carried out a brief but successful high-intensity conventional military operation against Georgia during the Russo-Georgian War. Operations were initially centered in South Ossetia (or the Tskhinvali region, as commonly called in Georgia) and Abkhazia, two breakaway provinces under Russian protection. Operations commenced with clashes between Russian and Georgian troops in South Ossetia, with the Georgian government seeking to reincorporate the two provinces into Georgia proper. Russia effectively crushed the Georgian armed forces in a five-day campaign, bringing overwhelming power to bear. To carry out the mission, Russia reportedly assembled a force of 25,000 combat troops backed by over 1,000 tanks and armored vehicles, artillery, rocket forces, and airpower.[121] Although Russia prevailed in the war, it incurred significant casualties and equipment losses.

Assessment: The Russian military would be challenged to carry out a similar operation in the Caucasus without a high degree of risk, while the war in Ukraine is ongoing, given their high loss rates in the current conflict. Once the war is over, it would likely take a year or so before Russia could comfortably mount such an operation due to the need to restore its forces in light of the heavy tank and artillery losses and ammunition expenditures in Ukraine. Prior to this, such shortages could make it challenging for Russia to quickly assemble a ground force component capable of offensive operations comparable to the one it used in the 2008 Russo-

Georgian War. Assessments of this kind are highly contingent, however. Unlike Ukraine, a conflict in the Caucasus would be less demanding given the small size of the countries in the region and their lack of strategic depth. Local militaries are also smaller and less well equipped. Thus, if vital interests were at stake, the Kremlin could probably assemble such a force, provided it had sufficient time to mobilize equipment and personnel beforehand. It would have to rely extensively, however, on reserve ground combat equipment.

A convoy of Russian troops heading toward South Ossetia to help local separatists on August 9, 2008.

Photo: DMITRY KOSTYUKOV/AFP via Getty Images

Reconstituting the Force

Beyond these limited contingencies, Russian forces would be hard-pressed to undertake another conventional military conflict on the scale of Ukraine over the next few years. Russian losses in Ukraine are simply too great for Russia to manage an operation of this scale until the Kremlin has made sufficient headway in restoring its losses. Russia will need time to reconstitute its forces, and most observers agree that it will take many years to rebuild its ground forces, especially if Western sanctions remain in effect. Much will depend on how effective Moscow is in mobilizing defense production and on what kind of force it decides to build. The degree to which it chooses to rely on its vast weapons stores will also affect the time it takes to restore capacity. If Russia decides to try to build a more advanced force than the one it fielded in Ukraine, this would extend the total time needed to reconstitute its forces. If sanctions take hold more effectively, then Russia may also need technical assistance from China and other countries still willing to do business with it. As long as Russia maintains sufficient energy revenues to fund such activities, it is likely to find partners willing to share weapons and technology. Otherwise, it will have to rely more fully on import substitution—a challenging proposition given the state of Russia's technology base. Most observers agree, however, that Russia will eventually succeed in rebuilding its military, with estimates of 5–10 years according to recent testimony from U.S. intelligence officials.[122] Russian production rates during the most recent state armament programs provide some guidance on the defense industry's production potential. For example, according to the Swedish Defense Research Agency, Russia was able to modernize around 185 main battle tanks per year between 2011 and 2018 and, as noted above, manufacturing has reportedly increased to around 250 tanks per year.[123] But these figures do not take account of recent Russian efforts to expand capacity and ramp up production, which may eventually result in higher production rates.[124]

Key Findings and Conclusions

Since the start of the war in Ukraine, the United States and its allies have made a concerted effort to support Ukraine through the provision of military assistance and the imposition of sanctions on Russia. Military assistance is centered on the provision of military equipment and intelligence sharing on Russian force dispositions. It has had the most immediate and visible effect, affording Ukraine the means to rapidly upgrade its own military and to vigorously contest Russian forces, resulting in heavy attrition of Russian military capabilities and extraordinarily high equipment losses. Sanctions have also had an immediate impact on Russian defense production by abruptly severing supply linkages with Russia, though their direct effects are harder to discern. Yet, there are numerous indications that sanctions are placing Russia's defense industry under duress and making it harder to overcome capacity limitations. Numerous Russian media reports cite the need to increase import substitution.[125]

The attrition of Russian forces has substantially depleted equipment inventories, which in turn has undermined Russia's ability to prosecute the war in Ukraine. Resulting equipment and munition shortages are eroding Russian forces' fire superiority, limiting their ability to maneuver, and undercutting capabilities in other areas. Collectively, this is creating a window of opportunity for Ukrainian forces to renew their counteroffensive, though it is not yet clear how long the situation will last.

Russia is responding on both fronts, seeking to limit further attrition and to circumvent sanctions. Where possible, Russian military leaders have been reducing the tempo of operations in Ukraine, pulling back to more defensible positions, adjusting their tactics, and limiting munition consumption. Likewise, Russian defense leaders are taking extraordinary measures to ramp up defense production and replenish their forces. Due to the sanctions, this includes drawing Soviet-era equipment out of storage and sourcing drones from China and Iran. In essence, there are two separate attrition battles underway, both bitterly waged between Russia on the one hand, and Ukraine and its Western allies on the other. They include the war of attrition

on the ground in Ukraine to decisively attrite Russian forces, and the global sanctions campaign to suppress Russian budget revenues and defense production. The results of these two contests could well decide the war, but the outcome still very much hangs in the balance.

Due to the restricted nature of the data in question, the assessments in this report have had to rely, at times, on circumstantial or incomplete evidence. Nonetheless, this report draws several conclusions about the impacts of attrition and sanctions on Russia's ability to prosecute the war in Ukraine and elsewhere.

1. **To date, U.S. and allied support for Ukraine aimed at increasing attrition rates have been very effective, resulting in substantial reductions in the quality of Russian forces.**

Attrition has taken a heavy toll on Russian forces in Ukraine, undermining their capabilities across the board. The impact on Russia's offensive capabilities has been greater, however, than it has on its defensive capabilities. Moreover, the effects of attrition have impacted some weapons categories more than others, since Russia has been more successful in some areas in finding ways to resupply its forces.

Attrition has taken a heavy toll on Russia's tank forces, which have lost two-thirds of their frontline MBTs. Replacing them with Soviet-era models pulled from storage has partially offset such losses, but it has also reduced the quality of the tank force and significantly limited Russia's ability to maneuver. Yet Russia's maneuvering problems are not solely a function of the size and quality of its tank force. They are linked, as well, to deficiencies in personnel, lack of training and morale, poor planning and execution, limited leadership, deficiencies in combined arms operations, and other factors. Over time, these issues can potentially be rectified. Moreover, Russia still has thousands of tanks in storage that it could draw upon, although most of the remaining systems will likely require more extensive refurbishment before they can be placed in service. Moreover, Russia also has the potential to increase production, so it should gradually be able to replenish its forces, although it will take several years to fully reconstitute its prewar tank fleet.[126] Thus, Russia's potential to restore its armored maneuver capabilities should not be underestimated.

Waging a high-intensity war of attrition has taken a toll on Russa's artillery units amid growing signs of depletion of their ammunition stockpiles. The latter is emerging as a major problem for Russian forces in Ukraine, which rely heavily on mass firepower to sustain operations, offset their deficiencies, and contain Ukrainian counteroffensives. Russia is drawing deeply on its munition reserves while its leaders are scrambling to obtain munitions from other countries. But it is not yet clear whether these actions will be sufficient to avert a serious crisis. The defense industry is also pushing to expand production of artillery and MLRS munitions but is facing capacity limitations. Over time, however, Russia is likely to increase production sufficiently to maintain a reduced though more sustainable rate of fire.

By contrast, Russia has been able to maintain a relatively high tempo of drone operations despite significant UAV losses during the war, yet shortages persist. It has managed to do so by boosting production rates for some frontline drones, such as the Orlan-10 and Lancet, and even more so by importing UAVs in large numbers from other countries. The purchase of small Chinese civilian drones, including DJI quadcopters, has been particularly important for sustaining drone operations, while Iranian drones are filling gaps in other areas. However, Russia's growing dependency on foreign sources remains a vulnerability due to the threat of sanctions and, to a lesser extent, the potential for reduced access to Chinese civilian drones.

Russia has also managed to maintain a sufficient number of EW platforms to sustain operations, despite incurring significant losses in Ukraine. Data regarding their initial and remaining stockpiles and relevant

production rates are harder to come by, limiting visibility in this area. Yet there are reasons to believe that EW may be an area of vulnerability for Russia, given their high dependence on specialized Western microchips. Moreover, maintaining and replenishing such a diverse array of EW platforms is likely to present logistical challenges. Given their importance for Russian operations in Ukraine, more research is needed in this area to target Russian EW systems more effectively.

Thus far, Moscow has demonstrated an ability to sustain its theater strike capabilities despite heavy expenditures of its best frontline missiles (Kalibr, Kh-101, and Iskander). This has led to a decline in the use of these particular systems, though the Kremlin may be holding some in reserve for other contingencies. By shifting to a more diversified mix of theater missiles, hypersonic weapons, and OWA drones, the Kremlin has been able to sustain operations in this area, but at a cost of reduced quality and performance. Russia will face challenges in increasing production of new missiles due to sanctions and capacity limitations. But over the near term at least, it is likely to maintain enough missiles to sustain operations, even if at decreased frequency.

2. **Attrition could be even more effective if carefully tailored to the situation, though there are limits to this approach.**

The impact of attrition on Russian weapons and munition stockpiles varies considerably across weapons categories. For instance, Russian tank losses significantly exceed artillery losses on an absolute basis. Likewise, Russia's ability to replace its losses also varies across the various weapons categories. Although drone losses are high, Russia's ability to obtain replacements has been good enough to sustain a relatively high tempo of operations. By the same token, the impact on Russian military operations in Ukraine depends on the extent of the resulting equipment and munition shortages. Thus, the effects of attrition on Russian weapons inventories—and hence, Russian operational capabilities—remain uneven, affecting some capabilities more than others.

On a similar note, it is important to recognize that Russian operational capabilities in Ukraine—with some exception—require integrated use of all the various weapon categories covered in this report. For example, maintaining fire superiority over Ukraine relies on a combination of systems. It relies not only on substantial amounts of artillery and ammunition, but also on adequate UAV coverage to obtain targeting data. It also depends on having sufficient EW and air defense assets for counter-UAS operations to prevent Russian artillery platforms from being targeted by counterbattery fires.

Finally, not every Russian weapons category is equally important in terms of sustaining the war effort. In the case of Ukraine, Russian artillery is paramount since it plays a central role in Russian operations. Since the conflict has devolved into a war of attrition, artillery has become the center of gravity for Russian forces in Ukraine. Thus, suppressing Russian artillery fires (even if only locally), is of central importance for Ukraine, both for escaping the cycle of attrition and for providing opportunities to maneuver.

Policymakers can potentially use such information to refine their strategy by focusing military assistance and sanctions in areas where they are most likely to achieve operational and strategic effects. As an example, focusing on measures to degrade Russian artillery capabilities has the potential to significantly undermine Russia's ability to use mass fires to blunt Ukrainian counter-offensives. This could be done by reducing Moscow's ability to obtain battlefield surveillance drones for target acquisition, by curtailing artillery ammunition shipments from foreign suppliers, and by improving Ukraine's counter-battery fires.

Since the conflict has devolved into a war of attrition, artillery has become the center of gravity for Russian forces in Ukraine. Thus, suppressing Russian artillery fires (even if only locally), is of central importance for Ukraine, both for escaping the cycle of attrition and for providing opportunities to maneuver.

3. **The heavy attrition of Russian forces has substantially depleted their capabilities, creating a window of opportunity for Ukraine to renew its counteroffensive. However, it is unclear how long the window will remain open before Russia is able to replenish its forces sufficiently to shore up its defenses.**

Sustained large-scale Western military assistance has significantly strengthened the AFU's capabilities. As a result, the balance of forces in the war has shifted over time in ways favorable to Ukraine. Most importantly, the AFU is rapidly approaching parity in terms of firepower, and it has acquired certain advantages over Russia in terms of maneuverability.[127] This is creating openings for Ukraine to seize the initiative and go on the offensive during the next phase of the war. But it is unclear how long this window of opportunity will last before Russian efforts to resupply and reconstitute its forces start to pay off.

4. **Prolonged war in Ukraine, coupled with heavy personnel and equipment losses, will likely limit the Kremlin's ability to conduct high-intensity conventional military operations at scale in other areas, at least over the near term.**

More specifically, significant MBT and artillery losses incurred by Russia in Ukraine, as well as growing ammunition shortages, would make it increasingly challenging for Moscow to promptly deploy a well-equipped and sizeable ground force component—comparable to the one it used in the 2008 Russo-Georgian War—in other parts of the world. However, the Kremlin still likely retains enough capacity to conduct certain stability and expeditionary operations of limited duration, scale, and scope.

Recommendations

Although there are multiple factors shaping the conflict in Ukraine—many of which are outside the control of Western policymakers—this report concludes by proposing several ideas for Western policymakers to consider in calibrating Western military assistance and sanctions to contribute further to the attrition of Russian forces in Ukraine:

- Continue to resupply Ukrainian forces with tanks, armored vehicles, artillery, and precision munitions at rates required to secure and maintain maneuver and firepower superiority over Russia and to set conditions to bring the war to a favorable conclusion as early as possible.
- Consider granting Ukrainian manufacturers rights to use selected Western technologies for licensed production of selected weapons systems, component parts, and/or ammunition needed to wage the ground war in Ukraine.

- Focus Western military assistance on degrading Russian artillery to help break the cycle of attrition, including counterbattery radars, airborne ISR, and secure battlespace networks.
- Provide platforms to suppress Russian EW and air defense systems to help Ukrainian drones and loitering munitions maneuver more freely in Russian-controlled airspace.
- Boost Ukrainian counter-UAS capabilities with short-range air defense and EW to break Russia's artillery kill chain.
- Bolster Ukrainian air and missile defense networks to maintain area denial against Russian combat aircraft and to sustain high attrition rates on Russian long-range missiles and OWA drones, although this will take time and will require concerted effort to ramp up Western production.
- Eliminate sanctions loopholes allowing delivery of civilian drones to Russia for use in the Ukrainian conflict, particularly drones produced by China's DJI, which Russia uses extensively, although this will admittedly be difficult given the multiple existing distribution channels.
- Tighten export controls and enforcement activities to block transfers of high-end microchips used in Russian EW platforms, including through illicit channels.

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