

BRADLEY MARTIN, D. SEAN BARNETT, DEVIN McCARTHY

Russian Logistics and Sustainment Failures in the Ukraine Conflict

Status as of January 1, 2023

KEY FINDINGS

- Russia's failures in the war with Ukraine were due to poor planning in that it did not correctly assess the logistics requirement, even if it possessed the capacity.
- Even if Russia had assessed the threat more effectively, it is not clear that Russia possessed the required force structure to execute its plans.
- Russia ran out of critical supplies early in its campaign to rapidly seize territory, but this gap appears to be largely the result of simply underestimating the resistance encountered. Russia did not provide for adequate capacity because it did not believe such a capacity would be necessary.
- However, when the Russian army was required to rely on extended ground transportation, it became increasingly vulnerable to interdiction, particularly when Ukraine came into possession of standoff missile systems.
- Over the course of the conflict, basic issues of poor maintenance and supply support, compounded by lack of trained and effective maintenance personnel, have affected Russia's ability to carry out the war. To a degree, inability to carry out even basic sustainment has led to failure on the battlefield.
- Over the longer term, Russia does not have the capacity for a long war in the face of economic sanctions. Although it can continue to generate revenue from oil and gas exports, it does not have the ability to manufacture advanced weapons or even sufficient material to keep its army fielded.

Russia invaded Ukraine on February 22, 2022, on multiple fronts to establish Russian dominion on several provinces where separatist movements had contested Ukrainian government control. However, Russian aims were not restricted to annexing territory (at least initially) but extended more broadly to challenge a Ukrainian regime that had been moving steadily away from Russia. At the outset of this invasion, the Russian military enjoyed a reputation as a professional and modernized force—a reputation widely accepted in the West (Global Firepower, undated; O'Brien, 2022). Clearly, the Russian military's battlefield performance has not lived up to expectations.

There are many explanations for why the Russian invasion stumbled so significantly and several possibilities for the ultimate outcome. These failures have occurred across

Abbreviations

BTG	battalion tactical group
CAA	Combined Arms Army
GDP	gross domestic product
GMLRS	Guided Multiple Launch Rocket System
HIMARS	High Mobility Artillery Rocket System
MRL	multiple rocket launcher
MTO	material-technical support brigade

a variety of warfighting functions, but the failures of logistics and sustainment are noteworthy (Vershinin, 2021). This report examines the logistics and sustainment shortfalls in three phases of the campaign, concluding in January 2023.

Approach

We first consider a hypothetical case. Although we know as a matter of record that the invasion failed in the initial stages—and can analyze the various reasons for this failure—was it possible even under Russia’s assumed conditions? This question is not just a matter of idle interest. Failure to apply sustainment and logistics planning can have a major impact under even very favorable conditions. If the invasion was never executable, failures thereafter would continue to have an impact, but parts of the outcome would have been determined in advance. To carry out this hypothetical assessment, we use known doctrine and planning factors.

We will then consider, in turn, actual (1) failures of operational logistics, which is the provision of support to forces operating in a battle area; (2) failures of sustainment, which is the practice of keeping ready equipment and personnel; and (3) failures of strategic logistics in the sense of having a sufficient supply of war materiel to support a long-term campaign. These are *not* doctrinal definitions, neither Russian nor universal.

The primary method of assessment is a review of literature concerning logistics and sustainment

planning, and then an examination of the campaign as reported by various sources. This is not an effort to consider whether Russia followed its own doctrine or to evaluate logistics and sustainment relative to an absolute standard. For many aspects of these activities, doctrine is not developed or specified. We do use these categories as organizing principles for how logistics and sustainment occur, and we consider them in the temporal order in which they affected the campaign. Failures of operational logistics, specifically the ability to resupply and rearm an invading force, affected the first phase of the campaign. Sustainment issues, which were matters not just of movement of provision of materiel units simply trying to operate, affected the succeeding operational phase. Failures to consider the ability of the Russian economy to provide strategically important material overarch all these categories.

To summarize in temporal order, the failure to perform operational logistics doomed the initial invasion. The failure to provide sustainment made the subsequent effort to concentrate forces and advance on a more limited geographic area tenuous. The inability to provide an adequate means for supplying a military engaged in a war over an extended period made the overall enterprise tenuous, with the ultimate result still hanging in the balance.

Could The Outcome Have Been Different?: A Hypothetical Assessment

If Russia had successfully carried out its initial coup de main, many of the sustainment and strategic logistics issues discussed in later sections would have been moot. Therefore, for our counter-factual assessment, we will focus on operational logistics in support of rapid movement. It was this failure to achieve initial objectives that created the conditions for a prolonged war.

The Logistics Concept of Support

For operations requiring movement from storage to marshaling points, ground forces and supplies within Russia move predominantly by rail. This materiel

from Russia is initially delivered to the army group level for distribution, or possibly even the division or brigade, leaving it to them for receiving and sorting cargo. Besides receiving and sorting cargo, these forward railhead operations involve repackaging for specific units and storing excess.

To store excess cargo, the ground must be prepared so that cargo can be stored in safe, distributed environments. This process is expected to take one to three days for newly established railheads. Therefore, cargo storage sites must be outside the range of enemy artillery and secured from irregular forces and saboteurs. Military districts own transportation brigades of trucks for further movement of supplies. Army groups use pipelines from the national system to pump fuel directly to rear service areas. From there, the fuel is trucked to the end user (Vershinin, 2021).

To test feasibility without execution challenges, we will assume that Russia could have had rail transport available up to its own borders, the borders of Belarus, and within the occupied Donbas. For this analysis, we will first assume that needed supplies are unloaded from rail cars before the attack and stored a safe distance from enemy fires.

The logistics concept for the attack would be based on the material-technical support brigade (MTO is the Russian acronym) supporting the Combined Arms Army (CAA) and managing supply depots. The MTO would push supplies forward from the depots to MTO battalions, which are colocated with and supporting the army's maneuver brigades, and to separate brigade artillery groups. The MTO battalions would push supplies to MTO companies and, for example, mortar batteries. The MTO companies (supporting maneuver battalions) would push supplies to combat units and distribution points. If the MTO lacked the capacity to push forward all the supplies needed by the CAA, its movements would be supplemented by MTO battalion capacity.

The Logistics and Support Force Structure

The Russian army uses fewer support soldiers than other militaries even under ideal conditions. Battalion tactical groups (BTGs) notionally consist of 700

Even in ideal conditions, the ratio among Russian troops “would still not come close to that of the U.S. Army, which deploys about 10 support soldiers for every combat soldier.”

to 900 troops, about 150 of which could be considered support (Berkowitz and Galocha, 2022). These units would generally be part of a larger force in an area, so they could expect help from other logistics units, a condition that might not be practical when supporting a rapidly moving assault. But, even in ideal conditions, the ratio among Russian troops “would still not come close to that of the U.S. Army, which deploys about 10 support soldiers for every combat soldier” (Berkowitz and Galocha, 2022).

This system is optimal for BTGs in their normal operational and tactical employment. BTG “capabilities are extremely lethal when concentrated against individual units but diminish rapidly against high-tempo distributed maneuver or defense-in-depth because a BTG can't resource economy-of-force missions” (Grau and Bartles, 2016). This kind of employment allows the use of a relatively slow and fixed resupply line. Without modifications, the force structure would not be suitable for supporting rapid movements with extended supply lines.

The Hypothetical Upsides

The Russian army does not have standardized CAAs or MTO force structures, so we will look at hypothetical operational combinations of CAAs and MTOs. Russian CAAs vary considerably in size. The smallest, the 6th CAA, includes two motor rifle bri-

In the initial stages of an invasion, it is more likely that Russian MTO trucks are able to travel for more than 12 hours per day. This assumption could increase Russian capacity, possibly by up to 50 percent.

gades, one artillery brigade, one anti-aircraft missile brigade, and one missile brigade, possessing three multiple rocket launcher (MRL) battalions in total, with an estimated personnel strength of about 11,000. Such a force would require about one-half of the sustainment required by larger units, such as the 20th Guards CAA. Reducing the size of the invasion force would also reduce the requirement for support forces.

The MTO structure described in Grau and Bartles (2016) has a command and control element, two motor transport battalions, a maintenance battalion, a pipeline battalion, a road commandant battalion, warehouses, a field refueling company, a motor transport company (water), a general support company, bath and laundry services, and mobile bakeries. Vershinin states that the brigade possesses a total of 150 general cargo trucks with 50 trailers and 260 specialized trucks (Vershinin, 2021).

Those assets are nearly the same as the truck assets possessed by the MTO battalion as described in Grau and Bartles (2016), although the MTO battalion possesses several subunits (support companies) beyond its motor transport companies. The carrying capacity of the MTO battalion cited by Grau and Bartles is 1,870 tons of cargo (1,190 dry and 680 liquid).

For the purpose of this analysis, we will assume that the MTO has the same capacity.

In the same vein, the range at which Russia could sustain ground forces forward could theoretically be increased if it dedicated more logistics capacity (MTOs) to sustaining those forces. Accomplishing this move would require Russia to take away MTOs from CAAs not involved in the subject operation.

Finally, on the upside, in the initial stages of an invasion, it is more likely that Russian MTO trucks are able to travel for more than 12 hours per day. This assumption could increase Russian capacity, possibly by up to 50 percent.

The Russian Military Was Operating Very Near Its Capacity Even Using Favorable Planning Assumptions

For our analysis, we selected the 20th Guards CAA as a larger—but not the largest—army in the Russian ground forces. It includes two motor rifle divisions (each containing two motor rifle regiments, one tank regiment, one artillery regiment, and one anti-aircraft missile), a missile brigade, an artillery brigade, an air defense brigade, and a command brigade. Its total personnel is around 20,500.

Using a universal estimation factor, Russian ground forces would be expected to consume, on average, 200 kilograms of supplies (food, fuel, and ammunition) per day per soldier in the force (Johnson and Coryell, 2016). Applying this figure, the 20th Guards CAA would require about 4,100 tons of supplies per day to sustain. This universal factor may, however, understate the sustainment requirements where the campaign calls for heavy artillery use. Looking at another recent Russian campaign, in the Battle of Grozny from November 1999 to January 2000, a Russian force of about 21,000 was estimated to have fired about 4,000 artillery rounds per day. That quantity could be transported in about 50 trucks, which would be around 250 tons per day. If that quantity was added to the estimated requirements for the 20th Guards CAA, a total of 4,350 tons of supplies would be needed per day (Vershinin, 2021).

To meet this demand, an MTO would be assigned. For our purposes, we follow Alexander Vershinin's assumption that brigade trucks can deliver supplies for 12 hours each day (with the remaining 12 hours spent on truck maintenance, meals, refueling, weapons maintenance, and sleeping). During those 12 hours, trucks can load, travel to forward units, unload, and return to their depots. If it takes one hour for each truck to both load and unload, and road conditions can support truck speeds of 45 mph, then the trucks can make three trips per day of 45 miles, two per day of 90 miles, or one per day of 180 miles (Vershinin, 2021).

These assumptions are likely optimistic in terms of truck operability and the challenges of carrying out a complicated operation. But using these assumptions, carrying capacity, and operational concepts, the MTO could deliver 5,610 tons of supplies per day (1,870 tons of cargo \times 3 trips per day) to a distance of 45 miles; 3,740 tons per day to a distance of 90 miles; or 1,870 tons per day to a distance of 180 miles. With highly optimistic assumptions, the MTO could have met the requirement to support to a distance of 45 miles, but it would have difficulty between a distance of 60 miles and 70 miles.

However, even these assumptions would only apply if (1) Russian forces' reliance on rocket artillery and (2) the greater volume rocket ammunition compared with tube artillery shells add to the demand for transportation capacity. Combined, these assumptions would likely make sustainment impossible. Vershinin (2021) estimated that each MRL volley requires one truck to transport. The 20th Guards CAA has been estimated to possess three 122 mm MRL battalions (of 18 launchers each) and one 220 mm MRL battalion (of eight launchers)—for a total of 62 MRLs.

Thus, one volley from every launcher would take up more than one-third of the trucks in an MTO (occupying more than 300 tons of truck cargo capacity out of the 1,190 tons of dry cargo capacity for the entire brigade). Even before factoring in some very likely operational limitations, Russian operational requirements were poorly aligned with logistics requirements.

As a final challenge, the Russian logistics concept of operations assumed the ability to move materiel

from fixed depots located at railheads. In the presence of any kind of standoff munitions threat, this concept is unworkable.

Overall Hypothetical Assessment— Russia Might Have Successfully Carried Out the Invasion with Better Planning, but . . .

The supply requirement and transportation capacity estimates for the 20th Guards CAA and an MTO, respectively, suggest that Russia could sustain such a force at a distance between 60 miles and 70 miles forward of its supply depots. Given the need to protect its depots from Ukrainian attacks, these depots would likely have been 12 miles to 20 miles to the rear of the border. That location would have allowed for operations potentially 40 miles to 60 miles inside Ukraine.

Such operations would only be possible if the enemy had limited means to interdict traffic or attack storage sites, and would rapidly degrade in the face of traffic jams or other unfavorable road conditions. The force could likely count on foraging some items—such as food or water—which could reduce the demand for

The Russian logistics concept of operations assumed the ability to move materiel from fixed depots located at railheads. In the presence of any kind of standoff munitions threat, this concept is unworkable.

transportation. However, the conclusion is clear. Even under favorable conditions, this operation would have been difficult to logistically supply. The initial conclusion is that this plan was barely executable in the best of conditions, and very likely to fail with even moderate impediments, let alone the impediment of a determined and capable adversary. We next discuss what actually happened.

Failures of Operational Logistics and Support

We now turn to a discussion of logistics required to support an invasion and where Russia actually failed, beginning with the operational logistics required to support an invasion. We begin our analysis at the operational level because it appears to be the place where the overall Russian campaign suffered its initial setbacks. There are no universal definitions of *operational logistics*. However, there are essential functions performed by militaries that fall within the definition supplied here. We will use a U.S. Marine Corps definition as a general guide:

Operational-level logistics is the art of applying the military resources available to operating forces to achieve national military objectives in a theater or area of operations or to facilitate the accomplishment of assigned missions in a military region, theater, or campaign. (Marine Corps Tactical Publication 3-40C, 2016, p. 1-1)

Russia's assumption was that light resistance would allow rapid movement and reinforcement, with no significant requirement for materiel.

An operation is presumed to be underway—such as an invasion—and logistics forces are being oriented to supply the particular needs of the operation (Dalsjö, Jonsson, and Norberg, 2022). This effort would require planning, organization, and capacity. Absent such support, the invasion might collapse simply because it lacks the materiel means to continue. From the beginning, Russian forces that were carrying out operational-level functions were hampered by insufficient support from logistics forces.

The Logistics Force Was Not Structured or Organized to Support an Invasion

Russia's initial plans for the Ukraine campaign were for a rapid seizure of territory. The intent was a quick tactical victory and then the decapitation of the Ukrainian regime. Russian military leaders set in motion "a risky *coup de main* to take Kyiv," relying heavily on speed (Dalsjö, Jonsson, and Norberg, 2022). Russia's assumption was that light resistance would allow rapid movement and reinforcement, with no significant requirement for materiel.

Given that the conditions for this operation were not ideal, the logistics force structure was likely insufficient from the beginning. As discussed in the hypothetical discussion, the demands on individual support soldiers to effectively move and coordinate support were barely executable in the best of circumstances. However, circumstances were not ideal and several factors worked to make the invasion and attempted seizure of Kyiv a failure.

Advance Support Transportation Planning Was Not Conducted

Russian forces as a matter of doctrine would be expected to carry out support transportation planning to ensure a well-supported movement using combined arms (Friedman, 2022). However, to achieve surprise, Russia kept its intentions secret from everyone, including its own forces, until the attack was imminent (Dalsjö, Jonsson, and Norberg, 2022). This lack of planning and coordination led to

shortfalls in numerous areas, which both influenced and were affected by logistics shortfalls.

For example, this failure to communicate intention had a significant impact on motor rifle brigades and the Rosgvardia (Russian national guard troops). These troops

received their orders less than 24 hours before the invasion. As a consequence, they did not fight a methodical campaign of breakthrough and exploitation by successive echelons as their doctrine dictated, nor were they supported by sufficient artillery as is considered essential. (Watling and Reynolds, 2022, p. 3)

The forces were trying to (1) move ahead without battlefield preparations and (2) advance coordination without possessing the five days of provisions that would be necessary in normal planning.

Supply Lines Were Not Secure

Russia believed it would be able to rapidly advance on Kyiv and, by doing so, could decapitate the Ukrainian government and secure a rapid victory. The Russian Army's initial movements were intended as rapid advances, and it managed to move a substantial force forward. However, in attempting this effort, Russian forces did not attempt to ensure adequate supply lines. The forces were intended to conduct a rapid assault with a rapid collapse, not a prolonged campaign (Schiffrin and Quran, 2022). Russian forces were poorly equipped and poorly trained to defend extended lines of sustainment. Ukrainian forces understood and exploited these limitations by attacking on multiple fronts and forcing Russian units into a defensive posture. The Russian units—poorly equipped and poorly trained for defense in depth—failed to repel attacks, which resulted in the loss of materiel for the maneuver forces (Fiore, 2017, p. 1). Indeed, the assaulting units were forced to send large numbers of troops back along corridors to defend supply lines, thus slowing the initial movement (Berkowitz and Galocha, 2022).

This quick pace also caused units to become separated, which led to communications problems and, in turn, an inability to effectively manage logistics requirements. BTGs were either not communicating

Russian forces were poorly equipped or trained to defend extended lines of sustainment. Ukrainian forces understood and exploited these limitations by attacking on multiple fronts and forcing Russian units into a defensive posture.

with support forces concerning need and location or they were communicating on easily intercepted and unencrypted civilian cell phones (Crowther, 2022). In cases where communications were easily intercepted, Ukrainian forces were able to locate and attack the resupply forces (Berkowitz and Galocha, 2022).

Air Fires Were Not Available, Increasing the Need for Ground-Based Fires Requiring Resupply

Air-delivered fires can ease the burden on artillery and ground transportation. Indeed, Russian fires doctrine calls for the use of fixed-wing aviation to both supplement and replace ground-based fires. Resupply takes place away from the immediate point of engagement; transportation of resupply can take advantage of well-established infrastructure into bases.

However, air-delivered fires also take a considerable amount of training and coordination to be

Mobility on the limited road network in Ukraine posed a serious challenge to Russian ground forces—particularly, for logistical forces.

effective, which Russian forces had not performed. According to Bronk (2022),

Running joint engagement zones in which combat aircraft and SAM [surface-to-air missile] systems can engage enemy forces simultaneously in a complex environment without friendly fire incidents is hard; it requires close inter-service cooperation, excellent communications and regular training to master.

Because this training was not carried out, the Russian air force played no significant role in the ground battle.

The result of this ineffective support was that Russia made even heavier use of artillery fire both in its initial invasion and in subsequent campaigns. In turn, use of such fires required use of ground transportation to resupply artillery batteries, adding to what was an already overburdened system. Of particular note, rocket-propelled artillery imposed an even more significant burden on transportation than conventional artillery that could quickly consume the dry cargo capacity of the MTOs. The high demand imposed by artillery sustainment explains the Russian practice seen in Ukraine of creating dumps where ammunition stocks can be built up over time to support attacks.

This additional demand for artillery was not expected but was the result of Russia's inability to establish air superiority and provide air fires. Indeed, not only were these air forces not available to reduce

the burden on ground-based logistics, but they also were not available to protect ground forces from Ukrainian attacks.

Reliance on a Limited Road Network Created Bottlenecks

In the hypothetical calculations, we showed the challenges of resupply with trucks moving at the average speed of 45 miles per hour. Such movement would require roads in good condition, unobstructed by other traffic, and not interdicted by enemy attacks.

Mobility on the limited road network in Ukraine posed a serious challenge to Russian ground forces—particularly, for logistical forces. Although “tracked vehicles might be able to move alongside the road where the terrain is reasonably permissive, trucks carrying ammunition, fuel or food cannot, which has crucially impeded the Russian advance” (Dalsjö, Jonsson, and Norberg, 2022, p. 12). According to Russian doctrine, logistics battalions should move at an advance rate of 20 to 30 kilometers per day, while actual movement early in the campaign was less than half that amount (Clark, Barros, and Stepanenko, 2022; Cranny-Evans and Kaushal, 2022).

Long convoys of vehicles were seen stopped by the traffic on the roads for days. Russian convoys were also attacked by Ukrainian ground forces that had not been cleared from Russian rear areas and by Ukrainian artillery that could reach the roads used to deliver supplies. Those conditions made sustainment of the attacks on Kyiv extremely difficult. These difficulties ranged from rearming to the evacuation of wounded personnel. As one source reported with respect to medical evacuation, “stretched lines of communication made it difficult to transport wounded soldiers to hospitals, probably increasing the death toll unnecessarily” (Dalsjö, Jonsson, and Norberg, 2022, p. 15). The potential impact on morale from this inability to evacuate is not specifically known, but the combined effects of undelivered support and then the lack of urgency in evacuating the wounded likely affected the forces' will to fight.

Operational Logistics for the Initial Assault Were Wholly Insufficient, Both in Planning and Execution

The operational logistics of supporting an invasion has challenges that go beyond the normal resupply of a force engaged in peacetime operations or even defense of static lines in conflict conditions. An invasion requires movement against an opposing force. Large-scale movements of motorized or mechanized forces require extensive logistics support and coordination. This support was not generally available to the Russian Army in the early stages of the war and caused the initial failure to reach objectives.

Russian assault forces were forced to a standstill as they reached Kyiv's suburbs. Russian units abandoned vehicles and left the field (Jones, 2022). These defeats occurred, in part, because assault forces could not defend against Ukrainian antiarmor munitions but also because support forces could not reliably provide resupply to forces that were supposed to be carrying out an assault instead of defending rear areas and supply lines. The failure to achieve objectives resulted in reorientation of forces away from Kyiv and into the eastern areas that had been under dispute for years. Although this diversion into eastern areas might have posed fewer operational logistics challenges, it was not the war Russia had planned and different shortfalls emerged, which we consider next.

Sustainment Shortfalls

We focused on the logistics of supporting an invasion in the previous section because this was the first thing to fail. However, in the next phase of the campaign, where the lines became mostly static, Russian forces still lacked essential materiel to continue the fight. This is best addressed as a failure of sustainment.

With sustainment, as with operational logistics, we are dealing with functions and requirements, but not necessarily doctrinal definitions. The U.S. Army uses the following definition of *sustainment* (Army Doctrine Publication 4-0, 2019):

Russian assault forces were forced to a standstill as they reached Kyiv's suburbs. The failure to achieve objectives resulted in reorientation of forces away from Kyiv and into the eastern areas that had had been under dispute for years.

For the Army, sustainment is the provision of logistics, financial management, personnel services, and health service support necessary to maintain operations until successful mission completion. Sustainment is accomplished through the coordination, integration, and synchronization of resources from the strategic level through the tactical level in conjunction with our joint and multinational partners.

Not every nation—or even every service—uses the same definition, but the U.S. Army's definition captures the important tenet that sustainment happens *throughout* an operation. Sustainment is not only a matter of having the physical ability to transport; it also requires a preconflict inventory level of materiel sufficient to meet prospective demand and then a consistent ability throughout the war to resupply combat losses, parts use, and ammunition expenditure. Sustainment is also specific to the military. Although sustainment depends on the national economy, the intended uses are military. We will consider the broader questions of strategic logistics in the final section.

Russia's shift to the east and south reduced sustainment challenges because the support was focused more on interior lines between well-protected railheads, local storage depots, and then to firing units.

Sustainment Issues Began Early and Got Steadily Worse

As early as mid-March 2022, Russian forces were dealing with shortages of everything from fuel to precision munitions (Van Brugen, 2022a). Russian forces have lacked medical supplies since early in the war, which, along with evacuation, reportedly led to increased losses of its personnel (Institute for the Study of War, 2022; "EXPLAINER: Russia's Military Woes Mount . . .," 2022). These shortages, to a degree, were a consequence of the transportation issues discussed earlier; but, in some cases, these shortages persisted even when the forces were effectively static.

The April Shift in Russia's Campaign Initially, but Only Temporarily, Improved Sustainment

After failing to achieve its initial goal of rapidly capturing Kyiv, Russia shifted its campaign in early April 2022 to focus on eastern and southern Ukraine. Forces shifted away from the Ukrainian capital into a narrower campaign to seize territory in the southern and eastern areas of Ukraine (Kramer and MacFarquhar, 2022). The Donets Basin (Donbas),

parts of which had been controlled by separatists and is located on the eastern edge of Ukraine, was the base of operations for drives further to the south and east. The campaign emphasized heavy use of artillery against defended positions—including cities—and then a slow advance, with no presumption of mobility.

Because Russian forces operating from Donbas were able to advance on broad fronts and secure their rear areas, the road network did not impose as many constraints as the drive toward Kyiv did. Additionally, the proximity of Russian-occupied territory and its rail network reduced the movement challenges.

Thus, Russia's shift to the east and south reduced sustainment challenges because the support was focused more on interior lines between well-protected railheads, local storage depots, and firing units. Being in close proximity to ammunition resupply allowed batteries to keep up a near-constant barrage on Ukrainian positions. If units could stay in close proximity to resupply, they could function. According to Ukrainian sources, Russia was able to use approximately 60,000 rockets and artillery rounds per day against Ukrainian targets, in contrast to the 6,000 artillery rounds that Ukrainian forces were using (Schogol, 2022). By May 2022, Russia was crowdsourcing to provide its forces with clothing, food, water, and medical supplies, and there is evidence that the massed and persistent barrages were damaging Ukrainian morale and allowing a slow advance of Russia forces in April and May. By June, Ukraine's position in the cities of Severodonetsk and Lysychansk were thought to be precarious (O'Grady, Galouchka, and Sonne, 2022).

Ukrainian Receipt of Standoff Weapons Decisively Affected Russian Sustainment

Beginning in June, however, Ukrainian forces began receiving the M142 High Mobility Artillery Rocket Systems (HIMARS), each carrying a pod of six Guided Multiple Launch Rocket System (GMLRS) missiles, with each missile having a 200-pound fragmentation warhead and 42-mile range ("US Confirms Delivery to Ukraine of 4 M142 HIMARS

Rockets/Missiles Launcher Vehicles,” 2022). Even with a limited delivery of four HIMARS and limited numbers of GMLRS rounds, Ukraine was able to attack Russian supply depots, including their ammunition. Russian supply depots were indeed driven rearward by up to 25 miles by the threat of Ukrainian HIMARS/GMLRS fires (Osborn, 2022).

Since then, a steady stream of reports suggest that basic shortages have only gotten worse (Sauer, 2022). There are accounts of equipment in storage for extended periods that lacked components when returned to service—parts having already been cannibalized or outright stolen (Reich and Starr, 2022). Recently, Russia has been forced to bring older equipment, such as Cold War-era T-62 tanks, back into service to replace war losses (Kadam, 2022). Its artillery ammunition has also been running low, according to reports from October 2022 (“Russia Scrambles to Increase Weapons Production for Ukraine War,” 2022).

Ukrainian ability to use standoff munitions has had a marked effect on Russian sustainment. Russia was again forced to rely on trucks to move munitions. We established that resupply in this manner is difficult in ideal conditions—and, in this situation, the conditions were highly contested. Russian resupply dropped to a trickle, allowing Ukrainian forces to reconstitute, reposition, and launch a counteroffensive in late August 2022, which recaptured parts of eastern Ukraine (Sauvage, 2022).

Ukrainian use of standoff munitions no doubt had other effects on Russian mobility and operational tempo, but we will not attempt to assess whether these effects were more significant or less so than the impact on sustainment. However, it is clear that the HIMARS/GMLR combination greatly complicated Russia’s ability to resupply even relatively static battle lines.

The Role of Corruption

Corruption, varying from outright theft of materiel to systematic misreporting of actual readiness, may have played a role in the supply collapse (Shikman, 2022). Various kinds of corruption were apparently present in the Russian military and its support complex. The impact of corruption became appar-

The impact of corruption became apparent very early in the Russian campaign with, for example, accounts of units operating with rations that had expired seven years prior.

ent very early in the Russian campaign with, for example, accounts of units operating with rations that had expired seven years prior (Aitken, 2022). With sustainment capacity already on a narrow edge, unexpected shortages were likely to be particularly damaging. If supplies are intended to be “just in time” but are either missing or never show up, the consequences are likely to be felt in mission failure.

Problems with Arms Performance Contributed to Sustainment Shortfalls

To a degree, the failure to ensure resupply of artillery is a matter of operational logistics and the deficiencies we have already covered. However, the continuous need to shift to unguided rounds and keep forces back from immediate engagements speaks to a broader sustainment problem. Many arms used by Russian troops have not operated correctly due to lack of maintenance. For example, “while Russia expended over 1,900 short- and medium-range missiles in Ukraine during the first two months, performance and effect has been poor, with a reported daily failure rate of up to 60% for some types” (Dalsjö, Jonsson, and Norberg, 2022, p. 13).

Russia's lack of sustainment—particularly of weapons—can be partially attributed to its heavy reliance on Western parts.

Russian Sustainment Has Been Ad Hoc and Largely Insufficient

If the war had been over as quickly as Russia expected, sustainment issues might not have been a significant problem. However, as the war went on, sustainment shortfalls became debilitating (Troianovski, 2022). Russia's lack of sustainment—particularly of weapons—can be partially attributed to its heavy reliance on Western parts. At the start of the war, Russia was placed under economic sanction and denied access to key commodities. Lack of access to key commodities limited Russia's ability to manufacture equipment necessary to continue military operations (U.S. Department of State, 2022). These included semiconductors, the lack of which affects Russia's ability to manufacture any weapons more sophisticated than artillery rounds (Gould, 2022).

These “supply chain challenges will likely affect Russia's short- and long-term supply of components to conduct stand-off attacks, forcing Russia to look for substitute markets” (Jones, 2022, p. 4). It is not just missile production that has been an issue in Russia. Two of Russia's leading tank manufacturers have been forced to stop production due to a lack of parts (Jones, 2022, p. 6). Russia may also have been hesitant to use such advanced weapons as Iskander-M missiles in case Russian forces need to defend themselves from the North Atlantic Treaty Organization (NATO) (Jones, 2022, p. 4). But, as a general matter, Russian forces were simply not receiving all manner

of supplies. For a variety of reasons, the materiel needed to carry out a war was not reaching the forces charged to fight it (Van Brugen, 2022b).

Although some of this failure is likely due to poor organization, insufficient transportation, and specific limitations related to sanctions, many of the shortfalls likely trace back to broader limitations on the Russian economy—limitations related to *strategic logistics*, which we will discuss next.

Strategic Logistics Failures

There is no specific doctrinal definition of *strategic logistics*. There are, however, elements of national economic power that are essential to the exertion of national influence, including fighting a war. In this report, we are looking at Russia's ability to impose and overcome economic sanctions, operate industries in a contested environment, and provide resupply. For our purposes, we use *strategic logistics* in a manner similar to what Henry Eccles used to describe logistics in general: “. . . the bridge between the economy of the Nation and the tactical operations of its combat forces” (Paparone and Topic, 2014).

Thus far, we have essentially described problems of organization and military transportation, not necessarily the inability of the economy to make enough equipment to support a war. However, this lack of capacity to make enough things may be the most fundamental limitation on Russia's ability to continue this war and also keep its economy functioning in a wartime setting. “They've fired thousands of missiles, of artillery shells. Even without the sanctions, they would be having trouble” (Tegler, 2022). This limitation is related both to the defense industrial base—the set of capabilities that directly allows Russia to produce defense materiel—and to the overall ability of the economy to create productive capability overall.

Russia's Defense Industrial Base Was Too Small and Too Dependent on the West to Cope with Sanctions

Even if a nation does not have a generally productive economy, it can still maintain a credible defense

industrial base sufficient to support limited operations. Examples could include the Axis powers in World War II, which were able to sustain a war effort by focusing heavily on the production of war materiel, despite not possessing the wealth or industrial capacity of its allied opponents (Feldgrau, undated).

Turning to Russia immediately prior to the war, it had a sizable defense industry that made up roughly 20 percent of its manufacturing sector. Russia was capable of designing, developing, and producing a full range of advanced air, land, missile, and naval systems. Although, since 2010, it has imported limited amounts of military hardware from several countries, including the Czech Republic, France, Iran, Israel, Italy, Turkey, and Ukraine. Its defense budget in 2019 was estimated to be approximately \$104 billion. As of the time of this writing, Russia is the world's second largest exporter of arms, behind the United States (Central Intelligence Agency, 2022b).

Despite these apparent capabilities, the Russian defense industrial base has not kept up with the demands of what was supposed to be a limited war. As of January 2023, there were reports that the Russian army might be down to “one more month of ammunition” (McGrath, Doyle, and Crabtree, 2022). This is not an issue of poor distribution or a poor plan for sustainment, but rather the inability to make weapons and ammunition.

Much of this shortfall can be attributed to sanctions, which directly target defense industries, which have become, in some respects, highly dependent on Western suppliers (Farley, 2022). However, Russia's defense industry was declining before the war and the imposition of sanctions, in part, due to budget cuts and the impact from coronavirus disease 2019–related disruptions (McGerty, 2020). There appears to have been no effort to shift from a limited defense sector focusing on an export market toward one ready to produce sufficient weapons for even a limited war, let alone a war lasting several months.

Russia's defense industry was declining before the war and imposition of sanctions, in part, due to budget cuts and impact from COVID-19–related disruptions.

Russia's Economy Depends on Energy Production and Has Limited Industrial Capacity

But the overall weakness of the defense industrial base likely reflects an overall weak economy, largely dependent on energy production and to a lesser extent on agricultural exports. Russia's nominal gross domestic product (GDP) in 2022 was \$2.13 trillion, ninth in the world behind Canada and ahead of Italy (Central Intelligence Agency, 2022a). This relative wealth depends heavily on energy resource exports. Its economy has limited manufacturing, research, or service capabilities. Russia relies on revenue from energy resource production, allowing it to buy rather than produce most of the goods in its economy (Lau, 2022). Of its ten biggest companies, six are related to oil and gas, and two others are related to mines and minerals (Wallach, 2021). In 2019, the oil and gas sector accounted for about 60 percent of Russia's exports, 40 percent of its federal budget revenues, and 14 percent of its GDP (Davydova, 2021).

Because much of Russia's economy depends on oil and gas, its ability to carry out a military campaign depends heavily on maintaining oil and gas production. In the years leading up to the Ukraine invasion, Russia's military operational tempo varied with the price of oil and the resulting oil revenue (Martin et al., 2021). When it has ample energy revenue, it can

Although it was clearly in Russia's interest to keep Ukraine from exporting grain, the consequences of interrupting the exports were sufficient to keep Russia from exploiting this vulnerability.

operate its military. When it does not, it has no good means of sustaining and resupplying an army.

Being a major exporter of oil and gas does confer strategic advantages on Russia, giving it leverage over countries that rely on Russian oil and gas. Indeed, sanctions on Russian energy exports to Western countries may have served only to increase energy prices and allow Russia to continue exporting fuel to countries not participating in the sanctions, some of which include China and India (Pettinger, 2022). Nevertheless, Russia's ability to gain oil revenue still substantially depends on the economic health of the nations supporting Ukraine. In March 2022, one-half of Russia's crude oil exports and 75 percent of its natural gas exports went to countries in the European Union ("By the Numbers: Where Do Russia's Energy Exports Go?" 2022). When the nations of the European Union prosper, they consume oil and gas; they also retain the ability to produce the kinds of military equipment needed by Ukraine or can carry out robust trade with the nations that do. Russia's reliance on exports causes it to sustain the economies that are creating the means for opposing its military.

Russia is the world's largest wheat exporter, and Ukraine is the fifth—another instance in which Russia's position as an exporter created as much leverage against it as for it (Workman, undated). Russia's abil-

ity to both control its wheat exports and stop the flow of Ukraine's could have been a significant strategic vulnerability for the West—who, while producing large amounts of grain, probably could not have met the demand for grain without exports from Russia and Ukraine. Russia opted to refrain from interfering in these exports, largely to avoid the appearance of creating a famine for political ends ("Russia and Ukraine Sign Grain Export Deal: What You Should Know," 2022). A key point is that vulnerabilities are symmetric. Although it was clearly in Russia's interest to keep Ukraine from exporting grain, the consequences of interrupting the exports were sufficient to keep Russia from exploiting this vulnerability. Russia's economy largely depends on the ability to export, which seriously limits its ability to carry out a war when its export customers are belligerents or allies of belligerents.

Russia Also Lacks a Sufficient Labor Pool for an Extended War

Russia began the war believing it had sufficient personnel in its military for the likely campaign. This assumption proved to be incorrect as the war went on for longer than Russia expected, with a far larger casualty count (Stewart and Ali, 2022). This shortfall led to a "military mobilization" in September, which, besides being extremely unpopular with the Russian population, might create unsustainable impact on the Russian economy in the future. One Russian economist has predicted that the Kremlin's exclusive focus on mobilization and war efforts will divert government funds away from investment in business and the economy and that the military draft will cause the labor market to lose millions of men between direct conscription and those attempting to avoid the draft by emigrating or avoiding work altogether (Lau, 2022).

From the perspective of strategic logistics, Russia entered the war with insufficient numbers of personnel to both man its Army and man what production capacity it had. The ultimate outcome appears to have been that neither was adequately supported.

The Strategic Logistics Failures Contain a Familiar Theme: Simple Lack of Planning

No nation is likely to begin a war with a complete understanding of its vulnerabilities. However, Russia appears to have entered the war in Ukraine with little appreciation for areas where it was—and continues to be—vulnerable. Although Russia’s economy has not collapsed, it has contracted, and its ability to produce war materiel has been significantly degraded. Russia appears to be betting that it can keep fighting for long enough that Western support will diminish to the point that it ceases support for Ukraine (U.S. Department of State, 2022).

Whether this bet will pay off remains to be determined. But it appears that Russia entered this war with more hope than rational planning as to its likely outcome. Russia generally lacks the strategic means to continue a war under broad sanctions. Although Russia does have points of economic leverage over the West, such as energy, these factors to date have only been enough to create inconvenience, not victory.

Overall Conclusions

In offering these conclusions, we are not asserting that operational logistics, sustainment, or strategic logistics failures were, by themselves, decisive. Indeed, the outcome of the war overall is still to be decided. However, we know that multiple logistics and sustainment systems and processes did fail, leaving Russian soldiers without the means to fight and with an almost certain impact on morale. However, Russia’s invasion may have cautionary value for any force planning a prolonged fight and potential insight into how a nation can defend itself against an aggressor trying to carry out a complicated operation with major support requirements.

Key Findings

- Russia was unable to provide critical supplies to its invasion forces early in its campaign to rapidly seize territory. This shortfall appears to be largely the result of underestimating the

Although Russia does have points of economic leverage over the West, such as energy, these factors to date have only been enough to create inconvenience, not victory.

- resistance encountered. Russia did not provide for adequate capacity because it did not believe such a capacity would be necessary.
- Under highly favorable assumptions, Russia would be theoretically capable of logistically supporting its original invasion concept. However, the conditions required would have been favorable to the point of being completely unrealistic. Ukraine would have had to have offered little or no resistance. Trucks would need to have been operable to a degree rarely seen in any army. Traffic flow would have had to be essentially unimpeded. In a basic sense, Russia’s failures in the war with Ukraine were due to poor planning in that Russia did not correctly assess the logistics requirement for the plan it tried to implement, even if it possessed the capacity.
- The Russian army lacks the logistics force structure to support rapid movement, but it does seem to possess sufficient force structure to carry out campaigns where it has a road network ready to connect railheads to the battlefield, for at least some period of time. If Russia had followed a plan that was more attuned to the strengths and capabilities of its

CAAs, the plan would have been more in line with MTO capabilities.

- However, such a plan would not have been a rapid movement and might have accentuated some of Russia's sustainment and strategic logistics limitations even sooner than how it actually occurred in the campaign. Operational logistics for the initial invasion might have been more effective, but the failure to provide commodities went beyond a simple lack of transportation.
- Ukrainian use of standoff munitions, which became prevalent during a period in which Russian use of artillery along static lines was beginning to have an impact, significantly disrupted Russian sustainment. Russian artillery ammunition could no longer be collocated with firing batteries. All supply depots became vulnerable to attack, and Russia had to begin relying on the already stressed ground transportation system. Russia could only effectively sustain forces near a railhead in Russian territory.
- Over the course of the conflict, basic issues of poor maintenance and supply support, compounded by lack of trained and effective maintenance personnel, have affected Russia's ability to carry out the war. To a degree, Russia's inability to carry out even basic sustainment has led to failure on the battlefield.
- Over the longer term, Russia does not have the capacity for a long war in the face of economic sanctions. Although it can continue to generate revenue from oil and gas exports, it does not have the ability to manufacture advanced weapons or even sufficient materiel to keep an Army fielded.

Broader Implications

In the early parts of its campaign, Russia found that road network constraints made logistics support tenuous. It found in later stages of its campaign that deep fires made its supply depots vulnerable and its transportation system for resupply very difficult. If it were to fight NATO, the deep fires threat to its supply depots could be so severe as to render Russia's logistical concept of operation untenable. That would require Russia to improvise a dispersed concept based on small supply caches, which would add to the challenges of managing and moving sustainment, likely with negative implications for its ground combat operations.

This situation is similar in many respects to requirements for logistics support and sustainment in other theaters and with other nations. Even a military as well prepared and capable as the U.S. joint force might operate under promising assumptions as far as its ability to support extended operations, either in the geographic or the temporal sense. As a more general cautionary lesson, however, Russia is not the first nation to underestimate logistics and sustainment requirements as it entered a campaign that proved to be longer than expected. When Russia failed to execute its initial campaign, various shortfalls in defense production, basic sustainment, and overall readiness for a sustained conflict became apparent. These factors were not to the point of immediately costing Russia the war, but they were to the point that the cost-benefit assessment of the invasion was becoming an issue that needed to be considered. We refrain from a discussion of the broader strategic environment concerning maintenance of international influence and simply note that Russia has been engaged in a conflict since February 2022 with a country it believed to be singularly weak and now labors under sanctions and a diminished economy.

Bibliography

- Aitken, Peter, "Ukraine War: Russia's Corruption Is 'No Doubt' Affecting Its Military's Combat Performance," *Fox News*, March 6, 2022.
- Army Doctrine Publication 4-0, *Sustainment*, Department of the Army, July 2019.
- Baker, Ryan, "The Russian Invasion Has Some Logistical Problems. That Doesn't Mean It's Doomed," *Washington Post*, February 28, 2022.
- Berkowitz, Bonnie, and Artur Galocha, "Why the Russian Military Is Bugged Down by Logistics in Ukraine," *Washington Post*, March 30, 2022.
- Bronk, Justin, "The Mysterious Case of the Missing Russian Air Force," Royal United Services Institute, February 28, 2022.
- "By the Numbers: Where Do Russia's Energy Exports Go?" *Russia Matters*, March 25, 2022.
- Central Intelligence Agency, "Russia, Economy," *The World Factbook*, October 31, 2022a.
- Central Intelligence Agency, "Russia, Military and Security," *The World Factbook*, October 31, 2022b.
- Clark, Mason, George Barros, and Kateryna Stepanenko, "Russian Offensive Campaign Assessment, March 12," Critical Threats Project, March 12, 2022.
- Cranny-Evans, Sam, and Sidhartha Kaushal, "Not Out of the Woods Yet: Assessing the Operational Situation in Ukraine," Royal United Services Institute, March 14, 2022.
- Crowther, Alexander, "Russia's Military: Failure on an Awesome Scale," Center for European Policy Analysis, April 15, 2022.
- Dalsjö, Robert, Michael Jonsson, and Johan Norberg, "A Brutal Examination: Russian Military Capability in Light of the Ukraine War," *Survival*, Vol. 64, No. 3, 2022.
- Davydova, Angelina, "Will Russia Ever Leave Fossil Fuels Behind?" *BBC*, November 23, 2021.
- Durkee, Alison, "Russia's Soldier Shortage: Here's Why It's Recruiting Foreign Fighters," *Forbes*, March 10, 2022.
- Edmonds, Jeffrey, "Start with the Political: Explaining Russia's Bungled Invasion of Ukraine," *War on the Rocks*, April 28, 2022.
- "EXPLAINER: Russia's Military Woes Mount Amid Ukraine Attacks," Associated Press, October 6, 2022.
- Farley, Robert, "Russia's Defense Industry Is in Serious Trouble Due to Sanctions," *19FortyFive*, August 28, 2022.
- Feldgrau, "A Germany-Soviet Military-Economic Comparison," webpage, undated. As of March 21, 2023: <https://www.feldgrau.com/WW2-Germany-Soviet-Military-Economic-Comparison/>
- Fiore, Nicolas J., "Defeating the Russian Battalion Tactical Group," *Armor*, Spring 2017.
- Friedman, George, "Russian Military Doctrine," Geopolitical Futures, July 5, 2022.
- Global Firepower, "2023 Russia Military Strength," webpage, undated. As of March 21, 2023: https://www.globalfirepower.com/country-military-strength-detail.php?country_id=russia
- Gould, Joe, "New US Sanctions Target Russia's Multibillion-Dollar Defense Sector," *Defense News*, March 2, 2022.
- Grau, Lester W., and Charles K. Bartles, *The Russian Way of War: Force Structure, Tactics, and Modernization of the Russian Ground Forces*, Foreign Military Studies Office, 2016.
- Institute for the Study of War, "Ukraine Conflict Updates," webpage, August 15, 2022. As of May 19, 2023: <https://www.understandingwar.org/backgrounder/ukraine-conflict-updates>
- Johnson, Rob, "Dysfunctional Warfare: The Russian Invasion of Ukraine," *Parameters*, Vol. 52, No. 2, 2022.
- Johnson, Michael, and Brent Coryell, "Logistics Forecasting and Estimates in the Brigade Combat Team," *Army Sustainment*, November–December 2016.
- Jones, Seth, "Russia's Ill-Fated Invasion of Ukraine: Lessons in Modern Warfare," *CSIS Briefs*, June 2022.
- Kadam, Tanmay, "Biggest Upgrade in History? Russia to Reactivate 800 Cold War-Era T-62 Tanks Amid Depleting Arsenal," *Eurasian Times*, October 14, 2022.
- Kasapoglu, Can, "A Winning Strategy in Ukraine," Hudson Institute, March 7, 2022.
- Kramer, Andrew E., and Neil MacFarquhar, "Russia in Broad Retreat from Kyiv, Seeking to Regroup from Battering," *New York Times*, April 2, 2022.
- Lau, Yvonne, "The Russian Economy Will 'Die by Winter' Because of the 'Catastrophic Consequences' of the Military Mobilization, a Top Russian Economist Warns," *Fortune*, September 26, 2022.
- Marine Corps Tactical Publication 3-40C, *Operational-Level Logistics*, U.S. Marine Corps, May 2, 2016.
- Martin, Bradley, Paul DeLuca, Kristen Gunness, Michael Junge, and Melissa Shostak, *U.S. Naval Forces Europe Cost Imposition Strategies*, RAND Corporation, April 2021, Not available to the general public.
- McGerty, Fenella, "Budget and Pandemic Present Challenges to Russia's Defence Industrial Base," International Institute of Strategic Studies, August 17, 2020.
- McGrath, Ciaran, Liam Doyle, and Emma Crabtree "Putin Faces Missile Crisis as Russian Army May Only Have Enough Ammunition to Last a Month," *Daily Express*, Nov 26, 2022.
- O'Brien, Philips Payson, "How the West Got Russia's Military So, So Wrong," *The Atlantic*, March 31, 2022.
- O'Grady, Siobhán, Anastacia Galouchka, and Paul Sonne, "'They're in Hell': Hail of Russian Artillery Tests Ukrainian Morale," *Washington Post*, June 3, 2022.
- Osborn, Kris, "Who Needs Air Superiority? U.S. GMLRS Are Pounding Russia In Ukraine," *National Interest*, August 11, 2022.
- Paparone, Christopher R., and George L. Topic, Jr., "The 'Clausewitz' of Logistics: Henry E. Eccles," U.S. Army, January 13, 2014.
- Pettinger, Tejvan, "Russia v Europe—Impact of Economic Sanctions," *Economic Help*, October 3, 2022.
- Reich, Aaron, and Michael Starr, "Ukraine-Russia War: Russia Forced to Use Outdated Soviet Equipment—GUR," *Jerusalem Post*, April 24, 2022.

“Russia and Ukraine Sign Grain Export Deal: What You Should Know,” Al Jazeera, July 22, 2022.

“Russia Scrambles to Increase Weapons Production for Ukraine War,” Al Jazeera, October 26, 2022.

Sauer, Pjotr, “‘The Army Has Nothing’: New Russian Conscripts Bemoan Lack of Supplies,” *The Guardian*, October 20, 2022.

Sauvage, Grégoire, “Ukrainian Counteroffensive: Kyiv Could ‘Seize Kherson Before the Winter,’” *France 24*, July 9, 2022.

Schifrin, Nick, and Layla Quran, “Russia Begins Assault on Kyiv Amid Fierce Fighting Across Ukraine as U.S. Sanctions Putin,” *PBS NewsHour*, February 25, 2022.

Schogol, Jeff, “Russia Is Hammering Ukraine with Up to 60,000 Artillery Shells and Rockets Every Day,” *Task & Purpose*, June 13, 2022.

Shikman, Paul D., “How Russian Corruption Is Foiling Putin’s Army in Ukraine,” *U.S. News and World Report*, August 31, 2022.

Stewart, Phil, and Indrees Ali, “More Than 100,000 Russian Military Casualties in Ukraine, Top U.S. General Says,” *Reuters*, November 9, 2022.

Tegler, Eric, “A New Kremlin ‘Committee’ Won’t Accelerate Production of Weapons for Russian Troops in Ukraine,” *Forbes*, October 26, 2022.

Trew, Bel, and Jane Dalton, “Russia Suspends Grain Export Deal with Ukraine After ‘Drone Attack’ on Black Sea Fleet,” *Yahoo! News*, October 29, 2022.

Troianovski, Anton, “Drones. Crutches. Potatoes. Russians Crowd Fund Their Army,” *New York Times*, May 28, 2022.

“US Confirms Delivery to Ukraine of 4 M142 HIMARS Rockets/ Missiles Launcher Vehicles,” *Defense News*, June 3, 2022.

U.S. Department of State, “The Impact of Sanctions and Export Controls on the Russian Federation,” fact sheet, October 20, 2022.

Van Brugen, Isabel, “Russia Suffering Shortages, Struggling to Sustain Troops: Pentagon,” *Newsweek*, March 18, 2022a.

Van Brugen, Isabel, “Russia Admits It’s Running Out of Equipment for Mobilized Soldiers,” *Newsweek*, October 27, 2022b.

Vershinin, Alex, “Feeding the Bear: A Closer Look at Russian Army Logistics and the Fait Accompli,” *War on the Rocks*, November 23, 2021.

Vershinin, Alex, “The Return of Industrial Warfare,” commentary, *Royal United Services Institute for Defence and Security Studies*, June 17, 2022.

Wallach, Omri, “The Top 10 Biggest Companies in Russia,” *Visual Capitalist*, December 14, 2021.

Watling, Jack, and Nick Reynolds, *Operation Z: The Death Throes of an Imperial Delusion*, *Royal United Services Institute for Defence and Security Studies*, April 22, 2022.

Workman, Daniel, “Wheat Exports by Country,” *World’s Top Exports*, webpage, undated. As of May 19, 2023: <https://www.worldstopexports.com/wheat-exports-country/>



The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest.

Research Integrity

Our mission to help improve policy and decisionmaking through research and analysis is enabled through our core values of quality and objectivity and our unwavering commitment to the highest level of integrity and ethical behavior. To help ensure our research and analysis are rigorous, objective, and nonpartisan, we subject our research publications to a robust and exacting quality-assurance process; avoid both the appearance and reality of financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursue transparency in our research engagements through our commitment to the open publication of our research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. For more information, visit www.rand.org/about/research-integrity.

RAND's publications do not necessarily reflect the opinions of its research clients and sponsors. **RAND**® is a registered trademark.

Limited Print and Electronic Distribution Rights

This publication and trademark(s) contained herein are protected by law. This representation of RAND intellectual property is provided for noncommercial use only. Unauthorized posting of this publication online is prohibited; linking directly to its webpage on rand.org is encouraged. Permission is required from RAND to reproduce, or reuse in another form, any of its research products for commercial purposes. For information on reprint and reuse permissions, please visit www.rand.org/pubs/permissions.

For more information on this publication, visit www.rand.org/t/RR-A2033-1.

© 2023 RAND Corporation

www.rand.org

About This Report

The armed forces of Russia invaded Ukraine on February 24, 2022. Given the apparent overwhelming imbalance in military size and capability between Ukraine and Russia, this operation was expected—both by Russian leadership and external observers—to last no more than a matter of weeks. The attack failed to achieve its stated objectives, in part because of poor planning and lack of capacity in logistics and sustainment. Similar issues have persisted through the time that this report was written in January 2023. This report examines the issues of logistics and sustainment facing the Russian armed forces throughout this campaign.

National Security Research Division

This research was sponsored by RAND research support within the Acquisition Technology Policy Center of the RAND National Security Research Division (NSRD), which operates the National Defense Research Institute (NDRI), a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense intelligence enterprise.

For more information on the RAND Acquisition Technology Policy Center, see www.rand.org/nsrd/atp or contact the director (contact information is provided on the webpage).

Acknowledgments

We gratefully acknowledge the support of Barbara Bicksler. We also thank Christopher Mouton and Yun Kang for their support. Finally, we thank our reviewers Gian Gentile and George Topic.