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Penetrating An Arctic A2ad Zone: A Consideration Of Recent Concepts For A Future Uk Amphibious Force Structure[1]

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Introduction

This paper considers the role and employment of UK amphibious forces in the High North. In particular, it addresses the employment of the amphibious force structure and doctrine in the Arctic battlespace proposed in a recent Royal United Services Institute occasional paper.[3] The key question addressed is: *What aspects of the Arctic battlespace should be considered in proposing a UK amphibious force structure?*

The increasing significance of the littoral environment in the geopolitics of the 21st Century has become clear in recent history, as has the ability to dominate such a battlespace by the application of force from specific points. Not only has the economic

[1] This paper represents the opinions of the author. No connection with the views of Her Majesty's government is mplied, or should be inferred.

[2] Scott Polar Research Institute, University of Cambridge.

[3] Sidharth Kaushal and Jack Watling, *Requirements for the UK's Amphibious Forces in the Future Operating Environment* (London: Royal United Services Institute, 2019). https://rusi.org/sites/default/files/201911_op_requirements_for_the_uks_amphibious_forces_in_the_future_operating_environment_kaushal_watling_web.pdf

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and political value of littoral zones increased, so too has the technological ability to exert dominance over them – particularly through the application of surface to air and anti-shipping missiles. Much of the discussion regarding this issue has centred on A2/AD zones[4]. From an historical perspective, the development of such zones may come to represent the type of watershed in maritime operations that occurred during the Second World War, in which the application of air power enabled the aircraft carrier to gain supremacy over the battleship. As the distinguished naval architect David Brown observes:

> It is often said that the battleship died because it was vulnerable. This is incorrect; it was replaced by the fleet carrier which was much more vulnerable. The battleship died because it was far less capable of inflicting damage on the enemy.[5]

The aircraft carrier remains vulnerable, but its advantage in inflicting damage in littoral waters is now challenged by coastal missile batteries that now hold it, its organic air assets, and large amphibious warfare vessels at risk if they operate in proximity to shore. Advances in missile technology have enhanced their capability to inflict damage at long range, and it remains to be seen where the balance of advantage will fall.

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4 See for example: Ionuț Alin Cîrdei, "A2AD concept in the modern security environment," In *International Conference Knowledge-Based Organization* 24, no. 1 (2018): pp. 50-57. Sciendo, 2018. DOI: 10.1515/kbo-2018- 0007; Daniel Cochran, "Will the Aircraft Carrier Survive? Future Threats to the Carrier (and How to Defend it)," *Journal of the JAPCC 27*, (Autumn/Winter 2018): pp. 22-28; William F. Cunningham, *Antiaccess/Area-Denial: Old Concepts, New Frontiers* (Fort Leavenworth United States: US Army School for Advanced Military Studies, 2015). https://apps.dtic.mil/sti/pdfs/AD1001275.pdf; Robert Dalsjö, Christofer Berglund, and Michael Jonsson, Bursting the Bubble? Russian A2/AD in the Baltic Sea Region: Capabilities, Countermeasures, and Implications (FOI-R—4651—SE. Stockholm: FOI Totalförsvarets forskningsinstitut, 2019), https://muep.mau.se/bitstream/handle/2043/30208/FOI-R--4651--SE.pdf?sequence=2&isAllowed=y;; Andrew F.Krepinevich, Barry D. Watts, and Robert O. Work, *Meeting the anti-access and area denial challenge* (Washington, DC: Center for Strategic and Budgetary Assessments, 2003). https://csbaonline.org/uploads/documents/2003.05.20-Anti-Access-Area-Denial-A2-AD.pdf; Guillaume Lasconjarias, "NATO's Response to Russian A2/AD in the Baltic States: Going Beyond Conventional?" *Scandinavian Journal of Military Studies* 2, no. 1 (2019), https://sjms.nu/articles/10.31374/sjms.18/);and William A. Perkins, "Component Integration Challenges presented by Advanced Layered Defence Systems (A2/AD),) *The Three Swords Magazine*, 33 (2018): pp. 52-64, https://www.jwc.nato.int/images/stories/threeswords/A2AD_2018.pdf.

5 David K. Brown, *Nelson to Vanguard: Warship Design and Development 1923-1945* (Barnsley UK: Seaforth Publishing, 2000/2012).

Although the use of the term A2/AD is relatively recent[6] – and some would contend, relatively loose[7] – it incorporates an ancient notion in warfare: that of being able to strike at an enemy on the battlefield from positions of geographical advantage. Such positions may accommodate missile launch sites and sensor locations, with the denied area they generate often abstracted in the literature to diagrams with circles or polygons. The reality is of course much more subtle and dynamic, with detection and engagement ranges fluctuating with asset types and environmental conditions. The denied areas are also multi-layered, consisting of overlapping systems of sensors and weapons. The ability to counter-impose a denied area, to reverse (flip) it to one's advantage as Kaushal and Watling[8] propose, is also an ancient idea, having its equivalent in military history to capturing a castle or building a redoubt in enemy territory.

Kaushal and Watling make four central propositions: [9]

- The emphasis of littoral operations must shift from manoeuvre inland to positional warfare which aims to secure and control key nodes within the littoral zone.

- Operations within the littoral must balance traditional concerns with seizing ground with efforts to constrain an opponent's freedom of action in littoral regions and thus exercise effective control.

- Operating in littoral regions will require the current exclusive emphasis on big deck assault ships to be modified in favour of a scalable force capable of operating within an opponent's anti-access bubble in order to degrade it and thus enable the insertion of heavier follow-on forces.

[6] Cunningham, *Antiaccess/Area-Denial*.
[7] Michael Kofman, "Russian A2/AD: It is Not Overrated, Just Poorly Understood," *Russian Military Analysis*, 25 January 2020. https://russianmilitaryanalysis.wordpress.com/2020/01/25/russian-a2-ad-it-is-not-overrated-just-poorly-understood/; Michael Kofman, "Western Military Thought Persists in Self-Comforting Delusions on Russian A2/AD: They do not even understand no such doctrine exists in the Russian military, its recipe is entirely different" *Anti-empire*, 28 January 2020. https://www.anti-empire.com/western-military-thought-persists-in-self-comforting-delusions-on-russian-a2-ad/
[8] Kaushal and Watling, *Requirements for the UK's Amphibious Forces.*
[9] Ibid.

- The concepts which guide littoral strikes must be conceptually focused on enabling access for the Joint Force to exploit, and thereby achieve strategic effect.

In amplification of their argument, Kaushal and Watling offer three scenarios in which they explore the application of a scalable amphibious force concept to specific littoral warfare problems: one in the High North, one in the Baltic, and one in the Persian Gulf. The non-Arctic scenarios considered in the paper lie outside the purview of this assessment. It is for others, perhaps with operational experience in the Persian Gulf or elsewhere, to determine if the approach proposed in the Kaushal and Watling report would be effective in those theatres of operation. Such experts may wish also to comment on the suitability of the US approach, geared as it is to an island assault campaign in the South China Sea, to UK amphibious tasking in a non-Arctic battlespace. Indeed, at least one commentator suspects that the A2/AD concept is a Western construct, unknown to Russian military thinking.[10]

To be clear, the fundamental precepts expounded by Kaushal and Watling are not in dispute. However, the *applicability* of the approach proposed for A2/AD penetration and reversal (flipping) to all littoral battlespaces is a serious misjudgement. It lacks detailed consideration of the combination of factors that differentiate the Northern Regions battlespace and exposes any UK force attempting such an operation to unnecessary risk. That combination is the fusion of a near-peer opponent with the need to operate in the Arctic littoral. At the same time, the Russian military has benefited from investment in sensor and weapons technology. All battlespaces have unique features. However, the question here is one of relative weight of factors under combat conditions. A common template for A2AD penetration, applied against a capable adversary *and* in a lethal and impeding environment, has an enhanced likelihood of both failure and high casualty rates.

The Arctic Littoral Environment in the Post-unipolar Era

The Arctic scenario examined in the Kaushal and Watling report describes a process under which a Russian attempt to exert A2/AD in the western boundary to the Northern Seas is reversed (flipped) by UK and NATO forces. NATO dominance over

[10] Kofman, "Russian A2/AD;" Kofman, "Western Military Thought."

the battlespace is established with three key locations, each forming the centre of overlapping circles of influence. These key points are on Svalbard, Bear Island and at Svarsvåg, respectively. In the context of a conflict with NATO, seizing part of the Svalbard archipelago, together with Bear Island and a portion of northern Norway, and establishing batteries of surface to air and anti-shipping missiles confers significant strategic benefits to Russia.[11] Not only does it block access to the Barents, but it also forces land assets away from critical Russian infrastructure on the Kola Peninsula. It can be expected that the operation would be characterised by speed of action and the use of surprise. A common perception of NATO is that the alliance is slow to act.[12] Such political reticence can be exploited militarily.

The idea of an A2/AD zone in the Arctic has featured in military thought for some years, albeit not necessarily in the form currently attracting attention. The bastion concept, of which much has been written, was intended by the Russians to protect the maritime assets of the Northern Fleet, in particular the ballistic missile submarines, against any assault by NATO.[13] Within the larger purview of this debate, the Svalbard archipelago has been a source of concern due to its location, offering a salient with the potential to dominate and control access to both the Barents and the central Arctic Ocean.[14] Russia, then the Soviet Union, was debarred from negotiations for the 1920

[11] John Ash, "Svalbard and Conflict Management in a Changing Climate: A Risk Based Approach," *Nordlit* 45 (2020): pp. 56-85. https://doi.org/10.7557/13.5027; James K. Wither, "Svalbard: NATO's Arctic 'Achilles' Heel,'" *The RUSI Journal* 163, no.5 (2018): pp. 28-37. https://doi.org/10.1080/03071847.2018.1552453; Michael Zimmerman, "High North and High Stakes: The Svalbard Archipelago Could be the Epicenter of Rising Tension in the Arctic," *PRISM* 7, no.4 (2018): pp. 106-123. https://www.jstor.org/stable/26542710

[12] Elisabeth Braw, "Why NATO Needs a Streamlined Decisionmaking Process," *The National Interest*, 1 May 2018. https://nationalinterest.org/feature/why-nato-needs-streamlined-decisionmaking-process-25649; Svein Efjestad and Rolf Tamnes, "NATO's Enduring Relevance," *Whitehall Papers*, 95 (2019): pp. 1, 8-25, DOI: 10.1080/02681307.2019.1731206; Christopher Harper, "'Game Out' Decision Making," *NATO 20/2020* (Atlantic Council, Scowcroft Center for Strategy and Security, 2020), pp. 86-90.

[13] Michael MccGwire, "Naval Power and Soviet Global Strategy," *International Security* 3, 4 (Spring, 1979): pp. 34-189.

[14] John Ash, "Svalbard and Conflict Management," pp. 56-85. https://doi.org/10.7557/13.5027; Wither, "Svalbard," pp. 28-37. https://doi.org/10.1080/03071847.2018.1552453; Zimmerman, "High North and High Stakes," pp. 106-123. https://www.jstor.org/stable/26542710

Svalbard Treaty as an unrecognised state and acceded with reservations in 1935.[15] The terms of the Treaty grant Norway absolute sovereignty over the islands, subject to stringent restrictions limiting their use for military purposes.[16] In the post-unipolar world, with high-performance anti-ship and anti-aircraft missiles, the Arctic islands and archipelagos have gained military significance, particularly those of the Svalbard archipelago and Bear Island. Russia would certainly wish to impose control over those islands during periods of tension but would be even more eager to deny their use to NATO. Politically, an operation to capture, in whole or part, Svalbard or Bear Island would signal the gravity with which Russia viewed the actions of NATO or Norway. Such an action would appeal to a desire to expose any disunity within NATO, many of whose members might be disinclined to support military action to recapture such remote territory.[17] Moreover, it would be a confrontational action that fell short of the risk involved in a tactical nuclear strike[18]. Thus, if surprise could be achieved and casualties minimised, it might be regarded as a prompt and proportionate response to NATO action elsewhere, fostering Russian domestic support.

If Russian action extended to seizing a portion of mainland northern Norway, it would be militarily advantageous in the context of establishing an A2/AD zone to protect the Barents. However, it would constitute a far greater political risk, and almost certainly elicit a more positive response from NATO members in the context of an Article 5 declaration.

The Arctic littoral represents a highly specific challenge within the Arctic battlespace. Conducting amphibious operations in a location that combines significant

[15] Timo Koivurova and Filip Holiencin, "Demilitarisation and neutralisation of Svalbard: how has the Svalbard regime been able to meet the changing security realities during almost 100 years of existence?" *The Polar Record* 53, no. 2 (2017): p. 131. DOI:10.1017/S0032247416000838.

[16] Originally referred to as the Spitzbergen Treaty: *Treaty between Norway, The United States of America, Denmark, France, Italy, Japan, the Netherlands, Great Britain and Ireland and the British Overseas Dominions and Sweden Concerning Spitsbergen Signed in Paris 9th February 1920.* For an English translation see: https://www.spitzbergen.de/wp-content/uploads/2020/01/Spitsbergen-treaty_English.pdf

[17] Wither, "Svalbard," pp. 28-37.

[18] At time of writing, President Putin is reported to have endorsed the Russian policy of nuclear first use under conditions including a conventional attack that "threatens the very existence of the state" Vladimir Isachenkov, "New Russian policy allows use of atomic weapons against non-nuclear strike," *The Associated Press*, 2 June 2020. https://www.defensenews.com/global/europe/2020/06/02/new-russian-policy-allows-use-of-atomic-weapons-against-non-nuclear-strike/.

geographical factors with a capable adversary requires the most stringent planning and highly specialist resources, as history has shown.

The Challenges of an Arctic A2AD zone

While as Polmar and Mersky[19] note, the majority of the approximately 600 amphibious operations of World War II were conducted successfully, there were some conspicuous failures. Other operations, although successful, incurred needless casualties, including Operation Sandcrab,[20] an assault to recapture the sub-Arctic Aleutian Island of Attu in 1943. Of an invasion force of some 16000 men,[21] 1237 were lost to action through injuries sustained through exposure to the cold and wet environment.[22] The Attu operation was marred by a failure to appreciate the nature of the terrain and climate, and shortfalls in providing troops with appropriate equipment[23]. The rate of movement of troops was much slower than anticipated, and major problems were encountered in moving equipment.[24] Vehicles were rendered immobile; even caterpillar tractors towing artillery pieces proved useless – their tracks broke through the muskeg and churned helplessly in the soft mud beneath.[25] Artillery movement had to await the construction of roads.[26] Troops were reduced to portering

[19] Norman Polmar and Peter B. Mersky, *Amphibious Warfare: An Illustrated History* (London: Blandford Press, 1988), p. 7.

Reported in some sources as Operation Landcrab.

[21] Brian Garfield, *The Thousand-Mile War: World War II in Alaska and the Aleutians* (Fairbanks: University of Alaska Press, 1995).

[22] In, John Cloe, *Attu: the forgotten battle* (Government Printing Office, 2017), p. 113, Cloe properly notes the difficulty in accurately counting the many casualties of World war II. Of the three sources he notes, two provide detailed figures for non-battle injuries, and in both cases the number exceeds that for personnel wounded in battle. The number quoted here is that reported by the 7th Infantry Division surgeon.

[23] For environmental aspects of the battle and associated planning failures, see Cloe, *Attu: the forgotten battle,* pp. 8-9, 40-1, 46) and Garfield *The Thousand-Mile War,* pp. 253-340). Garfield provides a comprehensive account of the planning process and its shortfalls.

[24] Garfield, *The Thousand-Mile War,* pp. 281-3.

[25] Garfield, *The Thousand-Mile War*, pp. 281-2.

[26] Cloe, *Attu: the forgotten battl,* p. 56.

equipment and supplies on foot.[27] Electronic communications fell prey to *Aleutian static*, seriously inhibiting operational coordination.[28]

Following the amphibious operation to retake Attu, army doctors submitted copious reports to the US Surgeon General.[29] Changes were made to footwear, clothing, tentage, bedding and food.[30] Information and expertise in cold weather operations was collated into military publications.[31] Despite this, problems in dealing with the cold weather battlespace have persisted into the modern era. In the case of the Falklands conflict, almost 20 percent of British casualties were cold injuries.[32]

The Arctic is characterised by geographical remoteness, comparatively low average temperatures, and extremes of weather.[33] Depending upon latitude, polar day or night can persist for months. In some cases, even survival without shelter may be unlikely. As Operation Sandcrab demonstrated, surface mobility by land may become all but impossible, while sea ice may impose significant risks in the maritime domain.[34] Logistic chains, extended by geography, may become more exposed and vulnerable to enemy action. Aircraft deck handling and flight operations are constrained by weather that reduces visibility, renders deck fittings useless, decks treacherous, and restricts elevator operations.[35] Arctic and sub-Arctic weather brings other complications, sometimes with tragic operational consequences including fratricide in battle. In 1943,

[27] Cloe, *Attu: the forgotten battle,* p. 57; Garfield, *The Thousand-Mile War,* p. 285.
[28] Garfield, *The Thousand-Mile War,* pp. 276, 289
[29] Garfield, *The Thousand-Mile War*, p. 333.
[30] Ibid.
[31] See for example, US Army, *FM 31-71 Northern Operations* (Washington DC: Headquarters, Department of the Army, 1963: and US Army, *FM 31-70 Basic Cold Weather Manual* (Washington DC: Headquarters, Department of the Army, 1968).. Although superseded, these manuals still provide a useful overview of the problems of cold weather land warfare.
[32] Michael D. Robinson and Phillip R. Bryant. "Peripheral Nerve Injuries," in *Textbook of Military Medicine, Part IV Surgical Combat Casualty Care, Rehabilitation of the Injured Combatant*, Vol. 2, Chapter 9, edited by Russ Zajtchuck (Washington DC: Borden Institute, Walter Reed Army Medical Center, 1999), pp. 419-574. https://ke.army.mil/bordeninstitute/published_volumes/rehab2/RH2ch9.pdf
[33] For comprehensive descriptions of the Arctic environment and its effects on military operations, see Canadian Army, *Operations in Cold Weather. B-GL-323-003/FP-001* (Kingston, ON: Directorate of Army Doctrine, 201; and US Army, *ATP 3-90.97 Mountain Warfare and Cold Weather Operations* (Washington DC: Headquarters, Department of the Army, 2016).
[34] US Navy, *US Navy Cold Weather Handbook for Surface Ships* (Washington DC: Chief of Naval Operations, 1988).
[35] Ibid., pp. 2-10 - 2-11.

Operation Cottage was launched to recapture Kiska Island in the Aleutian chain.[36] An assault force of over 34,000 troops launched an attack in fog. In an engagement that lasted some 24 hours, friendly forces mistakenly fought each other, resulting in 24 dead and many wounded.[37] No enemy forces were present.[38]

High latitude environments restrict the reliability of navigation and communications in a number of ways. The maritime Arctic is not comprehensively charted to a standard sufficient for modern navigational needs.[39] At the same time, electronic signals are limited by three factors: fluctuations in the density of the ionosphere,[40] line of sight, and weather.[41] In addition to other factors, the density of the ionosphere at high latitudes is sensitive to auroral activity.[42] These density fluctuations influence its ability to reflect and refract energy at HF frequencies back to surface receivers.[43] Line of sight issues occur with satellites in geostationary orbits above the equator.[44] At high latitudes, the line of sight between a ground station and a satellite in such an orbit may be such that the antenna is pointing barely above the horizon.[45] Local topography may impede such signals.[46] Line of sight imposes a further restriction because unlike a satellite signal received by an antenna at a high angle of elevation,

[36] William Garrett, "Report A066262 Fratricide: Doctrine's Role in Reducing Friendly Fire," Fort Leavenworth, *KS: School Of Advanced Military Studies, Army Command and General Staff College*, December 1992.
[37] Ibid.
[38] Ibid.
[39] Laura Leppälä, Salomon Honkala, Giorgia Ferrara, Martti Kirkko-Jaakkola, Heidi Kuusniemi, and Seija Miettinen-Bellevergue. "Challenges in Arctic navigation: The user perspective." In *2019 European Navigation Conference (ENC)*, pp. 1-8. IEEE, 2019.
[40] Taylor Grant Cameron, R. A. D. Fiori, E. M. Warrington, A. J. Stocker, T. Thayaparan, and D. W. Danskin. "Characterization of high latitude radio wave propagation over Canada," *Journal of Atmospheric and Solar-Terrestrial Physics* 219 (2021): p. 105666.
[41] Fritz Bekkadal, "Arctic Communication challenges," *Marine Technology Society Journal* 48, no. 2 (2014): pp. 8-16.
[42] Cameron et al, "Characterization of high latitude radio."
43 For a useful description of the fundamentals of ionospheric propagation, see H. Charles Wood, "Ionospheric-Propagation Predictions," *Electronics World*, April 1969. https://www.rfcafe.com/references/electronics-world/ionospheric-propogation-predictions-electronics-world-april-1969.htm.
[44] Bekkadal, "Arctic Communication challenges."
[45] Ibid.
[46] Ibid.

signals following a path close to the horizon travel a greater distance through the atmosphere, and consequently are subject to greater absorption.[47]

Finally, the weather imposes significant effects through high wind and the icing of antennas, which may inflict physical damage or influence the electrical properties of the system.[48] At the same time, sea state and consequent ship movement can interrupt line of sight in antennae systems that are already operating close to the horizon.[49]

There are technical solutions to some of these problems, such as the use of non-geostationary orbits. The Iridium-NEXT system consists of a constellation of 66 active satellites in six high inclination orbits that relay signals between individual satellites before transmitting them back to the surface.[50] Although Global Navigation Satellite Systems (GNSS) operate as far as the North Pole, the number of satellites visible to a receiver reduces with latitude, limiting system accuracy[51]. It was reported in 2013 that a Multi-User Objective System (MUOS) geostationary satellite had maintained a telephone link with an aircraft flying at an altitude of 7km at 89.5^0 north latitude.[52] Geometrically, that is the equivalent of a sea-level station at 83^0 north, although the company representative cautioned that stable communications could not be expected at that latitude on a 24/7 basis.[53] The warning is significant. A survey conducted by Leppälä et al[54] that examined the challenges of Arctic navigation from a user perspective reported: "...uneven coverage of positioning, untimely weather information, and telecommunication issues." Over 60 percent of the participants classified

[47] Ibid.
[48] Ibid.
[49] Ibid.
[50] For a full description of the Iridium-NEXT system, see Spaceflight101.com, "Iridium-NEXT. 2021. https://spaceflight101.com/spacecraft/iridium-next/.
[51] For a comprehensive discussion of this problem, including a comparison of available systems, see Iain Sheridan, "Drones and global navigation satellite systems: current evidence from polar scientists," *Royal Society open science* 7, no. 3 (2020): p. 191494.
[52] Peter De Selding, "U.S. Allies' Access to MUOS Debated after North Pole Satcom Demo," *Spacenews.com*, 8 November 2013. https://spacenews.com/38051news-from-global-milsatcom-us-allies-access-to-muos-debated-after- north/.
[53] Ibid.
[54] Leppälä et al, "Challenges in Arctic navigation."

telecommunication issues as catastrophic, critical, or major.[55] The reliability of the Iridium system was questioned.[56]

As McCrory[57] notes, Russia has demonstrated considerable electronic warfare proficiency in Ukraine. Such proficiency includes the ability to apply disruptive or deceptive signals to GPS, unmanned aerial vehicles, satellite communications, and other systems.[58] In this context the Arctic environment acts as a force divider, placing operational limitations on signals traffic that a Russian force can degrade with greater ease. It may be objected that the Arctic environment constitutes an impediment or potentially confers a tactical advantage to both sides of a conflict. However, this paper considers a situation in which Blue[59] forces are attacking, and are therefore likely to be more exposed. The Arctic environment adds significantly to the operational risk[60] already incurred by having to adopt the role of the attacking force in an anti-A2/AD scenario.

An operation to collapse the A2/AD zone would aim to incapacitate the missile batteries and associated assets an opponent had established at key points in the Arctic littoral. The advantage of surprise is unlikely to be available: a counter-attack would doubtless be anticipated and perhaps even desired, as its repulse would strengthen the political benefits of the attack. Thus, Blue would be placed in a lose/lose situation: either refrain from action and appear weak or counter-attack from a position of disadvantage and risk a humiliating defeat. In either case, Russia could negotiate the way ahead from a position of strength. Second, the geography of the Arctic would tend to favour a defender already established in the location. This is particularly the case for an Arctic

[55] Ibid.
[56] Ibid.
[57] Duncan McCrory, "Russian Electronic Warfare, Cyber and Information Operations in Ukraine: Implications for NATO and Security in the Baltic States," *The RUSI Journal* 165, no. 7 (2020): pp. 34-44, and cittions therein.
[58] US Army Asymmetric Warfare Group, *Russian New Generation Warfare Handbook* (Fort Meade MD: Asymmetric Warfare Group, 2016).
[59] The term Blue will be used in this paper as a generic reference to UK forces, most likely in collaboration with NATO assets or a subset thereof. This differentiates the force structure from that of NATO operating as a unified body under an Article 5 declaration.
[60] The theme of added operational risk accruing from the Arctic environment is a key finding from the Fleet Arctic Operations Game conducted at the US Naval War College in September 2011 Christopher Gray,; Leif Bergey,; and Walter A. Berbrick, "Fleet Arctic Operations Game," *Game Reports* 17 (2011). https://digital-commons.usnwc.edu/game-reports/17.

archipelago such as Svalbard. It is remote, and depending on the time of year, the surrounding seas may well be ice-infested. Indeed, transit to effect landings or provide gunfire support may be restricted by ice.[61] Third, anti-satellite operations in the build-up to open hostilities may have degraded Blue's capacity to locate radar emitters and missile batteries, or even estimate with reliability the strength of opposing forces.[62] Finally, a combination of anti-satellite operations, GPS jamming, and ice-infested seas may inhibit the successful application of supporting fires for Blue amphibious assault forces.

The Assault Force – Converted Ferries and Operations Research Confusion

In their analysis,[63] consider the risk posed to amphibious force ships from anti-ship cruise missiles (ASCM). Citing Schulte,[64] they observe: "The historical likelihood of a salvo of cruise missiles securing a mission kill against a defended vessel alert to the presence of hostile platforms is around 23%, with no recorded instances of vessels with robust soft-kill capabilities being sunk by an ASCM."[65] This reassuring statement is misleading. Schulte himself warns against overgeneralisation from his findings: "Problems which exist are the small data set and small ship sizes, so the "best" model must await further data."[66] He adds: "It is also emphasized that because most anti-ship missile victims were small warships, this analysis is unreliable when extended to warship larger than 7,000 tons displacement."[67]

[61] Specimen ice charts, including archived material produced by the Norwegian Ice Service may be found at: https://cryo.met.no/en/latest-ice-charts.
[62] Burns (2020) reports a number of sources suggesting that a recent operation involving Cosmos 2543 was an anti-satellite weapons test. Robert Burns, "US Accuses Russia of Testing Anti-satellite Weapon in Space," *Military Times*, 23 July 2020. https://www.militarytimes.com/news/your-military/2020/07/23/us-accuses-russia-of-testing-anti-satellite-weapon-in-space/.
[63] Kaushal and Watling, *Requirements for the UK's Amphibious Forces.*
[64] John C. Schulte, *An analysis of the historical effectiveness of anti-ship cruise missiles in littoral warfare* (Naval Postgraduate School Monterey CA, 1994), quoted in Kaushal and Watling, *Requirements for the UK's Amphibious Forces.*
[65] Kaushal and Watling, *Requirements for the UK's Amphibious Forces,* p. 18).
[66] Schulte, *An analysis,* p. 30.
[67] Ibid., p.36.

The small sample size is not a statistical nicety. It strikes at the confidence with which inferences are drawn that may one day entail battle deaths and operational failure.[68] The vessel displacement factor itself is crucial. With the possible exception of HMS Invincible, which may have been saved from a missile attack by hardkill,[69] the largest vessel in the analysis is USS Wainwright at 7930 tons.[70] Therefore using the Schulte data, there has been no reliable combat test of softkill defence where the target exceeds some 8000 tons displacement. Clearly, an amphibious warfare vessel may well exceed that tonnage. The problem is that the radar cross-section (RCS) of the vessel relative to that of the chaff cloud may be critical in determining success in seducing a missile seeker.[71] Hughes[72] emphasises the point, in connection with his own use of the data:

> If one wanted to play around with the salvo equations to reach his own conclusions about missile combat, are there any real numbers to replace the ones used up to now? The answer is yes, with the important proviso that they apply to engagements between small combatants.[73]

This is curious, because the Kaushal and Watling analysis then proceeds to consider an ASCM salvo fire scenario based on a model developed by Hughes.[74] The conclusion of this calculation is that the Russians can only have a reasonable expectation of success if they expend a large number of missiles. Moreover, as they admit: "Of course, this presumes that an opponent is denied track quality data, that effective countermeasures are deployed, and that littoral traffic remains a feature;..."[75]

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[68] Even the statistical *rule of three* (3/n) by which probable exceptions to a phenomenon may be deduced to a 95 percent level of confidence using only negative cases, would not assist here. The negative cases would be all of the vessels that employed softkill and were not hit by missiles. However, the technique requires a sample size of 30 or more ($n \geq 30$) for reliability.

[69] Gunfire.

[70] Tonnage reported at Naval History and Heritage Command (2015). Schulte, *An analysis*, pp. 10-13.

[71] For a useful overview of ship radar cross section and chaff, see Captain McGillvray's 1994 paper. John W. McGillvray, "Stealth Technology in Surface Warships," *Naval War College Review* 47 no. 1 (1994): pp. 28-39. https://www.jstor.org/stable/44642486.

[72] Wayne Hughes, *Fleet Tactics and Coastal Combat* (Annapolis MD: Naval Institute Press, 2000), p. 275.

[73] Ibid.

[74] Ibid.

[75] Kaushal and Watling, *Requirements for the UK's Amphibious Forces*, p. 21.

Setting aside the deployment of effective countermeasures and the issue of littoral traffic in the Arctic, the question then arises: what confidence can there be that Blue can deny the Russians quality track data? The Russian ability to detect and localise an amphibious force at sea rests on a number of assets, potentially including space systems, air and sea vehicles plus shore installations. Prospective sensors include active and passive radar, and sonar, the latter deployed both in submarines and shore stations. Consequently, the ability for the force to evade those systems depends to a great extent on vessel signature and the effectiveness of electronic warfare measures. These will be considered in turn.

Kaushal and Watling[76] offer a comprehensive description of a scalable force structure for UK amphibious operations, with a level of detail that includes three prospective maritime orders of battle: the Littoral Strike Group (LSG), Amphibious Strike Group (ASG), and the Joint Strike Group (JSG). These are intended to operate in sequence to penetrate and suppress an A2/AD zone. The first major amphibious transport asset to penetrate the A2/AD zone would be a Littoral Operations Vessel (LOV): "At the core of the LSG would sit an LOV. The LOV would need to have a low signature, both in terms of its radar cross-section and political visibility."[77]

The argument cites a 2017 article by Salvatore Mercogliano[78] that refers to the MV Ocean Trader (formerly MV Cragside), a merchant vessel converted by the US government for special forces operations, and featuring the capability to launch a range of assets, including helicopters and Unmanned Underwater Vehicles (UUVs). This is the exemplar for the LOV. However, Dr. Mercogliano's article concerns itself with the modesty of the ship's political signature: its lack of appearance in official records and Automatic Identification System (AIS) tracking. The apparent physical signature of the vessel, derived as it is from the Flensburger roll-on/roll-off ships, remains largely undiminished, with slab sides and reflecting angles evident in open media

[76] Ibid.
[77] Ibid. p. 33.
[78] Salvatore R. Mercogliano, "Navy's Stealthiest Warship May Be a Merchant Vessel," *Maritime Executive*,13 October 2017. https://www.maritime-executive.com/editorials/navys-stealthiest-warship-may-be-a-merchant-vessel.

photographs.[79] Lacking the energy scattering geometry of an object designed to minimise radar cross section, it will be a conspicuous radar target[80] unless it is intended that the vessel is to be swathed in radar absorbing material – a very expensive prospect.

The detection problem is exacerbated if the risk to the Blue force is taken to include detection by submarines, which may either proceed to independent attack or report targeting information for shore-based ASCMs. In referencing the Ocean Trader, a merchant hull design, there is no mention of acoustic quieting techniques having been applied during the conversion. It should be recalled that in 1982, HMS Conqueror made its initial detection of the Belgrano Group on the oiler Puerto Rosales at a range in excess of 50 miles.[81]

In addition to any satellite, airborne, navy surface ship, and submarine assets available to the Russians for searching the approaches to the seized littoral, they may also choose to picket an exclusion zone with fishing vessels, each capable of radar and visual search. Under such circumstances, detection of a Blue amphibious force, and its localisation for missile targeting, constitute significant risks.

To what extent could the shortfalls in vessel signature be compensated for by electronic warfare measures? While Kaushal and Watling propose that the LSG should include two equivalents of the Orca Extra Large Unmanned Underwater Vehicle (XLUUV) for the provision of electronic warfare and strike against A2/AD architecture,[82] there is a noticeable lack of supporting detail. Anti-ship missiles could receive targeting information from a number of radar sources, all of which have to be suppressed or at least deceived for the period during which the LSG is in range. The

[79] See for example the main image in Tyler Rogoway, "Photo of the Pentagon's Shadowy Special Operations Mothership Emerges," *The War Zone*, 18 May 2018. https://www.thedrive.com/the-war-zone/20959/photo-of-shadowy-u-s-special-operations-ghost-mothership-appears-on-twitter.

[80] Merrill I. Skolnik, *Radar Handbook* Second Edition (Boston MA: McGraw-Hill, 1990), p. 11.17. While formally, the radar cross section (RCS) of a ship may be determined as: $\sigma = 52 f^{1/2} D^{3/2}$ where f is the radar frequency measured in megahertz and D is the vessel full-load displacement in kilotons, Skolnik offers a simpler axiom in Merrill I. Skolnik, *Introduction to radar systems,* Second Edition (Auckland: McGraw-Hill, 1981), p. 44, under which the RCS in square metres approximates the displacement. Thus it may be assumed that the specimen multi-role vessel offered as an LOV has an RCS of some 21,000m^2 and that the detection range approximates line of sight.

[81] Mike Rossiter, *Sink the Belgrano* (London: Transworld Publishers, 2008), pp. 259-260.

[82] Kaushal and Watling, *Requirements for the UK's Amphibious Forces,* p. 34.

surface assets of the LSG are the LOV plus either a Type 26 or 31E frigate.[83] Vessels travelling in company arouse suspicion, and if they are not in company, how is the escort to protect the group? One might reasonably expect that the RCS of the LOV will greatly exceed that of a modern frigate. Under which circumstances, air or surface radars may first detect only a single contact (the LOV) closing the defended area – a contact of interest, nonetheless. Perhaps the unmanned underwater vehicles could be fitted with expendable jammers as Kaushal and Watling propose, and these could penetrate the A2/AD zone ahead of the LSG. But the full spectrum of the electronic force protection task is broad, and a complete list of opponent radars must be considered when an A2/AD penetration operation is planned. In theory, if an emitter can be detected,[84] some form of countermeasure should be possible. Even an over the horizon system may be susceptible to some interference.[85] But as indicated above, there are a large number of emitters to be jammed, deceived, or avoided en route to the objective, and expendable jammers, which are likely to have limited endurance, may offer only an incomplete defence.[86] As a basic observation, the relatively slow speed of the LSG suggests that masking its location and movement would require a sustained electronic warfare effort, potentially exposing the jammer(s) to counter detection and attack.

[83] Kaushal and Watling, *Requirements for the UK's Amphibious Forces,* pp. 33-34

[84] This cannot be taken for granted. Some emitters may transmit in such a manner as to have a low probability of interception.

[85] See R.J. Riddolls, *A Canadian Perspective on High-Frequency Over-the-Horizon Radar* (Ottawa: Defence R&D Canada). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.738.1641&rep=rep1&type=pdf for an excellent summary of OTH Radar, including susceptibility to jamming and limitations in the Arctic to auroral ionospheric clutter.

[86] While there is certainly interest in the electronic warfare potential of expendable drones, (see Brett Tingley, "The Navy's Secretive and Revolutionary Program to Project False Fleets from Drone Swarms." *The Drive*, 7 November 2019. https://www.thedrive.com/the-war-zone/29505/the-navys-secretive-nemesis-electronic-warfare-capability-will-change-naval-combat-forever) some measure of the potential of current systems may be had by examination of loitering munitions. Dan Getttinger, and Arthur Holland Michel. *Loitering Munitions in Focus* (Annandale-on-Hudson, NY: Center for the Study of the Drone, 2017). https://dronecenter.bard.edu/files/2017/02/CSD-Loitering-Munitions.pdf note the limited endurance of the devices, and significant unit cost.

The Need for Independent Options

Given the shortfalls in the Kaushal and Watling proposal, a Russian analysis might infer that a limited conventional action in the Arctic littoral might prove successful. As Wither notes: "Russia may venture that many NATO members would be reluctant to engage in a major war to retake occupied territory, particularly if the Russian government declared that its limited objectives had been achieved and no further military action was intended."[87] However, an A2/AD in the Arctic littoral could be breached, and it would be unwise for the UK to leave itself in a position in which it is unable to conduct independent operations in that regard.

The post unipolar world remains an uncertain environment in which the UK cannot always count on full NATO support for defensive action. Political complexity and the tardiness of response by members of the community of nations to disturbances in the international order may irremediably compromise UK interests. In the Arctic context, Britain has a geographical fringe position, yet its economic and geopolitical connectedness is much closer.[88] In this context, the assertion of UK sovereignty, while not territorially linked, may take the form of action in support of allies where political perspectives are similar and economic interests are conjoined. While the most likely scenario in which the UK would commit forces to the High North would be as part of a full NATO Article 5 response, it is conceivable that a confederation of nations – perhaps the UK and Canada in collaboration with Nordic and European states - might find itself engaged in military action in the High North under political circumstances in which America chose not to respond to an Article 5 activation. Indeed, operation in closer collaboration with states such as Norway and Canada was a theme that the recent House of Commons Defence Committee review[89] of UK Arctic policy was interested in considering.[90] But given the shortfalls in the scalable force structure discussed above, how could such an action be undertaken?

[87] Wither, "Svalbard," p. 28.
[88] Andrey A. Todorov and Dmitriy N. Lyzhin, "The UK's interests in the Arctic," *Arktika i Sever* [Arctic and North] 36 (2019): pp. 84–95. DOI: 10.17238/issn2221-2698.2019.36.84
[89] House of Commons Defence Committee, "On Thin Ice: UK Defence in the Arctic," *Twelfth Report of Session 2017–19*. https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/388/388.pdf
[90] The author was one of those who participated in this enquiry, contributing both written and oral evidence.

A Response to an Arctic A2/AD Zone – Lessons from the Falklands

In both geographical and political terms, the Falklands War provides a useful comparison with the type of Arctic littoral conflict in which the UK may be involved in the post-unipolar world. The Falklands archipelago occupies a sub-Antarctic position, with a climate on the transition between the Tundra and Subpolar oceanic zones[91]. It is remote, and has a history of challenged possession. Although the British succeeded in obtaining passage of UN Resolution 502, the US was reluctant to side openly against Argentina, which at the time was seen as a bulwark against communism in South America. [92] Economic and military sanctions would eventually be imposed on Argentina by President Reagan.[93] The US also provided assistance in the form of much needed stocks of ammunition, fuel and other resources, including satellite information. [94] But the campaign was not an Article 5 response, and despite the significant obstacles to the undertaking, including some political resistance in American circles for US support,[95] Britain succeeded in rebuffing a clear challenge to the principle of peaceful conflict resolution.

The campaign also offers valuable military comparisons. The archipelago was taken by amphibious assault and rapidly fortified by the Argentinians.[96] Those defences included surface to air and ground launched anti-ship missiles. Argentinian air and warship assets were similarly armed with anti-ship missiles, and although of an earlier generation than those currently available to Arctic nations, the effectiveness of shore

[91] Köppen–Geiger climate classification system *ET* and *Cfc*, respectively.

[92] Ken Kotani, "Political and Diplomatic Lessons of the Falkland War," in *International Forum on War History 2013 The Legacy And Implications Of The Pacific War* (Toyko: The National Institute for Defense Studies, 25 September 2013), pp. 115-121.
http://www.nids.mod.go.jp/english/event/forum/pdf/2013/09.pdf

[93] S. Woodward with P. Robinson, *One hundred days* (London: Harper Collins Publishers, 1992).

[94] Michael Getler, "U.S. Aid to Britain In Falklands War Is Detailed," *The Washington Post*, March 1984.
https://www.washingtonpost.com/archive/politics/1984/03/07/us-aid-to-britain-in-falklands-war-is-detailed/6e50e92e-3f4b-4768-97fb-57b5593994e6/

[95] Ibid.

[96] Martin Middlebrook, *The fight for the "Malvinas:" the Argentine Forces in the Falklands War* (London: Penguin Books, 1989).

based anti-ship missiles was proven, as exemplified by the damage inflicted on HMS Glamorgan by an Exocet missile.[97]

The war demonstrated also that even a non-peer adversary, operating with determination can inflict severe harm on a task force. The campaign cost the Royal Navy seven vessels, including a landing ship and a container vessel taken up from trade. Admiral Woodward, the task force commander, acknowledged that but for fusing problems with Argentinian Exocet and aircraft bombs, it would have lost 5 additional ships.[98] As noted above, the cost in human casualties bears examination also, in particular, the significant proportion of cold injuries.[99] Cold-weather warfare demands soldiers with specialist survival skills, training and equipment. However, one additional aspect of the Falklands campaign is striking in its relevance to current and future Arctic operations against a near-peer adversary. Admiral Woodward protected the aircraft carriers, conserving his key assets by distancing them to the east of the archipelago and away from the air threat. It was a lesson he had learned in naval exercises conducted with the US Navy some six months previously in the Indian Ocean.[100] War is a business of taking risks,[101] but they need to be taken in a calculated manner.

Penetrating an Arctic A2/AD Zone

The use of a scalable amphibious force as part of an operation to address the imposition of a Russian A2/AD zone in the Arctic can be conceived under two general sets of circumstances. First, displacement or reversal of the zone when Blue – however constituted – is able to impose air superiority[102] from the onset. Second, neutralisation of

[97] Paul Eddy, Magnus Linklater and Peter Gillman, *The Falklands War* (London: Sphere Books Ltd., 1982/1983), pp. 238, 250.
[98] Woodward with Robinson, *One hundred days.*
[99] Robinson and Bryant, "Peripheral Nerve Injuries," op cit.
[100] Woodward with Robinson *One hundred days.*
[101] For an excellent analysis of battlespace risk management drawing on the Falklands conflict as a case study, see Frederick Latrash, *Risk Management: An Integral Part of Operational Planning* (Newport RI: Naval War College, 1999). https://apps.dtic.mil/sti/pdfs/ADA363058.pdf.
[102] In this paper the term *air superiority* will be defined in accordance with AAP6-2011 NATO Glossary of Terms and Definitions of Military Significance for Use in NATO, p. 2-A-11: "That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its

the invading force without initial air superiority. The implications for both cases will be examined in turn (Table 1), in a scenario in which Russia has seized key points in Svalbard, Bear Island, and areas of Northern Norway.

Air superiority is the dominant feature in the A2/AD campaign. If it can be established promptly in the face of Russian combat air patrols[103] and SAM systems, the key assets – radars, missile launchers, and support systems – can be neutralised by standoff missiles prior to assault by amphibious forces. Blue air dominance may also permit ground assault forces to be protected by attack helicopters. The ability of Blue to establish air superiority, detecting and identifying opposing force assets, and engaging them from the air without significant own force losses, will be conditional on a number of factors. Targeting may have been degraded by anti-satellite operations and GPS jamming. Stealth benefits may have been annulled, at least in part, by the use of technologies including bistatic radar systems, and the exploitation of frequencies other than those for which attenuating materials on stealth aircraft have been designed. Significantly, while the B-2 is reported to be immune to radars operating in the VHF band, the F-35 is not.[104] Some of these systems, Over The Horizon Radar installations such as the Russian Resonance-N claim significant detection ranges.[105] Blue aircraft combat radii may be at their useful limits because aircraft carriers have been held at distance by A2/AD systems, and there must be a sufficient inventory of effective anti-radar and air to surface missiles. Added to all of this will be the systems performance degradation imposed by the Arctic environment.

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related land, sea and air forces at a given time and place without prohibitive interference by the opposing force".

[103] If Russian forces can capture the runway at Longyear intact, it has sufficient length to support the operation of interceptor aircraft. There has been some doubt that Russia's aircraft carrier, the Admiral Kuznetzov, will return to active service (Mark Episkopos, "Russia's only Aircraft Carrier is in Serious Trouble: Does Moscow even need a carrier?" *The National Interest*, 2 February 2019. https://nationalinterest.org/blog/buzz/russias-only-aircraft-carrier-serious-trouble-43157 and citations therein).

[104] Carlo Kopp, "Russian VHF counter stealth radars proliferate," *Defense Today* 4 (2008): pp. 32-36. http://ausairpower.net/SP/DT-Rus-VHF-Radar-2008.pdf.

[105] For a description of the Resonance-N system, including a link to the patent for the design, see Malte Humpert, "Satellite Images Reveal New Russian Long-Range Radar in the Arctic," *High North News*, 17 December 2019. https://www.highnorthnews.com/en/satellite-images-reveal-new-russian-long-range-radar-arctic..

Table 1: Overview of measures required to defeat an A2/AD zone in the Arctic littoral

FORCE REQUIREMENTS	WITH INITIAL AIR SUPERIORITY	WITHOUT INITIAL AIR SUPERIORITY		
	AIR STRIKE	AIR STRIKE	STRIKE FROM SHIPS OR SUBMARINES	AMPHIBIOUS RAID
Amphibious forces trained in Arctic warfare required.	YES. For consolidation post strike.	YES. For consolidation post strike.	YES. For consolidation post strike. May also provide targeting information.	YES
Precision Guided Munitions.	YES. Air to surface missiles or guided bombs	YES. Air to surface missiles with range exceeding SAM engagement range in A2/AD zone	YES. Surface to surface missiles	Preferable. Soldier portable anti-tank missiles. Guided mortar bombs.
Stealth aircraft	YES	NO	NO	NO
Stealth vessel	Preferable. For consolidation post strike.	Preferable. For consolidation post strike.	YES. Includes low signature surface vessels and / or submarines.	YES. Includes low signature surface vessels and / or submarines for insertion and support.
Intelligence	Essential for opponent asset targeting.			Ground force observation may be required for opponent asset targeting, plus force disposition, strength and composition analysis.
	Highly desirable for opponent force disposition, strength and composition analysis.			

<table>
<tr><td>Electronic Warfare</td><td colspan="3">Essential for opponent sensor, communication and navigation asset disruption. Opponent force may attempt to disrupt targeting, intelligence collection, communication and navigation.</td></tr>
<tr><td rowspan="3"></td><td colspan="3">ARCTIC ENVIRONMENTAL EFFECTS</td></tr>
<tr><td colspan="3">Limitations to communications reliability and consequently to asset interoperability. Increased operational risk.</td></tr>
<tr><td>Daylight and weather limitations to flight operations, plus launch / recovery of carrier air assets.</td><td>Weather limitations to operational efficiency. Sea ice and icing limits to surface vessel operations.</td><td>Weather effects on deployment, ground operations and personnel survival. Terrain limitations to surface movement. Ice limitations to deployment.</td></tr>
</table>

If Blue is constrained to act without initial air superiority, given sufficient targeting information, it may be possible to engage A2/AD radars and missile systems with air-launched missiles such as Stormshadow operating at the periphery of SAM engagement range,[106] or submarine-launched weapons, which in the UK case would be Tomahawk. It should be noted in this regard that Stormshadow is currently available for Typhoon aircraft, but not the UK F-35 fleet.[107] Tomahawk is being phased out of US Navy service, [108] and with no further production, the Royal Navy will need a replacement system.

The availability of space assets is critical. Target search, navigation, including some weapon navigation, and drone control all depend upon satellites, and their

[106] MBDA UK. "Storm Shadow/Scalp Conventionally Armed Long Range Deep Strike Weapon," Product Brochure V03. Stevenage UK: MBDA UK Ltd. 2019. https://www.mbda-systems.com/product/storm-shadow-scalp/.

[107] Andrew Chuter, "UK Defense Chief: F-35 Jets are 'Ready for Operations'," *Defense News*, 10 January 2019. https://www.defensenews.com/global/europe/2019/01/10/uk-defense-chief-f-35-jets-are-ready-for-operations/

[108] George Allison, "Britain's 1,000 mile punch – A Guide to the Tomahawk Cruise Missile," *UK Defence Journal*, 7 August 2018. https://ukdefencejournal.org.uk/britains-1000-mile-punch-a-guide-to-the-tomahawk-cruise-missile/.

effectiveness depends on the extent to which space assets are disabled.[109] Without the benefit of accurate targeting, or in lieu of a suitable missile strike capability, the only option remaining is to build air superiority from the sea up, having special forces and marines[110] access the Arctic littoral zone in question, conduct a ground-based search and neutralise A2/AD assets, either through direct action, or by identifying target positions for long range fires.

An amphibious ground force operation tasked with destroying the assets imposing the A2/AD zone may be considered in three phases:

> Phase 1: Littoral zone access. This requires a craft with very modest radar and acoustic signatures and preferably, long-range. Long-range insertion craft[111] may be of value, as may submarine-launched assets. However, the submarines must be equipped for, and current in, under-ice operations, and any vehicle for transporting troops ashore must be able to navigate ice-infested seas. This is crucial. Passage through ice-infested waters is hazardous and sometimes impossible.[112] The Russians may incorporate the obstacles presented by the weather into their operational planning. Other insertion options include stealth vessels such as the Norwegian Skjold class missile surface effect craft, and open sources report collaborative training between the Royal Marines and a warship of this type.[113]

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[109] While some systems may be vulnerable to locally applied GPS jamming, in a worst case situation, the satellite constellations themselves may by subject to direct attack through kinetic kill, jamming, or dragging out of orbit (Andy Netherwood, "A Space Defence Strategy for the UK," *Wavell Room*, 28 January 2020. https://wavellroom.com/2020/01/28/a-strategy-for-uk-space-defence/).

[110] The differentiation here is technical and intended to be inclusive. It may be that the operation is conducted by members of the Special Air Service, the Special Boat Service, which itself forms part of the Royal Marines, or the Royal Marines, or indeed some permutation of all three, as occurred in the Falklands.

[111] The term is used in a generic sense in this paper.

[112] For an account of the near loss of two canoes and their Special Boat Service crews to ice in Malagen Fjord in Norway see Don Camsell, *Black Water: A Life in the Special Boat Service* (London: Virgin Publishing Ltd., 2001), pp. 70-81.

[113] There are doubts regarding the future availability of Skjold Class of vessels, with a 2016 announcement of plans for their withdrawal, followed by a new long term plan for their retention until 2030 (John Pike, "Project 6300 RNoN Skjold-class Corvette Littoral Combat Craft (LCC)," *Global Security.org*. 6 June 2020. https://www.globalsecurity.org/military/world/europe/knm-skjold.htm).

Phase 2: Ground-based search. The assault force must be trained and equipped to survive in and traverse Arctic terrain undetected, and conduct search operations in that environment.

Phase 3: A2/AD asset neutralisation. Options for effective and risk-managed neutralisation include anti-tank missiles, anti-materiel rifles, and mortars. A sniper with a weapon with anti-materiel capability may be sufficient to ruin an installation such as a radar or missile launcher. Certainly, if such fire can be sustained, the crew can be killed or impeded in their task. Recalling the destruction wrought on the Argentinian corvette ARA Guerrico in 1982 by a detachment of 22 Royal Marines whose arms included a sniper rifle and anti-tank rockets, it is difficult to doubt the effectiveness of such weapons in skilled and determined hands.[114] However, it is to be anticipated that installations such as radar heads and missile batteries will have force protection, including assets such as thermal imagers, drone jammers, dogs, and directional mines. Novel technology is constantly being developed, for example, laser sniper detection technology.[115] Ultimately, target location reporting for submarine-launched land attack missiles may be the most effective way ahead.

Conclusions

This paper has addressed the question: *What aspects of the Arctic battlespace should be considered in proposing a UK amphibious force structure?* The current thinking on the A2/AD threat in relation to amphibious operations, as exemplified by Kaushal and Watling,[116] fails to take sufficient account of the Arctic battlespace in its full complexity. The combination of new technology with the challenges of the Arctic environment – including remoteness, ice-infested seas, vio,lent weather and effects on electromagnetic propagation – may be used in synergy by an aggressor, elevating the threat posed by a

[114] Roger Perkins, *Operation Paraquat: The Battle for South Georgia* (Chippenham UK: Picton Publishing Ltd., 1986), pp. 76-87.

[115] A great deal of research has been invested in anti-sniper methods. For an example of a system based on the reflection of coherent light from sniper optics, see Ian Kemp,"The Transition Force," *Armada International* 29, no.6 (December 2005/January 2006): p. 18.

[116] Kaushal and Watling, *Requirements for the UK's Amphibious Forces.*

near-peer adversary. Arctic islands, including Svalbard and Bear Island, are almost certain to feature in a future Arctic A2/AD operation. Their geographical position makes them ideal locations from which to dominate access to the Arctic Ocean and Barents Sea.

The limitations inferred by Kaushal and Watling concerning Russian anti-ship cruise missiles launched against an amphibious force, rest on assumptions that the source documents they cite specifically warn against. Moreover, assumptions regarding the inability of Russian defences to detect and localise approaching amphibious assets are optimistic at best. This paper has considered the complexity of the problem. Penetration measures for an Arctic A2/AD zone are contingent primarily on whether Blue forces can establish air superiority from the onset. If initial air superiority cannot be established, it may still be possible to neutralise opponent missile and radar assets with long-range fires from aircraft at the periphery of SAM engagement ranges, or from submarines. However, in the worst case, it may be necessary for amphibious forces to build battlespace dominance from the sea up. This would require an amphibious capability that can obtain *littoral zone access*, conduct *ground-based search*, and *A2/AD asset neutralisation* in the specific circumstances of the Arctic environment. If NATO partners wish to retain assurance that cooperative operations in the High North will prevail against A2/AD tactics, amphibious force planning should reflect the above three capabilities.

In the Arctic battlespace context, the key to maintaining peaceful stability is to ensure that Russia is not tempted into believing that an aggressive conventional action, involving the seizure of key points in the Arctic, would bring a successful outcome. The United Kingdom and other NATO nations currently have before them a number of options in determining the amphibious force structure that they will require in confronting the challenges of the post-unipolar world. In making those choices, particularly with regard to prospective Arctic operations, it is recommended that the points made here are considered in full.

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References

Allison, George. "Britain's 1,000 mile punch – A Guide to the Tomahawk Cruise Missile." *UK Defence Journal*. 7 August 2018. https://ukdefencejournal.org.uk/britains-1000-mile-punch-a-guide-to-the-tomahawk-cruise-missile/

Ash, John. "Svalbard and Conflict Management in a Changing Climate: A Risk Based Approach." *Nordlit* 45 (2020): pp. 56-85. https://doi.org/10.7557/13.5027

Bekkadal, Fritz. "Arctic Communication challenges." *Marine Technology Society Journal* 48, no. 2 (2014): pp. 8-16.

Braw, Elisabeth. 2018. "Why NATO Needs a Streamlined Decisionmaking Process," *The National Interest*, 1 May 2018. https://nationalinterest.org/feature/why-nato-needs-streamlined-decisionmaking-process- 25649.

Brown, David K. *Nelson to Vanguard: Warship Design and Development 1923-1945*. Barnsley UK: Seaforth Publishing, 2000/2012.

Burns, Robert. "US Accuses Russia of Testing Anti-satellite Weapon in Space." *Military Times*, 23 July 2020. https://www.militarytimes.com/news/your-military/2020/07/23/us-accuses-russia-of-testing-anti-satellite-weapon-in-space/

Cameron, Taylor Grant, R. A. D. Fiori, E. M. Warrington, A. J. Stocker, T. Thayaparan, and D. W. Danskin. "Characterization of high latitude radio wave propagation over Canada." *Journal of Atmospheric and Solar-Terrestrial Physics* 219 (2021): p. 105666.

Camsell, Don. *Black Water: A Life in the Special Boat Service*. London: Virgin Publishing Ltd., 2001.

Canadian Army. *Operations in Cold Weather. B-GL-323-003/FP-001*. Kingston, ON:

Directorate of Army Doctrine, 2012..

Chuter, Andrew. "UK Defense Chief: F-35 Jets are 'Ready for Operations'." *Defense News*, 10 January 2019. https://www.defensenews.com/global/europe/2019/01/10/uk-defense-chief-f-35-jets-are-ready-for-operations/

Cîrdei, Ionuț Alin. "A2AD concept in the modern security environment." In *International conference Knowledge-Based Organization*, vol. 24, no. 1 (2018): pp. 50-57. Sciendo. DOI: 10.1515/kbo-2018- 0007.

Cloe, John H. *Attu: the forgotten battle*. Government Printing Office, 2017.

Cochran, Daniel. "Will the Aircraft Carrier Survive? Future Threats to the Carrier (and How to Defend it)." *Journal of the JAPCC 27*, (Autumn/Winter 2018): pp. 22-28.

Cunningham, William F. *Antiaccess/Area-Denial: Old Concepts, New Frontiers*. Fort Leavenworth United States: US Army School for Advanced Military Studies, 2015. https://apps.dtic.mil/sti/pdfs/AD1001275.pdf.

Dalsjö, Robert, Christofer Berglund, and Michael Jonsson. *Bursting the Bubble? Russian A2/AD in the Baltic Sea Region: Capabilities, Countermeasures, and Implications.* FOI-R—4651—SE. Stockholm, 2019: FOI Totalförsvarets forskningsinstitut. https://muep.mau.se/bitstream/handle/2043/30208/FOI-R--4651--SE.pdf?sequence=2&isAllowed=y

De Selding, Peter. "U.S. Allies' Access to MUOS Debated after North Pole Satcom Demo." *Spacenews.com*, 8 November 2013. https://spacenews.com/38051news-from-global-milsatcom-us-allies-access-to-muos-debated-after- north/

Eddy, Paul, Magnus Linklater and Peter Gillman. *The Falklands War*. London: Sphere Books Ltd., 1982/1983.

Efjestad, Svein and Rolf Tamnes. NATO's Enduring Relevance, Whitehall Papers, 95 (2019): pp. 1, 8-25, DOI: 10.1080/02681307.2019.1731206.

Episkopos, Mark. "Russia's only Aircraft Carrier is in Serious Trouble: Does Moscow even need a carrier?" *The National Interest*, 2 February 2019. https://nationalinterest.org/blog/buzz/russias-only-aircraft-carrier-serious-trouble-43157

Garfield, Brian. *The Thousand-Mile War: World War II in Alaska and the Aleutians*. Fairbanks: University of Alaska Press, 1995.

Garrett, William. *Report A066262 Fratricide: Doctrine's Role in Reducing Friendly Fire*. Fort Leavenworth, KS: School Of Advanced Military Studies, Army Command and General Staff College, December 1992..

Getler, Michael. "U.S. Aid to Britain In Falklands War Is Detailed." *The Washington Post*, March 1984. https://www.washingtonpost.com/archive/politics/1984/03/07/us-aid-to-britain-in-falklands-war-is-detailed/6e50e92e-3f4b-4768-97fb-57b5593994e6/

Getttinger, Dan and Arthur Holland Michel. *Loitering Munitions in Focus*. Annandale-on-Hudson, NY: Center for the Study of the Drone, 2017. https://dronecenter.bard.edu/files/2017/02/CSD-Loitering-Munitions.pdf

Gray, Christopher; Bergey, Leif; and Berbrick, Walter A. "Fleet Arctic Operations Game." *Game Reports*.17 (2011). https://digital-commons.usnwc.edu/game-reports/17

Harper, Christopher. 2020. 'Game Out' Decision Making. NATO 20/2020. Atlantic Council. Scowcroft Center for Strategy and Security. 86-90.

https://www.atlanticcouncil.org/content-series/nato20-2020/game-out-decision-making/

House of Commons Defence Committee. "On Thin Ice: UK Defence in the Arctic." *Twelfth Report of Session* 2017–19. https://publications.parliament.uk/pa/cm201719/cmselect/cmdfence/388/388.pdf

Hughes, Wayne. *Fleet Tactics and Coastal Combat*. Annapolis MD: Naval Institute Press, 2000.

Humpert, Malte. "Satellite Images Reveal New Russian Long-Range Radar in the Arctic." *High North News*, 17 December 2019. https://www.highnorthnews.com/en/satellite-images-reveal-new-russian-long-range-radar-arctic

Isachenkov, Vladimir. "New Russian policy allows use of atomic weapons against non-nuclear strike." *The Associated Press*, 2 June 2020. https://www.defensenews.com/global/europe/2020/06/02/new-russian-policy-allows-use-of-atomic-weapons-against-non-nuclear-strike/

Kemp, Ian. "The Transition Force." *Armada International* 29, no.6 (December 2005/January 2006): pp. 12-26.

Kaushal, Sidharth and Jack Watling. *Requirements for the UK's Amphibious Forces in the Future Operating Environment*. London: Royal United Services Institute, 2019.

https://rusi.org/sites/default/files/201911_op_requirements_for_the_uks_amphibious_forces_in_the_future_operating_environment_kaushal_watling_web.pdf

Kofman, Michael. "Russian A2/AD: It is Not Overrated, Just Poorly Understood." *Russian Military Analysis*, 25 January 2020. https://russianmilitaryanalysis.wordpress.com/2020/01/25/russian-a2-ad-it-is-not-overrated-just-poorly-understood/

Kofman, Michael. "Western Military Thought Persists in Self-Comforting Delusions on Russian A2/AD: They do not even understand no such doctrine exists in the Russian military, its recipe is entirely different." *Anti-empire*, 28 January 2020. https://www.anti-empire.com/western-military-thought-persists-in-self-comforting-delusions-on-russian-a2-ad/

Koivurova, Timo, and Filip Holiencin. "Demilitarisation and neutralisation of Svalbard: how has the Svalbard regime been able to meet the changing security realities during almost 100 years of existence?" *The Polar Record* 53, no. 2 (2017): p. 131. DOI:10.1017/S0032247416000838.

Kopp, Carlo. "Russian VHF counter stealth radars proliferate." *Defense Today*, 4 (2008): pp. 32-36. http://ausairpower.net/SP/DT-Rus-VHF-Radar-2008.pdf

Kotani, Ken. "Political and Diplomatic Lessons of the Falkland War." In *International Forum on War History 2013 The Legacy And Implications Of The Pacific War*. 25 September 2013: pp. 115-121. Toyko: The National Institute for Defense Studies. http://www.nids.mod.go.jp/english/event/forum/pdf/2013/09.pdf

Krepinevich, Andrew F., Barry D. Watts, and Robert O. Work. *Meeting the anti-access and area denial challenge*. Washington, DC: Center for Strategic and Budgetary Assessments, 2003. https://csbaonline.org/uploads/documents/2003.05.20-Anti-Access-Area-Denial-A2-AD.pdf

Lasconjarias, Guillaume. "NATO's Response to Russian A2/AD in the Baltic States: Going Beyond Conventional?" *Scandinavian Journal of Military Studies* 2, no. 1. (2019). https://sjms.nu/articles/10.31374/sjms.18/

Latrash, Frederick. *Risk Management: An Integral Part of Operational Planning*. Newport RI: Naval War College, 1999. https://apps.dtic.mil/sti/pdfs/ADA363058.pdf

Leppälä, Laura, Salomon Honkala, Giorgia Ferrara, Martti Kirkko-Jaakkola, Heidi Kuusniemi, and Seija Miettinen-Bellevergue. "Challenges in Arctic navigation: The user perspective." In *2019 European Navigation Conference (ENC)*, pp. 1-8. IEEE, 2019.

MBDA UK. "Storm Shadow/Scalp Conventionally Armed Long Range Deep Strike Weapon." Product Brochure V03. Stevenage UK, 2019.: MBDA UK Ltd. https://www.mbda-systems.com/product/storm-shadow-scalp/

MccGwire, Michael. "Naval Power and Soviet Global Strategy." *International Security* 3, 4 (Spring 1979): pp. 34-189.

McCrory, Duncan. "Russian Electronic Warfare, Cyber and Information Operations in Ukraine: Implications for NATO and Security in the Baltic States." *The RUSI Journal* 165, no. 7 (2020): pp. 34-44.

McGillvray, John W. "Stealth Technology in Surface Warships." *Naval War College Review* 47 no. 1 (1994): pp. 28-39. https://www.jstor.org/stable/44642486

Mercogliano, Salvatore R. "Navy's Stealthiest Warship May Be a Merchant Vessel." *Maritime Executive*, 13 October 2017. https://www.maritime-executive.com/editorials/navys-stealthiest-warship-may-be-a-merchant-vessel

Middlebrook, Martin. *The fight for the "Malvinas": the Argentine Forces in the Falklands War*. London: Penguin Books, 1989.

Naval History and Heritage Command. "Wainwright III (DLG-28)." *Naval History and Heritage Command*, 3 October 2015.

https://www.history.navy.mil/content/history/nhhc/research/histories/ship-histories/danfs/w/wainwright-iii.html

Netherwood, Andy. "A Space Defence Strategy for the UK." *Wavell Room*, 28 January 2020. https://wavellroom.com/2020/01/28/a-strategy-for-uk-space-defence/

Perkins, Roger. *Operation Paraquat: The Battle for South Georgia*. Chippenham UK: Picton Publishing Ltd., 1986.

Perkins, William A. "Component Integration Challenges presented by Advanced Layered Defence Systems (A2/AD)." *The Three Swords Magazine*, 33 (2018): pp. 52-64. https://www.jwc.nato.int/images/stories/threeswords/A2AD_2018.pdf

Pike, John. "Project 6300 RNoN Skjold-class Corvette Littoral Combat Craft (LCC)." *Global Security.org*. 6 June 2020. https://www.globalsecurity.org/military/world/europe/knm-skjold.htm

Polmar, Norman and Peter B. Mersky. *Amphibious Warfare: An Illustrated History.* London: Blandford Press, 1988.

Riddolls, R.J. *A Canadian Perspective on High-Frequency Over-the-Horizon Radar*. Ottawa: Defence R&D Canada, 2006. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.738.1641&rep=rep1&type=pdf.

Robinson, Michael D. and Phillip R. Bryant. "Peripheral Nerve Injuries." In *Textbook of Military Medicine, Part IV Surgical Combat Casualty Care, Rehabilitation of the Injured Combatant,* Vol. 2, Chapter 9, edited by Russ Zajtchuck, pp. 419-574. Washington DC: Borden Institute, Walter Reed Army Medical Center, 1999. https://ke.army.mil/bordeninstitute/published_volumes/rehab2/RH2ch9.pdf

Rogoway, Tyler. "Photo of the Pentagon's Shadowy Special Operations Mothership Emerges." *The War Zone*, 18 May 2018. https://www.thedrive.com/the-war-zone/20959/photo-of-shadowy-u-s-special-operations-ghost-mothership-appears-on-twitter

Rossiter, Mike. *Sink the Belgrano*. London: Transworld Publishers, 2008.

Schulte, John C. *An analysis of the historical effectiveness of anti-ship cruise missiles in littoral warfare*. CA: Naval Postgraduate School Monterey, 1994.

Sheridan, Iain. "Drones and global navigation satellite systems: current evidence from polar scientists." *Royal Society open science* 7, no. 3 (2020): p. 191494.

Skolnik, Merrill I. *Introduction to radar systems.* Second Edition. Auckland: McGraw-Hill, 1981.

Skolnik, Merrill I. *Radar Handbook*, Second Edition. Boston MA: McGraw-Hill, 1990.

Spaceflight101.com. "Iridium-NEXT." 2021. https://spaceflight101.com/spacecraft/iridium-next/.

Tingley, Brett. "The Navy's Secretive and Revolutionary Program to Project False Fleets from Drone Swarms." *The Drive*, 7 November 2019.

https://www.thedrive.com/the-war-zone/29505/the-navys-secretive-nemesis-electronic-warfare-capability-will-change-naval-combat-forever

Todorov, Andrey A. and Dmitriy N. Lyzhin. "The UK's interests in the Arctic." *Arktika i Sever* [Arctic and North] 36 (2019): pp. 84–95. DOI: 10.17238/issn2221-2698.2019.36.84.

US Army. *FM 31-71 Northern Operations*. Washington DC: Headquarters, Department of the Army, 1963.

US Army. *FM 31-70 Basic Cold Weather Manual*. Washington DC: Headquarters, Department of the Army, 1968.

US Army. *ATP 3-90.97 Mountain Warfare and Cold Weather Operations*. Washington DC: Headquarters, Department of the Army, 2016.

US Army Asymmetric Warfare Group. *Russian New Generation Warfare Handbook*. Fort Meade MD: Asymmetric Warfare Group, 2016.

US Navy. *US Navy Cold Weather Handbook for Surface Ships*. Washington DC: Chief of Naval Operations, 1988.

Wither, James K. "Svalbard: NATO's Arctic 'Achilles' Heel.'" *The RUSI Journal* 163 no.5 (2018): pp. 28-37. https://doi.org/10.1080/03071847.2018.1552453

Wood, H Charles. "Ionospheric-Propagation Predictions." *Electronics World*, April 1969. https://www.rfcafe.com/references/electronics-world/ionospheric-propogation-predictions-electronics-world-april-1969.htm

Woodward, S. with P. Robinson. One hundred days. London: Harper Collins Publishers, 1992.

Zimmerman, Michael. "High North and High Stakes: The Svalbard Archipelago Could be the Epicenter of Rising Tension in the Arctic." *PRISM* 7 no.4 (2018): pp. 106-123. https://www.jstor.org/stable/26542710