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Security-Policy NET Nexus of Emerging Technologies

# NOTE FOR NATIONAL DEFENCE: Developments in Sub-Surface Warfare

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**Summary**
An analysis of Canada and their allies current anti-submarine warfare capabilities with respect to increasing global competition in the Pacific and South China Sea as well as technological prospects for the future of anti-submarine warfare through the use of autonomous unmanned vehicles and new detection methods.

## Background and Context:

Submarine warfare constitutes one of the most strategically important domains of the modern theater of war. Submarine operations include gathering surveillance data, communicating tactical information, delivering strike weapons and special operations units ashore in contingencies, and controlling the surface and underwater battlespace. In the event of a conflict submarines will be used to disrupt forward targets such as supply lines, trade vessels, or aircraft carriers and other high value targets before they can reach their destination or participate in combat. Given the obvious tactical usefulness of submarines it becomes important to analyze our own submarine and anti-submarine capabilities in comparison with rival nations. Primarily these considerations are observed in terms of how well we can protect shipping, how quickly and efficiently we can organize and deploy convoys, the technological capability and range of our ASW frigates and Aurora aircraft, the location and vulnerability of our hydrophone detection systems, intelligence of enemy submarine basing, and potential submarine threats to the arctic.

## Strategic Issue:

The threat to Canada and our NATO allies posed by submarines is multi-layered and global with both Russia and China posing significant danger to Canadian and NATO strategic objectives. With the resumption of great power politics and territorial claims from China within the South China Sea and Russia's increasing submarine patrols in the north Atlantic, it's becoming increasingly important for Canada to have anti-submarine warfare deterrents against both China and Russia's growing fleet of submarines. A fleet, which in the case of China, is projected to be larger than that of the United States within the next 10 years.

Of great concern is that NATO currently has a severe shortfall of anti-submarine warfare (ASW) capabilities across the alliance. According to Vice Admiral Sir Clive Johnstone, then commander of NATO's Maritime Command (MARCOM), the alliance is "very-short of high-end submarine warfare hunters". Further, NATO's scientific and technological edge has been eroding in comparison to their rivals, and the trend is particularly stark in terms of ASW (Alleslev, 2019) If Canada, The United States, and their allies continue to allow their submarine fleets and anti-submarine warfare capabilities to decline into the future it's very possible that China and Russia can achieve a strategic edge in this domain.

With regards to China, two key elements can explain their focus on submarine modernization. First, their at-sea nuclear deterrent does not yet present a credible second-strike capability, and secondly, they need tactical submarines to reinforce their anti-access/area-denial(A2/AD) strategy within the First Island Chain of the South China Sea.

Another area of particular concern is that of undersea communication cables. 80% of data between North America and Europe is transmitted through these cables with satellites only making up for 10% of transatlantic data transfers. Special purpose submarines play a key role in this threat as they can tap or cut the cables gaining valuable intelligence or disrupting vital services (Alleslev, 2019).

Finally, beyond current allied and rival submarine and ASW capabilities, the future of submarine warfare faces significant challenges. The ocean is becoming louder and warmer which makes submarine detection much more difficult. The background noise of the ocean has doubled every decade and radio-frequency interference has also drastically increased (Perkins, 2016). On top of this submarines are getting quieter and harder to detect as they gain better hull designs, air-independent propulsion, noise-cancelling, and acoustic jamming systems (Clark, 2015b). In all likelihood, so called ‘sound-parity’ might occur where submarines become quieter then the sea’s ambient noise. This has huge implications for the future of submarine warfare as historically much of the military’s detection methods have relied on sonar and sound waves (Alleslev, 2019)

**Canadian Anti-Submarine Warfare Capabilities:**

ASW is conducted through coordinated operations between surface, sub-surface, and aircraft units with a heavy focus on detection and counter-detection methods including active sonar, passive sonar, radar, electronic support measures (ESM), visual sensors, magnetic anomaly detection (MAD), forward looking infrared detectors (FLIR), and through the use of sonar buoys to set up detection barriers. Submarines have a distinct advantage of being able to stealthily enter enemy controlled waters and survive and perform with little assistance from other enemy units. Modern SSN and SSBN submarines have torpedo ranges of up to 50km so early detection and destruction of submarines is a vital aspect of ASW operations.

Canada currently maintains a fleet of 12 Halifax-class multi-role patrol frigates, 14 Lockheed CP-140 Aurora long-range patrol aircraft, 17 CH-148 Cyclone ship-borne maritime helicopters, and 4 Victoria-class hunter-killer submarines. Canada has also invested in building a new fleet of 15 Type 26 Frigates which would make it the largest fleet of it’s kind in the world.

**Solution:**

Given the probability of sound parity being achieved in the not-so-distant future it’s become important to increase our detection capabilities in areas that don’t rely on sound. Luckily, this area of research has already begun to increase with researchers hoping to develop technologies that could detect chemical and radiological emissions, use lasers to bounce light off of submarines, or sense tiny changes in the oceans surface level, wave patterns, or ocean temperatures when submarines pass underneath (Alleslev, 2019).

Further, much focus has been placed upon Autonomous Unmanned Vehicles (AUV) as the future of ASW, with The US Navy requesting USD 3.7 billion for future AUV programs. To understand the future envisioned, the concept of distributed networks need to be examined. By combining manned and unmanned sensors from the sea floor to space many single units would work together to create a vast system of systems. Instead of having large naval vessels packed with ASW sensors there would be many smaller platforms with fewer sensors and capabilities that would focus on fewer and more specified tasks. The scale and multiplicity of this system is what would give it an edge. With potentially thousands of AUVs working together to detect and disrupt enemy convoys and submarines, enemies would be overwhelmed. They would need to place expensive weaponry on much less costly targets that would require much more precision to destroy, unless they risk wasting large munitions on smaller targets.

Additionally, analysts believe AUV technology could lead to unmanned systems being placed in a 'net' which follows the target once they've been detected. They could then form a roaming net of sonobuoys which would replace our current sonobuoys which have to be placed at specific locations without the ability to move (Alleslev, 2019)

**Current Developments:**

New technology out of Stanford University looks to have promising potential for drastically altering the anti-submarine warfare landscape. Currently, researchers have developed a method for mapping objects below the surface of the water from the air. A previously insurmountable issue due to the decibel loss of sonar systems once they reach water. The researchers have achieved this feat by bridging the gap between electromagnetic imaging in the air and sonar imaging in the water. They do this through a laser-induced photoacoustic effect and high-sensitivity airborne ultrasonic detection (Fitzpatrick, 2020). Essentially what occurs is a short laser pulse heats the water surface causing it to expand rapidly which in turn produces a sound wave. This sound then works like a conventional sonar detection method and reflect back from the seabed or submerged objects. With the use of capacitive micromachined ultrasonic transducers (CMUTs) the researchers were able to capture an underwater image from a fully airborne acoustic imaging system. CMUTs are tiny micromachined capacitors that consist of two thin parallel plates placed close to one another. Any disturbance to the plates changes the electrical properties of the capacitor which can then be easily detected (Forbes, 2021). They hope to advance this technology to the point of being able to capture images continuously as the AUV flies overhead.

Additionally, CMUTs are already increasingly being used by companies like Phillips and Hitachi for medical applications and boast the advantage of being low cost. This mass production means that large and highly sensitive arrays of CMUTs are possible (Forbes, 2021).

While new technologies are being developed and promising discoveries have already been made, many challenges still exist before the envisioned future of AUV ASW can come to pass. Secure communication between underwater vessels and the surface, air, or space assets remains one area of difficulty. Despite this, short-range communications based on LED or laser systems are approaching the quality of wired communication. Alongside this, the networking of floating or towed radio transceivers that can communicate with surface vessels without risking detection is also making progress.

The major obstacle holding AUVs back from operational use remains power generation and storage, something that would play a particularly important role in power projection in areas like the South China Sea. With this in mind, research into new battery and fuel-cell technologies is a parallel area of research that holds massive strategic importance for this domain of warfare.

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