NATO PARLIAMENTARY ASSEMBLY

SCIENCE AND TECHNOLOGY COMMITTEE (STC)

NATO ANTI-SUBMARINE WARFARE: REBUILDING CAPABILITY, PREPARING FOR THE FUTURE

Draft Special Report

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Until this document has been adopted by the Science and Technology Committee, it only represents the views of the Special Rapporteur.

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I. INTRODUCTION

1. In recent years, Allies have seen a sizeable increase in Russian submarine patrols in Allied areas of operation. The UK Minister of Defence, Gavin Williamson, estimates that Russian patrols increased by a factor of ten between 2011 and 2017 (Cecil and Collins, 2018). Indeed, navies spotted Russian submarines in some very sensitive spots: a mere 350 kilometres from the US eastern seaboard, close to the home of the United Kingdom's nuclear deterrent, and near critical undersea communication cables. All of this led Admiral James G. Foggo III, current Commander of the US Naval Forces Europe and NATO Joint Force Command Naples, to argue that "Russian submarines are prowling the Atlantic, testing our defences, confronting our command of the seas, and preparing the complex underwater battlespace to give them an edge in any future conflict" (Foggo and Fritz, 2016). Russia may be the most immediate submarine threat to the Alliance, but there are other submarine fleets which should concern Allies. First, China's expanding global forays –such as the One Belt, One Road initiative or its increasing Arctic presence – go hand-in-hand with increasing defence investments, including submarine modernisation. Second, as North Korea seeks to create an operational nuclear deterrent directed against one NATO Ally in particular, its navy is seeking to develop submarines armed with sea-launched ballistic missiles.

2. The increased Russian submarine patrols should concern the political and military leadership of the Alliance. Since World War I, submarines have been a critical threat to civilian and naval vessels because of their stealth, silence, and speed (Perkins, 2016). A single submarine could shut down a strategic maritime chokepoint, threatening everything from merchant vessels to carrier strike groups. Submarines can thus deny naval power projection and disrupt critical sea lines of communication. When equipped with land-attack cruise missiles, they can also hold critical points at land at risk. Indeed, Russia has used them to attack targets inside Syria from the Eastern Mediterranean. Unlike other 'hard' military capabilities like tanks or even missiles, submarines are also very well suited for asymmetric and hybrid tactics because they lend themselves to deceit and deniability. In particular, the threat to undersea communication cables, which carry 97% of global data transfers, has risen substantially. Special purpose submarines play a key role, as they can covertly tap or cut these cables to gain valuable intelligence or disrupt vital services.

3. Another fact should worry NATO even more: a severe shortfall of anti-submarine warfare (ASW) capabilities across the Alliance. In the words of Allied Maritime Commander Vice Admiral Sir Clive Johnstone, NATO faces a situation where "we are very short of high-end submarine warfare hunters" (Fabey, 2018). Allies have belatedly woken up to this capability shortfall and have committed to remedying the situation. NATO has conducted strategic assessments, reinforced its maritime posture, initiated reforms of command and control mechanisms, and intensified its ASW exercise regime.

4. Certainly, the ASW challenge requires adaptation across the board, but no adaptation can compensate for possessing enough of the right capabilities. This draft special report thus squarely focuses on the need to rebuild NATO's ASW assets in the short and long term – a topic which must deserve the Allies' full attention. The draft report therefore:

- demonstrates the importance of the sea for the Alliance;
- examines the concrete Russian submarine threat to NATO;
- highlights key developments in the Chinese and North Korean submarine fleets;
- outlines the most critical ASW capability shortfalls in the Alliance;
- presents important national and NATO modernisation efforts; and
- sketches a future vision of ASW based on emerging technologies.

5. The Science and Technology Committee (STC) will discuss this first draft at its meeting at the 2019 NATO PA Spring Session. At the autumn's Annual Session, the Special Rapporteur will present a revised version for adoption at the 2019 Annual Session. The draft report also complements this

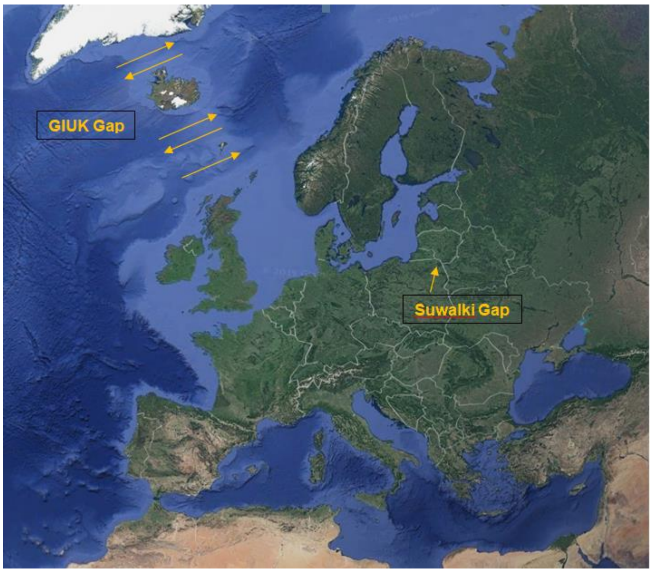
year's draft Report *Evolving Security in the North Atlantic* of the Defence and Security Committee (DSC).

II. THE IMPORTANCE OF THE SEA FOR THE ALLIANCE

6. The importance of the sea for the Alliance can hardly be overstated (see also Map 1). The conventional defence of Europe rests on two pillars (Breedlove, 2018). First, the Alliance must have robust military power, including Canadian and US forces, present and ready in Europe, including its maritime approaches. Second, the North American Allies must be able to reinforce and resupply the European continent with materiel and personnel in times of crisis or war. International law, norms, and multinational institutions underpin the principle of freedom of navigation in peace time (Tamnes, 2018). However, in contingency situations, the Alliance will only be able to guarantee such freedom if it can exercise control of the sea and project power into and across the sea.

7. As its name makes abundantly clear, the **North Atlantic Ocean** is at the core of the North Atlantic Treaty Organization. It is a vital part of NATO's area of responsibility and its most important sea line of communication (Olsen, 2018). It is "NATO's lifeblood", as General Philip M. Breedlove, NATO's former Supreme Allied Commander Europe, so aptly puts it (Breedlove, 2018). In addition to its military importance, it also remains the key to economic prosperity in North America and Europe and hosts critical undersea communication cables.

Map 1: GIUK and Suwalki Gaps



8. While the North Atlantic may be the most important maritime environment for the Alliance, NATO should also be in a position to exercise control of or guarantee access to its other maritime areas of responsibility, most importantly the Baltic, Mediterranean, and Black Seas.

9. The **Baltic Sea** connects nine European countries, including six Allies. Maritime traffic is extremely dense. Almost 15% of global maritime cargo traffic is related to the region (Nordenman, 2018). Moreover, the Baltic Sea is the third most important energy node after the Strait of Hormuz and the Strait of Malacca. If Russia ever succeeded in closing the 104-kilometre land border between Poland and Lithuania (the Suwalki gap), the maritime approaches in the Baltic Sea would also be the only viable reinforcement and resupply route for Estonia, Latvia, and Lithuania.

10. In recent decades, the **Mediterranean Sea** has become increasingly important for the Alliance and especially for the nine Allies with Mediterranean shores. Maritime trade between countries in the region accounts for almost a quarter of global maritime trade (UFM, n.d.). Another key reason remains the continuing difficult security environment in the Maghreb and the Eastern Mediterranean. A very visible sign of the Mediterranean Sea's rising importance was the move of the US Sixth Fleet's headquarters from London to Naples in the mid-2000s.

11. While the **Black Sea** boasts far less maritime traffic, it still represents a highly complex geopolitical environment for NATO as a whole and for Bulgaria, Romania, and Turkey in particular. This has been especially true after the 2008 Russia-Georgia conflict, Russia's illegal and illegitimate annexation of Crimea in 2014, and the ongoing aggression in eastern Ukraine. The military picture remains complicated for all sides, however, as the 1936 Montreux Convention imposes firm military restrictions for non-Black-Sea states. Non-Black-Sea countries cannot send submarines through the

Turkish Straits. Restrictions also apply to surface ships, thus curbing available ASW capabilities. Limits apply to the size of ships and fleets as well as to the duration of stay (maximum 21 days). Moreover, Black Sea countries can only send submarines through the Straits if they are joining their base in the Black Sea for the first time or if they return from maintenance or repair outside the Black Sea. This clause is the likely reason why two new submarines assigned to Russia's Black Sea Fleet have not yet joined their home base but remain in Tartus, Syria. If they entered the Black Sea, they could only leave and come back when in need of repair or maintenance.

12. As new opportunities and challenges arise due to the changing climate, the **High North** is another area deserving of close monitoring by the Alliance. Arctic oil and gas projects could still alter the global energy market. New maritime sea routes connecting the Atlantic and the Pacific could change global trade. Commercial fishing in the North Atlantic and North Pacific fisheries already accounts for about 40% of commercial fish landings globally. Tourism is on the rise. In short, the human footprint in the Arctic is increasing, and with its state interests. Submarines are ideally adapted to operate in the Arctic and thus show presence, gather valuable intelligence, present hybrid challenges, and close off increasingly busier Arctic chokepoints. In addition to Russia, China has aspirations to send its submarines into the Arctic in the future.

III. THE RUSSIAN SUBMARINE THREAT TO NATO

A. SUBMARINES IN RUSSIA'S STRATEGY

13. Russia's submarines must be placed in the context of the larger strategic picture. Russia's **grand strategy** remains to reclaim its status as a great power on the global stage. A key pillar of this effort is a substantial military modernisation premised on high levels of defence spending. Russia does not publish reliable, transparent figures on defence spending. According to one of the most reliable estimates, the level of defence spending has fallen slightly since its high point in 2015, when Russia spent 4.83% of its GDP on defence. Still, in 2018, it remained high at 4% (IISS, 2019). Regardless, Russian military spending, including on submarines, does not need to be high to achieve effective asymmetric effects, as should become clear below. Alongside military modernisation, Russia continues to seek political and military buffer zones in what it calls its 'near abroad'. For one, Russia pursues hybrid and asymmetric tactics to create strategic uncertainty and localised surprises (Metrick and Hicks, 2018). Additionally, its leadership pursues targeted tactical overmatch by creating anti-access/area-denial (A2/AD) 'bubbles' (Metrick and Hicks, 2018). Russia's northern shores and the Baltic and Black Seas are critical links in this A2/AD approach, and submarines play a vital role in this respect.

14. Russia's **maritime strategy** seeks to fulfil two fundamental goals: the provision and protection of its submarine-based nuclear deterrent and the defence of its homeland (Allport, 2018). As a consequence, the Russian navy continues to prioritise a) the replacement of its submarines equipped with nuclear warheads and b) strengthening its naval forces for conventional anti-surface warfare and land attack.

15. Overall, Russia's naval capabilities still remain "vastly inferior to the collective power of the Alliance" (Allport, 2018). As in other domains, Moscow seeks to compensate by maximising its asymmetric strengths – often to great effect. That is one reason Russia also turns to **maritime hybrid tactics** "to turn its weak hand into a strong one", notes Admiral James G. Stavridis, former NATO Supreme Allied Commander Europe (SACEUR) (Stavridis, 2018). Russia could employ the full range of military and civilian capabilities and operate as ambiguously as possible (Stavridis, 2018). Like certain other maritime assets (for example, ostensibly civilian vessels, amphibious special operation forces, or combat swimmers), submarines are well suited to create deniable effects and conduct seabed operations.

16. In particular, Allied defence leaders have sounded warnings that Russia could tap or sever **undersea communication cables**, as its vessels have been spotted near these cables (see Box 1 and Map 2). Although designed with redundancy in mind, the tapping or severing of undersea communication cables could be extremely consequential for transatlantic and intra-European communications. If the global undersea network was taken offline, satellites could only compensate for about 7% of the data passing through the network (Jones, 2018). The international trading and financial system is critically dependent on this network. A disruption would have massive and immediate effects on economic markets until internet traffic could be restored through other means or the cables repaired (BBC, 2017; Stavridis, 2018). As one prominent defence analyst has argued, Russia has learnt from its Crimea campaign: "physical access to the communications infrastructure and telecommunications" was the key to information dominance (BBC, 2017). In the absence of an effective monitoring system, a key advantage of disrupting undersea cables lies in deniability. A 2008 incident illustrates this: no bad actor was behind the near-simultaneous cutting of undersea cables from the Middle East to Europe and Asia; a ship dragging an anchor and an undersea landslide were responsible. However, if this happened to cables crucial for the Allies, how could they be sure a state was behind this (Smith and Hendrix, 2017)? Even if one Ally had good intelligence, would it be able to share enough to convince others? And what would happen if this took place at critical points in time? It is time for NATO to come up with a good answer.

Box 1: Notable quotes on the threat against undersea cables

Rear Admiral Andrew Lennon, Deputy Commander for Submarines at Allied Maritime Command (Ripley, 2019):

"We are now seeing Russian underwater activity in the vicinity of undersea cables that I don't believe we have ever seen. Russia is clearly taking an interest in NATO and NATO nations' undersea infrastructure."

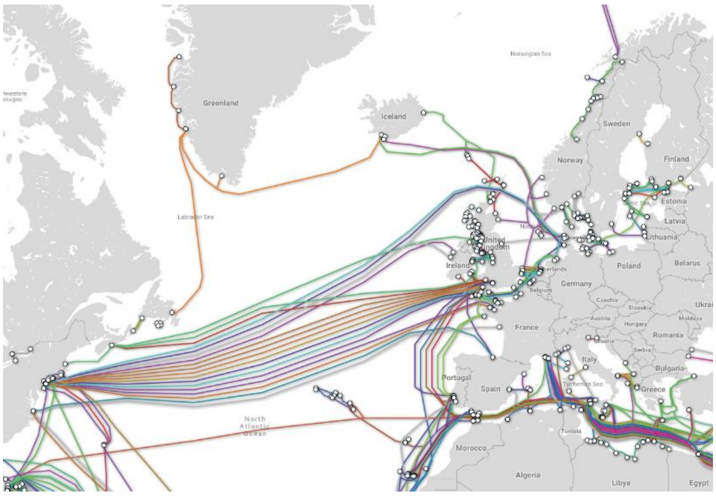
Air Chief Marshal Sir Stuart Peach, Chief of the Defence Staff, UK Ministry of Defence (Peach, 2017):

"There is a new risk to our way of life that is the vulnerability of the cables that crisscross the seabed."

Arnor Sigursjonsson, Director General of the Defence Directorate in Iceland's Ministry of Foreign Affairs, December 2018 (Willet, 2018):

"[Undersea cables] are not only linking Iceland to Europe and to North America, but they are the linkages between North America and Europe directly, south of Iceland […]. If you manage to disrupt those, that will have major consequences globally."

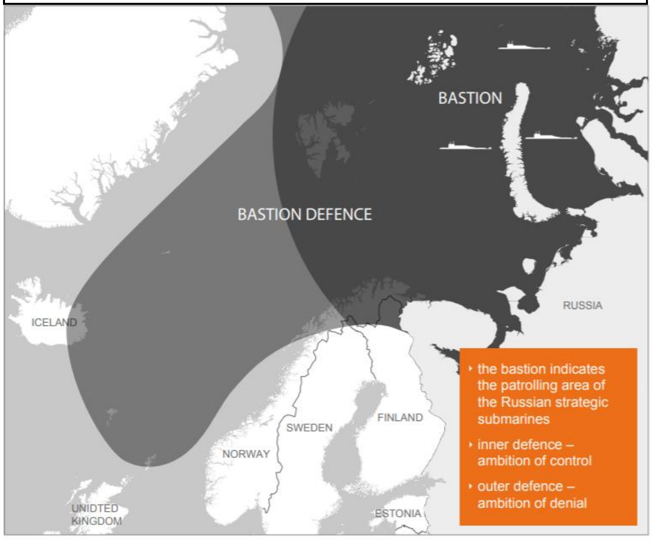
Map 2: Euro-Atlantic Undersea Cable Network (Source: TeleGeography)



17. With Moscow's revived focus on submarines, two classic Cold War concepts of operations have made a return when it comes to the **North Atlantic**: 'bastions' and 'bastion defence' (Olsen, 2018). Bastions are those maritime zones where Russia concentrates its at-sea nuclear deterrent. Naturally, Russia wants to keep these strategic submarines safe and thus heavily protects these bastions. Russia's European bastion is centred on its northern shores (see Map 3). Beyond the bastion, a defensive perimeter of bastion defence stretches all the way to the so-called Greenland-Iceland-UK gap (GIUK gap). One reason the GIUK gap is important to Russia is the fact that, from this line onwards, US assets equipped with *Tomahawk* cruise missiles can hit vital targets in Russia. Its military leadership is keenly aware it cannot challenge the Alliance for control of the North Atlantic. Thus, Russian naval assets, most importantly tactical submarines, would seek to deny access to Allied vessels venturing beyond the gap in times of crisis or war.

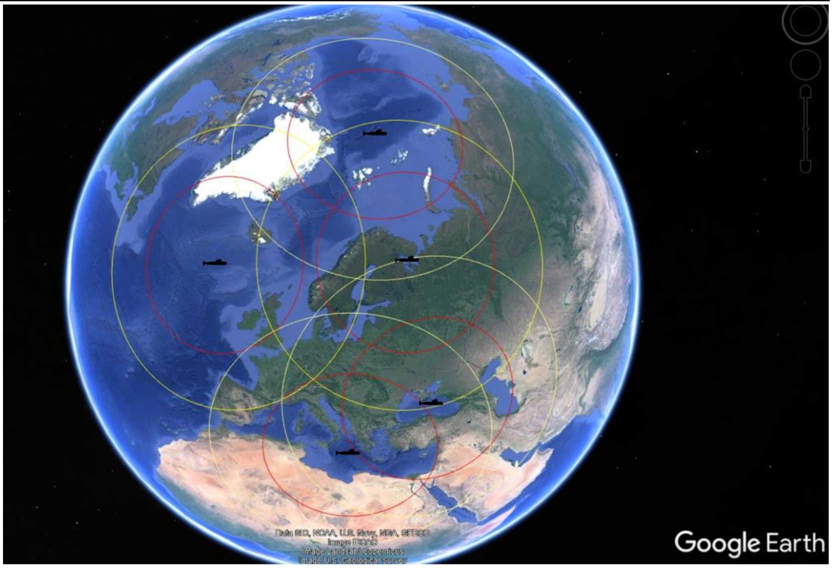
18. Not every element of Russian maritime strategy, naval modernisation, and operational activities should be seen as inherently threatening. After all, the Russian military was at a particularly low point when it initiated modernisation efforts. Reasonable experts differ on whether Russia's evolving maritime posture is defensively or offensively oriented. Some argue that Russia's maritime strategy and posture is defensive at its core (Allport, 2018). Others read Moscow's actions as geared towards the offensive (Olsen, 2018).

Map 3: Russia's Bastion Defence
(Source: Expert Commission on Norwegian Security and Defence Policy, 2015)



19. The Rapporteur would agree with the latter. One basic problem of Russia's strategy is that actions Russia would (want to) perceive Alliance – threatening the transatlantic link. Another element in Russia's naval modernisation also points towards an offensively oriented posture: the new *Kalibr*-3M14 long-range precision-guided missiles which can target both surface vessels and land targets from as far as 1,500 to 2,500 kilometres. As a result, Russian submarines not only present a threat to the transatlantic link; they can now also deny access to Alliance littorals in support of the much broader A2/AD threat (Tamnes, 2018). *Kalibr* missiles could hold critical nodes deep in Alliance territory at risk, even when on station in the Barents and White Seas. If the upper estimate holds true, a submarine in the White Sea could place a *Kalibr* on NATO Headquarters in Brussels and at least 13 Allied capitals (see also Map 4). In a crisis or war, Russian submarines could target critical disembarkation ports for troop reinforcements and potentially even North America's eastern seaboard if they slipped undetected into the western North Atlantic. Such a situation would have significant military, political, and psychological effects on member states, potentially undermining NATO's ability and will to fulfil its core tasks (Allport, 2018).

Map 4: Illustrated range of *Kalibr*-equipped submarines (lower and upper range estimates)



20. While the above shows the importance of the North Atlantic in Russia's strategic thinking, the Baltic and Black Seas are also central areas. The **Baltic Sea** is critically important to Russian interests. Russia ships about half of its maritime cargo through the region, and it is the maritime gateway for its Kaliningrad exclave (Nordenman, 2018). In operational terms, Russian submarines could use the Baltic Sea as a staging area for cruise-missile attacks, a haven to expand into the Atlantic Ocean, and an area to lie in wait (Perkins, 2016). In peace time, they can also seek to monitor Allies and engage in targeted provocation and intimidation. The Baltic Sea is a very challenging area for submarines, however, due to its shallow and confined waters, dense maritime traffic, and scores of unexploded sea mines. Conversely, these features, combined with the low salinity of the Baltic Sea,

also make submarines very hard to find. The Baltic thus presents a very good training ground for Russia submariners. Experts argue that NATO partners Finland and Sweden are 'useful' to Russia in this regard, as its submarines can train against high-end capabilities without the risk of confronting a NATO Ally (Perkins, 2016).

21. Before 2014, the Russian naval fleet in the **Black Sea** was in disrepair. Tellingly, only one new surface combatant had been assigned to the Fleet between 1991 and 2014 (Gorenburg, 2018). Missions in the Mediterranean Sea and the Gulf of Aden had to be carried out by other vessels (Gorenburg, 2018). Although Russia has not fulfilled all its Black Sea ambitions under its current modernisation, Moscow has nevertheless deployed large numbers of new surface combatants into its Black Sea ports and re-established a permanent submarine presence. Its *Kalibr* missiles put a significant part of Allied territory at risk. Russia also increasingly uses the region as a launch pad for power projection into the Mediterranean Sea.

B. THE STATE OF RUSSIA'S SUBMARINE FLEET

22. As a sign of its strategic importance, the submarine modernisation programme is, to a large degree, protected in the Russian defence budget. This has begun to pay dividends for its fleet of 58 submarines (excluding special-mission submarines) (IISS, 2019; see Table 1). The newest submarines are not the most modern in the world by any means, as their designs are about 10 to 15 years old. However, they represent a step change in quality. They are highly capable, approaching near parity with some Allied submarines. Overall, submarine modernisation is an efficient investment, as Russian submarines achieve effects disproportionate to the resources committed (Hicks et al., 2016)

23. The *Delta III* and *Delta IV* class submarines still represent the backbone of Russia's **nuclear at-sea deterrent**. The Russian navy is slowly replacing them with new *Borei* class submarines, which have much improved acoustic silencing and propulsion. Three are in service today out of a planned eight by the early 2020s (Connolly and Boulègue, 2018). However, Russia has faced substantial delays in the construction of the first three *Borei* submarines, due to problems related to the development of the diesel generators and especially the new *Bulava* 150-kilotonne nuclear ballistic missile.

24. The stealthy and fast *Oscar II* class **nuclear-powered cruise-missile submarines** are some of the largest submarines ever built. Some of the *Oscar II* submarines are being modernised to remain in service for another 15 to 20 years and will be refitted to carry up to 96 *Kalibr* missiles. Russia's **nuclear-powered general-purpose submarine fleet** has three different classes in its arsenal: the *Victor III*, *Sierra II*, and *Akula* classes. Some of the *Akula* submarines are undergoing modernisation efforts.

25. The successor for all of Russia's tactical nuclear-powered submarines is the multi-role ***Yasen* class.** Experts judge *Yasen* submarines to be extremely quiet, although not as quiet as the US *Seawolf* or *Virginia* classes. They are designed to hold between 32 and 40 *Kalibr* missiles. One is already in service, and a second one, known as the Yasen-M or *Husky*, due to certain modifications, is in the testing phase. By 2024, Russia plans to commission five more *Yasen* submarines (down from an initial target of 8 to 10). A key challenge for Russia will be to bring down costs. The *Yasen*-M has already cost an estimated USD 1.68 billion.

26. The *Kilo* and *Improved Kilo*-class submarines are Russia's **diesel-electric submarines** for anti-submarine duties. The *Improved Kilo*-class submarines are very stealthy and cheap for the level of capabilities they deliver. The *Lada* class submarines were supposed to replace these two classes, but the programme has run into significant problems and delays. One big problem appears to be that Russia faces severe difficulties in designing and manufacturing air-independent propulsion, a key modern submarine technology for diesel-electric submarines. Speculation is rife that this design could be scrapped in favour of a new *Kalina* class design.

27. Russia has perhaps the most developed **seabed-warfare** capabilities worldwide (Allport, 2018). In particular, military leaders in the Alliance have sounded warnings that Russia could tap or sever commercial or NATO undersea communication cables. Russia currently possesses special mission submarines of the *Delta III*, *Delta IV*, and *Oscar II* classes, although many may be at low readiness levels. These submarines could, however, serve as motherships for the manned mini-submarines and submersibles of the *Losharik*, *Paltus*, *Rus*, or *Consul* classes which can manipulate objects on the seabed, or for unmanned systems. It is unclear how many of these are actually in service (Ripley, 2019). Russia's Main Directorate of Deep-Sea Research aims to increase the number of such mini-submarines able to operate on the seabed.

28. Much secrecy surrounds another underwater threat: the *Poseidon* **unmanned underwater vehicle or torpedo** (formerly known as Status 6 or *Kanyon*). The *Poseidon* was 'accidentally' revealed a few years ago and now features prominently in President Putin's speeches. Russia claims that *Poseidons* could carry 100- to 2000-megatonne nuclear warheads for coastal destruction and contamination. The nuclear warheads are 'salted' with cobalt for maximum nuclear contamination. While information is too sparse to properly judge the accuracy of these claims, it is essential to closely watch the project.

Table 1: Russian Submarines (Source: IISS, 2019)

Strategic Submarines	**Number**
Delta III class (Project 667BDR; *Kalmar)*	1
Delta IV class (Project 667BDRM; *Delfin)*	6
Borei class (Project 955/A; *Dolgorukiy*)	3
Akula class (Project 941; *Typhoon*)	(1)
Tactical Submarines	
SSGN	
Oscar II class (Project 949A; *Antei*)	8
Yasen class (Project 885; *Severodvinsk*)	1+1*
SSN	
Schuka-B class (Project 971; *Akula* I)	9
Schuka-B class (Project 971M; *Akula II*)	2
Sierra II class (Project 945A; *Kondor*)	2
Schuka class (Project 671RTM; *Victor III*)	3
Sierra I class (Project 945; *Barracuda*)	(1)
SSK	
Kilo class (Project 877; *Paltus)*	16
Improved Kilo class (Project 636.6; *Varshavyanka*)	6
Lada class (Project 677; *Petersburg*)	1*
Special purpose submarines	12?

Numbers in parentheses show platforms in storage.

** in the test phase*

Box 2: Russian Submarines in a Regional Perspective

The North Atlantic: The greatest number of Russia's submarines is assigned to its Northern Fleet. The Northern Fleet holds eight strategic submarines (with two in refit and reserve respectively) and 21 tactical submarines in its arsenal (with four in refit and one in reserve) (IISS, 2019).

The Baltic Sea: Russia currently has two *Improved Kilo* class submarines stationed in the Baltic Sea, but only one was available for operations in 2016. Russia plans to introduce two *Lada* class submarines into the Baltic Sea by 2024.

The Black and Mediterranean Seas: Russia has four submarines in the Black Sea and two at its naval facility in Tartus, Syria (assigned to the Black Sea Fleet).

IV. A VIEW TOWARDS EAST ASIA

29. As China increases its global footprint in areas critical to Allied interests, NATO member states must take heed of the Chinese submarine challenge. Moreover, North Korea's nuclear weapons and submarine programmes continue to work towards a sea-based deterrent aimed against the United States – a threat the Alliance would ignore at its peril. This section therefore presents these countries' submarine fleets.

A. RECENT CHINESE DEVELOPMENTS

30. Like Russia, the Chinese government is very opaque when it comes to military strategy, programmes, and budgets. Experts estimate that China spent about USD 168.2 billion on defence in 2018, with a significant part dedicated to defence investment (IISS, 2019). In the context of this draft report, it is clear that China's armed forces are very much focused on improving its existing submarine force and conducting cutting-edge research and development for its future fleet (IISS, 2019).

31. Today, China possesses 4 strategic submarines as well as 6 nuclear-powered and 48 diesel-electric tactical submarines (IISS, 2019). They are all less capable than their Russian equivalents, but the country is making great strides on technological development. Two **key drivers** explain China's focus on submarine modernisation. First, its leadership believes that its at-sea nuclear deterrent does not yet present a credible second-strike capability, and most analysts agree (Zhao, 2018). Second, China also invests substantial resources into tactical submarines to reinforce its A2/AD strategy, as China would like to hold the United States and other naval powers out of the so-called First Island Chain (see Map 5).

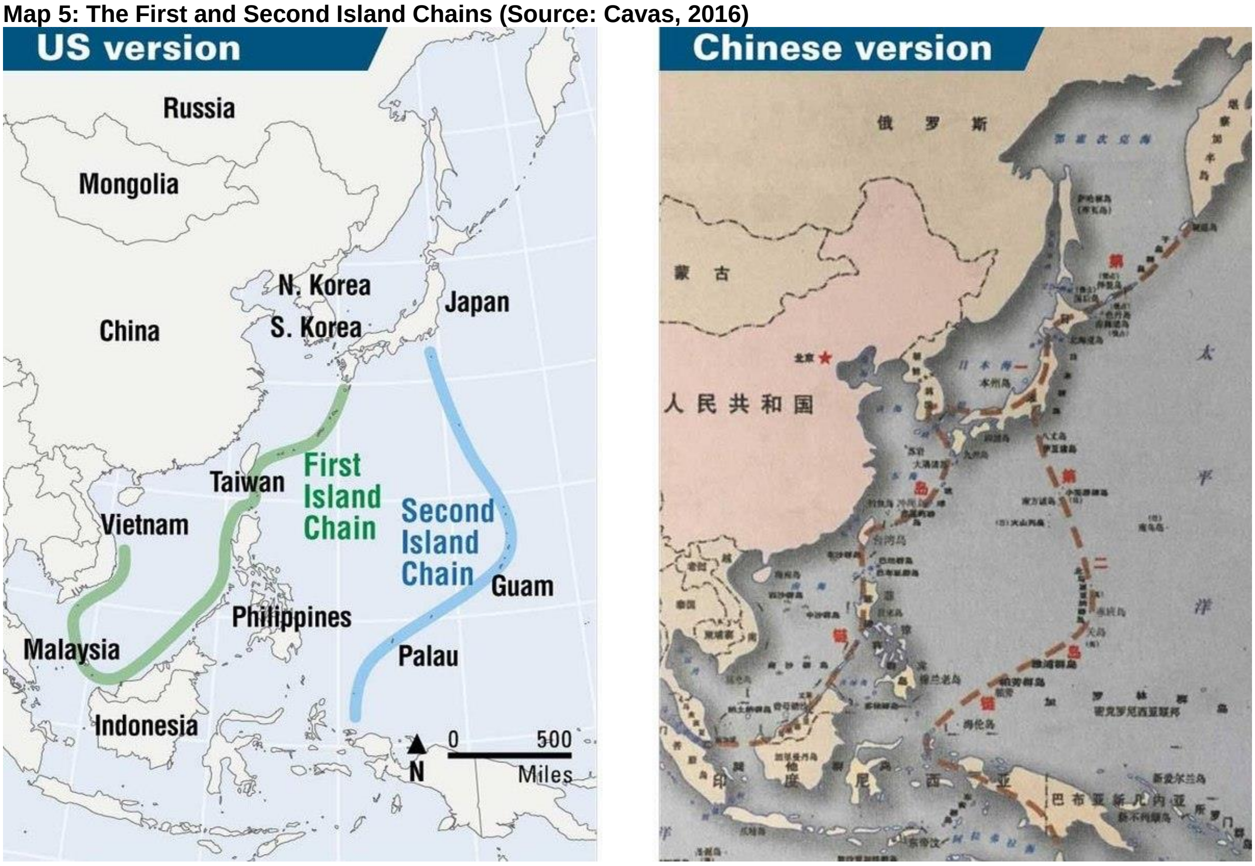
32. Most experts argue that Chinese nuclear-powered submarines, including strategic ones, are noisy compared to US and Russian high-end submarines (Zhao, 2018). Its **strategic submarines** could even be noisier than the Russian *Delta III* submarines, developed in the 1970s and now two generations removed from Russia's most sophisticated strategic submarine. China will only begin constructing its next-generation strategic submarines in the early 2020s (Zhao, 2018; Chan, 2018). Another problem for Chinese strategic submarines is the reported range of the JL-2 sea-launched ballistic missiles. These missiles could only hit the continental United States if China's submarines could break through the First Island Chain and into the Pacific Ocean. China is currently developing and testing the follow-on JL-3 missile, which could hit targets from a range of about 9,000 kilometres (Chan, 2018). Such a range would still be less than the best US and Russian sea-launched nuclear missiles and would only put part of the continental United States at risk from within the First Island Chain.

33. China's **tactical submarines** are also set to grow at a rapid pace, in both size and capabilities. China's nuclear-powered tactical submarines are estimated to be even noisier than its strategic ones (Zhao, 2018). Still, the new diesel-electric submarine of the *Yuan* class has incorporated quieting technology from Russian submarines and possesses an air-independent propulsion system – something which Russia has struggled to develop (Zhen, 2018).

34. China is investing heavily in **technologies** to make its submarines more survivable, most importantly by making them quieter through, for example, pump-jet propulsion and higher-temperature and gas-cooled nuclear reactors (Zhao, 2018). China is also making progress in another area which has long been a weakness: undersea communications (Zhao, 2018). Its navy appears to be able to communicate with submarines at super-low frequencies, which only two other states have achieved thus far. Moreover, Chinese researchers are working hard on extremely low frequency, airborne, and satellite communications. Notable other Chinese research and development efforts include work on quantum sensors which could reveal submarines by measuring magnetic fields, artificial intelligence applications for submarines, and maritime autonomous unmanned vehicles.

35. Experts argue that current Chinese **submarine strategy** mirrors the bastion concept, as practised by the Soviet Union in the 1970s and 1980s (Zhao, 2018). However, China faces bigger geographic constraints than the Soviet Union. First, its sea-launched ballistic missiles are fairly limited in range. Second, its coastal waters are very noisy. Adversary submarines could thus easily hide and shadow Chinese strategic submarines. This is one reason why China is also investing heavily into ASW capabilities, including seabed sonar systems as far out as the Indian Ocean. Third, the chokepoints Chinese submarines must break through in the South and East China Seas and the Sea of Japan are much narrower than the GIUK gap (Zhao, 2018). Nevertheless, Chinese submarines have patrolled further afield. They have patrolled as far as the Gulf of Aden, and China appears to be readying its submarine force for future Arctic operations (Tate, 2018).

Map 5: The First and Second Island Chains (Source: Cavas, 2016)



B. NASCENT NORTH KOREAN CAPABILITIES

36. North Korea maintains one of the world's largest submarine fleets. According to one reliable estimate, the country possesses 73 tactical submarines (IISS, 2019). Other experts argue the number could be as high as 86 (NTI, 2018). Most of them are, however, relatively small and incapable of sailing far from the Korean Peninsula, and, even if they could, they would face the same geographic obstacles and ASW assets as China.

37. The *Gorae* ballistic-missile-submarine programme suggests that North Korea plans to develop a **strategic submarine force** (NTI, 2018). Its single *Gorae* submarine (also known as Sinpo-B) has been used as a platform to test submarine-launched ballistic missiles. The *Gorae's* inability to remain submerged for more than a few days without surfacing limits its capability as a credible second-strike nuclear deterrent. For this reason alone, it is unlikely that North Korea intends to deploy the *Gorae* as an operational system.

38. North Korea appears to be building a new ballistic-missile submarine, the Sinpo-C (NTI, 2018). The Sinpo-C is estimated to displace more than 2,000 tonnes and have a beam of 11 metres, which would make the largest vessel in the North Korean navy (Majumdar, 2018). Even if the Sinpo-C

could become a viable strategic submarine, the navy would still need multiple Sinpo-C submarines armed with nuclear weapons to have a credible and survivable sea-based nuclear deterrent. However, given the strategic value, analysts deem these efforts unlikely to stop.

39. The North Korean sea-launched ballistic missile in development is the *Pukkuksong-1* (or *KN-11*), which appears to have a range of about 1,200 kilometres (Missile Defence Project, 2018). The country is believed to have undertaken four to six test launches of the missile since 2014 (Jeong, 2018). Most observers assess that North Korea still has numerous technical challenges to overcome before the missile could become operational – most importantly whether it would be able to fit a nuclear warhead. North Korea is pursuing further iterations of the *Pukkuksong* missile which could advance its pursuit of an operational sea-based ballistic missile.

V. ALLIED ASW CAPABILITY SHORTFALLS AND ONGOING MODERNISATION

A. THE OVERALL STATE OF ALLIED ASW CAPABILITIES

40. The principal purpose of ASW is to find a potential adversary's submarines in a game of 'cat and mouse' (Perkins, 2016). Given the difficulty of the task, ASW depends on high-end military capabilities, but as former US Chief of Naval Operations Admiral Gary Roughead aptly notes, it is also "a mix of art and science" (Roughead, 2018). Modern ASW mainly relies on a variety of manned platforms utilising passive and active sonar systems (see Box 3 and Table 2):

- tactical submarines;
- fixed-wing maritime patrol aircraft (MPA);
- surface vessels equipped with sonar systems;
- maritime ASW helicopters based on land or on surface vessels; and
- acoustic detection systems on the seabed or installed on shore.

41. NATO's overall ability to conduct high-end ASW operations has atrophied substantially. A 2017 tabletop exercise found that "neither the individual member states, nor the Alliance as a whole, presently possess the ability to conduct a comprehensive and coordinated anti-submarine warfare campaign under either peacetime or wartime conditions" (Smith and Hendrix, 2017). One of the participants argued that it would take 50 days or more to assemble an effective ASW force. While NATO still retains the capability to prosecute individual submarines at the current level of Russian patrols, it will soon lose this ability if current trends continue (Perkins, 2016). In short, the Alliance has "ceded much of the advantage it earned at the conclusion of the Cold War" (Perkins, 2016).

42. NATO faces a twin problem. For one, its own ASW capabilities have withered, as the number of ASW-capable platforms has fallen, in some areas radically. Moreover, the capabilities the Alliance still possesses are rapidly ageing and encounter interoperability problems (Hicks et al., 2016). At the same time, the submarine capabilities of near-peer competitors have increased significantly, even if they cannot best the most modern Allied submarines.

43. Several reasons explain but do not excuse this state of affairs. As the immediate threat of the Soviet Union waned in the early 1990s, defence budgets began to shrink substantially. They took another big hit after the financial crisis of 2007/2008. More importantly perhaps, a strategic reorientation towards expeditionary warfare took place after the Cold War ended. While based on sound reasons, this reorientation came at a high price for other capability areas, including ASW (Perkins, 2016; Allport, 2018; Hudson and Roberts, 2018):

- naval vessels conducted more and more generic maritime security or were repurposed for land attack missions;
- MPAs increasingly focused on wider intelligence, surveillance, and reconnaissance;
- ASW-capable vessels almost ceased operating in the North Atlantic and Arctic Oceans; and
- some Allies chose not to replace certain capabilities at the end of their lifetime.

Box 3: The Basics of Sonar Systems

Passive sonar systems: Passive sonar systems listen for submarines by employing hydrophones to detect noise emitted by propulsion systems and propellers as well as the noise the submarine produces when water flows over its hull. They are normally placed at the bow or on the flanks, or are towed behind surface vessels or submarines. Sonar systems placed on the seabed or on land in critical locations are also powerful tools for submarine detection. The performance depends on the oceanic environment, most importantly temperature, salinity, and ambient noise.

Active sonar systems: Active sonar systems detect submarines by emitting sound and listening for returns. While they create an accurate picture of the marine environment, they also give away the position of the listening station unless the emitter and the receiver are physically placed apart.

Low-frequency active sonar systems: First tested in the late 1980s, low-frequency active sonar systems have increased the range of active sonar systems and continue to evolve. They are becoming the primary sensor technology for detecting modern submarines at useful ranges. They are often used in towed array sensor systems trailing behind surface vessels, or in dipping sonars on helicopters.

Multi-static sonar systems: Multi-static sonar systems consist of a network of active and/or passive sonar systems spread out across an area of interest. Such systems offer very good triangulation, higher levels of covertness, and acoustic advantages.

44. One area where Allies have retained robust capabilities, including through timely replacement programmes, is maritime ASW helicopters. Acoustic detection systems installed on the seabed or on shore are highly classified systems, thus little information is available. It is understood, however, that the United States has placed its large underwater Sound Surveillance System near the GIUK gap in standby (Smith and Hendrix, 2017). Experts also question its ability to detect the quietest Russian submarines. The US Navy is pursuing upgrades and new systems, but little is known. Allied inventories of tactical submarines, MPAs, and frigates either continue to face significant shortfalls today or will in the near future. It is thus worth highlighting the ongoing modernisation efforts in this regard.

Table 2: Allied Assets Relevant to ASW (IISS, 2019)

Country	Tactical Submarines	Maritime Patrol Aircraft	ASW Helicopters	Principal Surface Combatants
Belgium	0	0	4	2
Bulgaria	0	0	2	4
Canada	4	18	15	12
Denmark	0	0	9	3
France	6	12 (+10)	38	24
Germany	6	8	22	14
Greece	11	5*	18	13
Italy	8	0	47	18
Netherlands	4	0	12	6
Norway	6	6	8	4
Poland	3	0	11	2
Portugal	2	5	5	5
Romania	0	0	0	3
Spain	3	3	21	11
Turkey	12	6	29	19
UK	6	0	58	20
US	53	140 (+12)	225 (+7)	112

Numbers in parentheses show platforms in storage.

**Greece is modernising its MPAs in storage.*

B. TACTICAL SUBMARINES: HIGH QUALITY, MIXED PICTURE OVERALL

45. The 124 tactical submarines currently available in Europe and North America still possess superior qualities compared to non-NATO submarines, with the US submarines remaining at the top of the class. Nevertheless, quantity counts in ASW, and it is therefore regrettable that the total number of submarines in the Alliance has fallen drastically. A few examples illustrate this (Hicks et al., 2016):

- **Denmark** did not replace its last submarines when they reached the end of their lifetime in 2004.
- **Germany's** submarine numbers fell from 14 to 6 between 2000 and 2019 (-57%).
- **Norway** went from 10 to 6 between 2000 and 2019 (-40%).
- The **United Kingdom** dropped from 12 to 6 between 2000 and 2019 (-50%).
- Even the **United States** lost almost 10% of its submarines.

46. The positive news is that all Allies with submarine fleets are committed to maintaining this capability. The most important submarine modernisation programmes include the following:

- **Canada** has decided to extend the lifetime of its *Victoria*-class submarines. The country purchased these submarines in 1998 from the United Kingdom, where they had entered service in the early 1990s.
- The four *Walrus*-class submarines of the **Netherlands** need to be replaced by about 2025. The country is currently defining a follow-on procurement programme.
- To replace its *Rubis* class submarines, **France** is in the process of building *Barracuda* class nuclear-powered general-purpose submarines. Six are planned, and the first delivery is expected in 2020.
- **Germany's** diesel-electric *Type 212* submarines boast some of the most advanced air-independent propulsion technology in the world. The German navy will add another two to its fleet in the coming years.
- **Italy** plans to procure another four German-designed *Type 212* submarines to remain at eight submarines once its four *Pelosi* class submarines retire.
- **Norway's** six *Ula* class submarines will reach the end of their lifespan in the early 2020s. They will be replaced by submarines based on the German *Type 212* class.
- **Poland's** submarines are deemed not combat-relevant by most experts. However, the country has committed to procuring new ones and initiated a competition for the programme.
- **Spain's** *S-80 Plus* class programme has run into severe problems, forcing the country to conduct a fifth overhaul programme of its *S-71 Galerna* class submarines, which entered service in the early 1980s.
- **Turkey** has launched a mid-life upgrade for its four *Preveze* class submarines.
- The **UK** Royal Navy is in the process of replacing the *Trafalgar* class submarines with the highly capable *Astute* class submarines. Three *Astute* submarines are already in service.
- While the **United States** is accelerating its submarine procurement, it will still face a tactical-submarine shortfall in the mid-2020s, when their number will bottom out at about 42. This prospect is likely a driving factor in the accelerated acquisition of maritime unmanned systems (see next section).

C. MARITIME PATROL AIRCRAFT: A KEY SHORTFALL AREA

Figure1: Multinational Maritime Multi Mission Aircraft Capabilities Cooperation

47. The capability shortfall in Maritime Patrol Aircraft (MPAs) for ASW missions has been especially dramatic. Compared to the end of the Cold War, the Alliance now possesses 120 fewer MPAs (Perkins, 2016). One data point illustrates what this really means: while the ratio of available Allied MPAs to Soviet submarines was about 1.8 to 1 at the end of the 1980s, the ratio has more than inversed at 1 Allied MPA for 2 Russian submarines (Perkins, 2016). While MPAs are certainly

expensive assets, they cannot be replaced solely by a layered federated system of sensors (Perkins, 2016). Indeed, to maintain 24-hour coverage of a single submarine, a country needs about seven to eight MPAs (Perkins, 2016).

48. The majority of the Allies' MPAs will reach the end of their operational lives in the 2025-2035 timeframe. They have realised the urgency of this challenge. Indeed, eight Allies have pursued a Multinational Maritime Multi Mission Aircraft Capabilities Cooperation under NATO's aegis since 2017 (see Figure 1). They have begun to define common requirements for such future aircraft capabilities, with ASW very much at the centre.

49. Individual Allies are already in the process of procuring new MPAs:

- **France** and **Germany** have declared their intent to work together in replacing their MPA fleets in a broader European project.
- **Norway** is replacing its P-3C *Orion* fleet with five P-8 *Poseidon* MPAs.
- **Italy's** new ATR-72 MPAs are not expected to be configured for ASW, but they retain the option.
- **Turkey** intends to procure six ATR-72 MPAs with ASW capabilities.
- The **United Kingdom** currently finds itself in a severe situation. In 2011, its *Nimrod* MPAs were not replaced. This has left the United Kingdom without an MPA capability and dependent on Allied support in the face of increased submarine activity along its shores. It is therefore fast-tracking the acquisition of nine P-8 *Poseidon* MPAs.

50. Another MPA-related shortfall is the very low level of sonobuoys, which MPAs (and ASW helicopters) drop into the sea to hunt submarines (Perkins, 2016). While these depleted inventories alone should be a cause for alarm, the situation is made worse by the fact that significantly more sonobuoys are now needed to achieve Cold War-levels of detection because submarines have become much quieter. Their utility has certainly been falling. However, in the short to medium term, they are still very much needed to locate submarines in a dynamic hunt, as newer technologies are not yet capable of fully compensating – and will not be within the next decade or two (see next section). Allies must therefore urgently build up stockpiles. Perhaps a NATO Smart Defence project similar to the joint procurement of precision-guided munitions could be explored.

D. ONGOING FRIGATE MODERNISATION ACROSS THE ALLIANCE

51. The ASW capabilities on surface vessels have not fallen quite as drastically, but certain Allies have seen significant reductions. For example, the Atlantic-facing NATO member states, who carry the brunt of the ASW burden on NATO's northern flank, lost about half of their frigate inventory between 1995 and 2017 (Smith and Hendrix, 2017). Even the United States faces difficulties. The US Navy is cutting the number of vessels equipped with the Surveillance Towed Array Sensor System from nine to five, possesses no frigate class specially dedicated to ASW, and lost ASW capabilities when the S-3 *Viking* fixed-wing aircraft retired from carriers in 2009 (Smith and Hendrix, 2017).

52. Allies are well aware of the need for high-end ASW surface vessels and are reacting accordingly. Importantly, 12 Allies are in the process of procuring new frigates, with many of these being designed for improved ASW capabilities. Some of the modernisation programmes most relevant to ASW include the following:

- **Belgium** and the **Netherlands** are developing a new Future Surface Combatant to replace the M-Frigates in their inventory. The first new frigate should be delivered to the Netherlands in 2024.
- In a sign that **Canada** takes the ASW threat seriously, its government has selected the *Type 26* frigate, designed in the United Kingdom and optimised for ASW, to replace its *Halifax* class frigates.

- **Denmark** has decided that its next frigate acquisition programme will focus heavily on ASW.
- The majority of **France's** new *FREMM* frigates will be ASW optimised. Moreover, a number of older frigates will be retrofitted with towed array sensors.
- **Germany's** *MKS-180* frigates, which are under development, will likely have advanced ASW capabilities.
- The **United Kingdom** will replace its *Type 23* frigates, which are highly capable of ASW operations, with the new *Type 26* class optimised for ASW. However, it has cut its planned orders from 13 to 8, and its incoming *Type 31* general-purpose frigates will likely have few ASW capabilities.
- The **United States** will design its new *FFG(X)* frigate with excellent ASW capabilities in mind, but they will not enter service until the mid-2020s.

VI. TOWARDS A NEW VISION FOR ASW

53. The previous section laid out some of the short- and medium-term challenges to the Alliance's ASW capabilities as well as some ways Allies plan to rebuild them. However, in the longer term, much more complex challenges abound. On the one hand, the seas are becoming louder and warmer, making it harder to detect submarines (Perkins, 2016). Maritime background noise has more or less doubled every decade, and radio-frequency interference has also risen markedly (Perkins, 2016). On the other hand, submarines are getting quieter and increasingly hard to detect as they employ better hull designs, air-independent propulsion, noise-cancelling, and acoustic jamming systems (Clark, 2015b). As a consequence of this twin movement, it is entirely possible that 'sound parity' might soon occur – i.e. submarines could become quieter than the sea's ambient noise (Perkins, 2016).

A. SENSOR TECHNOLOGIES

54. Progress in **traditional sonar detection technologies** continues to be slow and evolutionary (O'Hanlon, 2018). As submarines become quieter, the detection ranges for passive sonars – the dominant ASW sensor for the last five decades – have fallen from multiple miles to hundreds of yards (Perkins, 2016). Active sonar system ranges are still in the range of single-digit kilometres, but they face problems in the classification of submarine signals (Perkins, 2016). All this leads one expert to argue that traditional sensors "are rapidly approaching a point of obsolescence" (Perkins, 2016). However, artificial intelligence, big data, and the miniaturisation of computing power could help sustain traditional sensor technologies for some time. For example, artificial intelligence applications are enabling oceanographic modelling in (near) real time, boosting ASW sensor capabilities significantly, and giving the means to sift through the enormous amount of gathered data to find an actual target (Clark, 2015a).

55. Faced with the plateauing of traditional sensor capabilities, scientists and engineers are working on making new technologies viable. **Non-acoustic detection methods** are an increasing area of focus. Researchers hope to develop technologies that could, for example, detect the chemical and radiological emissions of submarines, bounce laser light off submarines to make them visible, or sense the tiny changes in ocean surface levels, wave patterns, or ocean temperatures when a submarine passes underneath (Clark, 2015a; Perkins, 2016; Hicks et al., 2016). Quantum technologies are crucial components for non-acoustic sensors. Scientists and researchers in Allied member states, but notably also in China, are investing in this area.

56. Navies are also developing new detection systems which can **be installed on the seabed or on land, or float in water**. The US Navy, for example, has programmes for a portable sensor in the Shallow Water Surveillance System and the Persistent Littoral Undersea Surveillance to be installed at key chokepoints (Clark, 2015a).

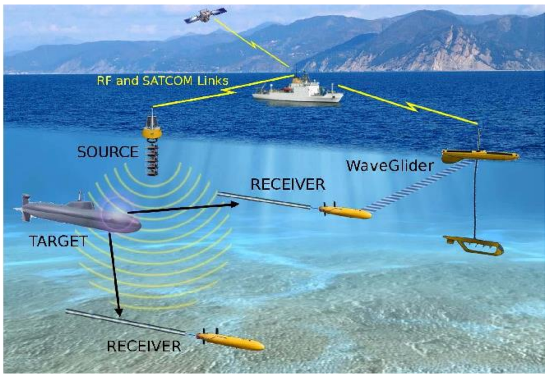
B. MARITIME UNMANNED SYSTEMS

57. In addition to new sensors, a new vision for the future of ASW is taking shape based on maritime unmanned systems (see also Figure 2). Maritime unmanned systems comprise two classes of autonomous unmanned vehicles (AUV): unmanned surface vessels as well as unmanned underwater vessels. Unmanned surface vessels can range from the big *Sea Hunter* to small *Aqua Quads* or *Wave Gliders*. Unmanned underwater vessels come in all sizes too – from buoyancy gliders to extra-large vessels.

58. AUVs offer many potential advantages for naval forces, as they can be designed to be:

- smaller and thus less detectable than manned platforms;
- much more focused on the payload, as no human operators need to be accommodated; and
- highly modular and scalable.

Figure 2:
Vision of Distributed ASW (Source: CMRE)



59. Moreover, AUVs could reduce personnel and unit costs and compress research and development cycles, as certain complex systems would be cut out. Perhaps most importantly, they could operate in degraded or denied environments without putting lives at risk.

60. A naval future based on AUVs, integrated with traditional platforms, could still be a decade or two away. Nevertheless, Allies see great potential for a number of naval missions, including ASW. As a result, 14 Allies signed a declaration of intent in October 2018 to cooperate on the introduction of maritime unmanned systems (see Figure 3). The initiative aims to pool resources, talent, and ingenuity to create better, more flexible, and more interoperable AUVs. The initiative seeks economies of scale to enable cost saving in an area which must become an area of increased investment.

Figure 3:
Allies partnering on Maritime Unmanned Systems

61. The concept of **distributed networks** is the key to understanding how many Allies see the future of ASW based on AUVs. Networks of manned and unmanned sensors from the sea floor to space would combine into a single system of systems. Navies would move away from platforms packed to the brim with ASW sensors. Instead, they would employ smaller platforms with fewer capabilities. While they would individually perform far fewer tasks than today's ASW platforms, the scale of the overall system would give it an edge. The US Navy, for example, envisages potentially thousands of such AUVs working together. An adversary would thus be overwhelmed with a multitude of small targets instead of a naval group consisting of a few surface vessels. Opponents would need to place expensive weapons on targets that are much less costly than the frigates of today. The distributed network would also have sufficient redundancy built-in, so that an adversary would be unable to neutralise all systems simultaneously. Swarming technology could also lead to maritime unmanned systems where AUVs could be placed in a 'net' which moves with a target once detected. Such a swarm of AUVs would form a 'roaming net of sonobuoys', replacing today's 'one-time use' sonobuoys in the long run. Concepts of launching unmanned aerial vehicles from MPAs or underwater platforms to release sonobuoys are also being explored.

62. Manned systems – frigates, MPAs, and submarines – would still play very important roles in such distributed networks. However, they could move away from the front line by acting as a host

for unmanned systems or a coordinator of sensors and weapon systems. They could gather intelligence, conduct surveillance, mine strategic chokepoints, and engage in electronic warfare in areas of high risk for manned platforms (Clark, 2015a).

63. Unsurprisingly, many challenges exist before such a future becomes possible. **Secure communication** is a long-standing challenge for the underwater domain and for the link with surface, air, or space assets. However, progress is being made in acoustic communications over operationally relevant distances, albeit at low bandwidth; in short-range communications based on LED or laser systems approaching, at short distances, the quality of wired communication; and in networking floating or towed radio transceivers to communicate with surface vessels without them risking detection (Clark, 2015a).

64. **Collision avoidance** will also likely remain a key challenge (Clark, 2015a). Compared to unmanned aerial systems, AUVs face dense traffic on the world's seas, especially in strategic areas. However, until navigation systems become more powerful, navies can concentrate their maritime unmanned systems efforts on those missions where mistakes do not matter as much. For example, autonomous mine-counter systems are currently more advanced than ASW systems, as it is a less dynamic task.

65. **Power generation and storage** on AUVs remains yet another problem and thus a focus of research, with researchers developing new battery and fuel-cell technologies. Indeed, a recent RAND study pointed out that the limitations of power generation and storage are currently the major obstacles holding back high-end AUVs (Martin et al., 2019).

66. Many other questions surround the future of maritime unmanned systems, for example:

- How do systems adapt and filter out clutter and ambient noise to find objects of interest?
- Can systems readily scale up – a key precondition to make them as capable as manned ASW assets?
- Can advanced sensors be miniaturised to fit on low-power, long-endurance AUVs?
- How will AUVs be able to operate with legacy systems?

67. Despite the obstacles, the possibilities AUVs offer and the challenges the Alliance faces make it imperative to continue investing into research and development programmes and, simultaneously, demonstrate the value of these systems to today's operators.

VII. PRELIMINARY CONCLUSIONS

68. This draft report has made it clear that the Alliance is facing an increased submarine threat from Russia and that Allies have let their ASW capabilities atrophy to dangerous levels. This threat is not limited to traditional 'hard security' threats. It also presents a clear, immediate danger when seen in the light of Russia's asymmetric and hybrid strategy, which seeks to undermine and split the Alliance over time. This draft report has also laid out a path towards a) rebuilding capabilities in the short and medium terms through modernisation of its ASW assets and b) a future of ASW based on new sensor technologies and the integration of AUVs into ASW missions. This path must include an increased focus on threats against undersea cable networks.

69. As with other capability shortfall areas, it must be stressed that it is essential that Allies live up to the Wales Defence Investment Pledge and move towards spending a minimum of 2% of GDP on defence and more than 20% of defence budgets on major equipment, including related research and development. If NATO wants to remain in a position where it can fulfil its core tasks, Allies must increase investment in ASW capabilities. They must continue to maintain robust fleets of tactical submarines, MPAs, ASW-capable surface vessels, maritime ASW helicopters, and acoustic detection systems.

70. As this Committee has made abundantly clear over the last few years, NATO's science and technology (S&T) edge is eroding. This trend appears to be particularly stark in ASW. Thus, ASW should be a test of the Alliance's willingness to heed the Committee's recommendations put forward in NATO PA Resolution 453, which was adopted in November 2018. Indeed, ASW is an area where NATO can make great strides *jointly*, in particular by leveraging its 2018 NATO S&T Strategy.

71. The Multinational Maritime Multi Mission Aircraft Capabilities Cooperation and the Maritime Unmanned Systems initiative are positive steps in the right direction. Moreover, NATO already has a world-class S&T institution at its disposal to further an ASW future based on maritime unmanned systems: the Centre for Maritime Research and Experimentation (CMRE) in La Spezia, Italy. The CMRE is leading the way for advances in AUV applications and operations, in particular demonstrating the potential of AUVs and remote operation and management of a fleet of undersea gliders and promoting the use of underwater digital communications using a NATO-developed standard. Allies should make good use of the Centre. In turn, the CMRE should continue to help NATO improve agility and demonstrate the value of S&T to the military community. This includes continued engagement in NATO exercises to showcase what today's S&T can offer Allied naval forces.

72. This draft report could not present a full picture of all ongoing capability shortfalls and ongoing modernisation efforts in Allied countries. The Rapporteur therefore invites Committee members to provide their input on the situation in their countries when the STC meets during the 2019 Spring Session. Based on this feedback and additional input from other stakeholders, the Rapporteur will develop a more robust set of recommendations over the course of the summer. NATO can no longer be in a situation where its ASW capabilities could potentially be overwhelmed. Too much is at stake.

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