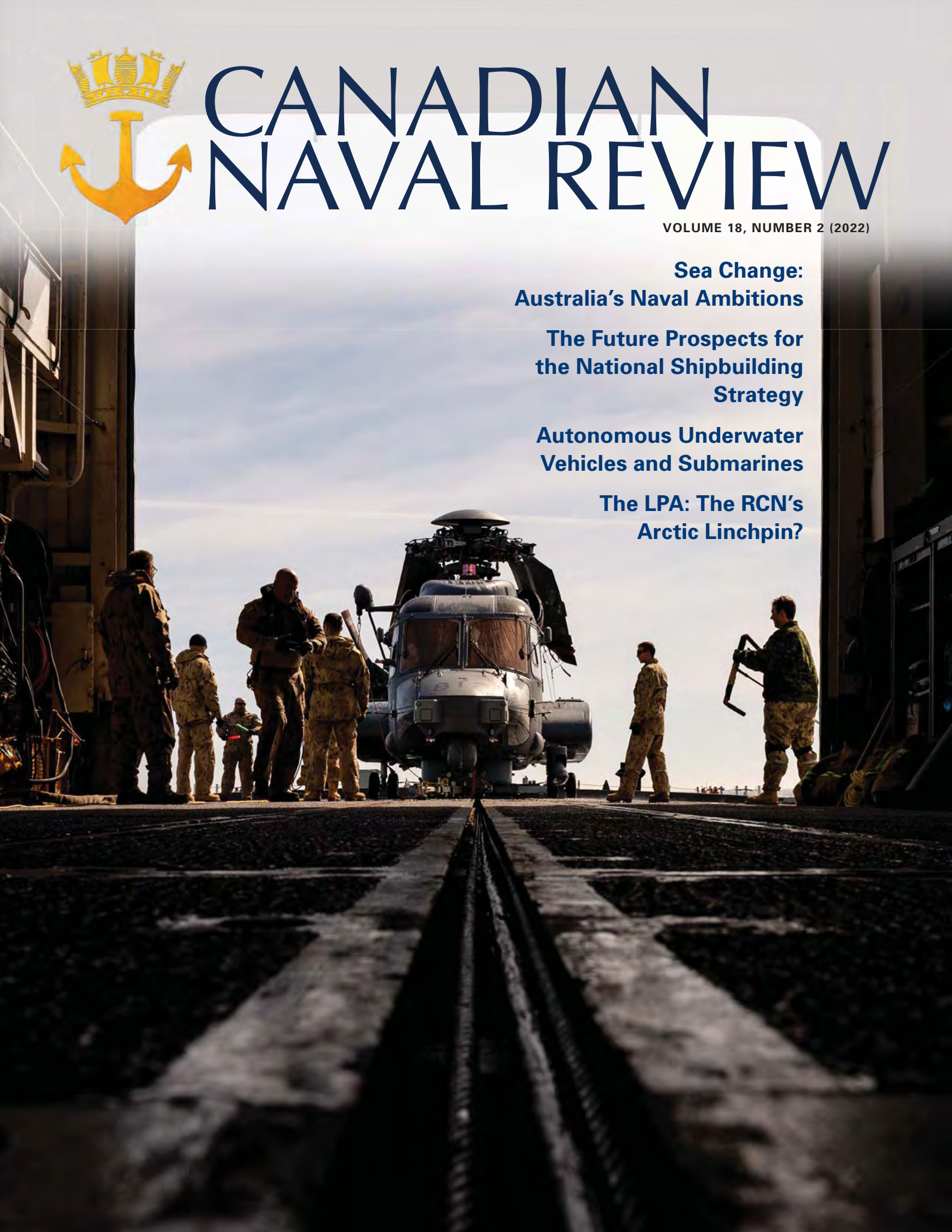
CANADIAN NAVAL REVIEW

VOLUME 18, NUMBER 2 (2022)



Sea Change: Australia's Naval Ambitions

The Future Prospects for the National Shipbuilding Strategy

Autonomous Underwater Vehicles and Submarines

The LPA: The RCN's Arctic Linchpin?

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Today's Policy Questions, Tomorrow's Policy Leaders

The editorial offices of *CNR* are located at the Brian Mulroney Institute of Government, St. Francis Xavier University in Antigonish, Nova Scotia. The mailing address is: Canadian Naval Review, C/O Adam Lajeunesse, Lane Hall, St. Francis Xavier University, 2330 Notre Dame Ave., Antigonish, Nova Scotia, Canada, B2G 2W5

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Canadian Naval Review is published by the Brian Mulroney Institute of Government at St. Francis Xavier University. It is a professional journal examining a wide range of maritime security issues from a Canadian perspective. In particular it focuses on strategic concepts, policies, operations, history and procurement of the Royal Canadian Navy, plus national security in general and marine/ocean affairs. This initiative brings together members of the Canadian defence and academic communities.

Canadian Naval Review has three primary objectives:

- provide a public forum for the discussion of the maritime dimension of Canada's national security;
- provide a public forum for the discussion of Canada's naval and maritime policies; and
- provide a source for the public examination of Canadian naval and maritime history and for the development of lessons learned.

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Credit: Pte Connor Bennett, Canadian Armed Forces

*The air department onboard HMCS **Halifax** prepares to bring a CH-148 Cyclone into the hangar after a maintenance flight during **Operation Reassurance** in northern European waters on 20 April 2022.*

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Editorial

Action this Day?

In a world very much tuned to instant gratification, the spectre of a long war in Ukraine raises the prospect of Ukraine's supporters losing patience. Authoritarian regimes in China and Russia stress that the inconsistency, fluctuation and internal debates characteristic of democracies make them weaker than authoritarian competitors. They argue that authoritarians 'get things done' while democracies facilitate, debate, fluctuate and procrastinate. They take the very strengths of legislative opposition, media freedom and public debates about strategy that define the democratic world as debilitating signs of weakness. This authoritarian analysis is self-serving for governments whose main purpose, superseding all else, is the survival of their own regimes, however corrupt, however disinterested in the views or quality of life at the street level of their respective populations.

This illustrates a fundamental lack of understanding of the strengths of democracy, and an under-estimation of the support that the West has extended to Ukraine. Every time a joint naval task force from NATO partners like the United States, the UK, France or Canada enters waters adjacent to the battle theatre where Russian aggression is continuously resisted by Ukrainian regular and irregular forces, it is about Western democracies making it clear that Ukraine's democracy is not alone. Every time the Royal Canadian Navy (RCN) deploys *Kingston*-class anti-mining and coastal patrol vessels to the region, to join other Canadian warships already in theatre, it makes it clear that Canada, and its women and men in uniform, is engaged. It is also a clear message to the Kremlin that Russian naval – or other designs – on NATO countries bordering the Russian Federation will elicit a joint force response by NATO countries writ large.

Minister of National Defence Anita Anand deserves recognition for the acuity and determination she has shown, as a new Minister of Defence, in facilitating Canadian supply and resupply to Ukrainian land forces and civilian authorities with defensive, medical, lethal and tactical supplies along with substantial fiscal support. It is not her fault that the supply base available within the stores, equipment and artillery reserves of the Canadian Armed Forces are not as deep as she might have wished. Her predecessors in both main political parties are responsible for that gap.

And, despite the faux analysis by Beijing and Moscow about democracies, Canada's partisan political divide has shown remarkable balance and coherence on the issue of arming and aiding Ukrainian forces. Parties often associated with anti-military or pacifist political views in the past have been constructive in their comments, supportive in their legislative deliberations and, while asking important questions and offering suggestions, very much on side with a democratic and sovereign Ukraine.

This recent violent and brutal breakout by Russia from the non-aggression framework that has defined the post-Berlin Wall world needs to be a wake-up call for all Western democracies and their military procurement plans. And it appears that the wake-up call has worked. The recent Madrid NATO doctrine update which calls for a massive ramping up of the rapid response force and the size and scope of NATO forces deployed in Eastern European potential land, sea and air battle zones illustrates the opposite of complacency.

Has the wake-up happened in Canada? Canada does not now have the military complement in any of its three services, and Special Forces, to do its share in this enhanced

Credit: Corporal Braden Trudeau Canadian Armed Forces

*HMCS **Montreal** fires its 57mm gun at a Hammerhead target drone simulating fast inshore attack craft during **Operation Reassurance** in the Mediterranean Sea on 11 May 2022.*

*Norwegian, German, Dutch, American, Danish, British, Portugese, French, and Canadian warships sail in formation during Exercise Dynamic Mongoose 2022 on 19 June 2022 in northern European waters. HMCS **Halifax** leads the column on the right.*

guarantee of stability. Long-term plans for gradual ramp-ups over many years will only re-assure the Russians that Canada is happy with the 'big hat, no cattle' epithet about Canadian military capacity.

In the Second World War, when Winston Churchill had to rebuild an armed force that, except for the Royal Navy, had been deeply diminished by years of under-investment, he did not rely on the usual procurement and military construction stream. He brought in experienced private sector leaders, untied to existing slow shipbuilding or aircraft construction interests, and gave them the 'action this day' mandate.[1] The bureaucratic powers-that-were back then hated the idea. Churchill did not care. The fighter aircraft ramp-up was extraordinary, as was the ramp-up in Canada and other Allies in building and dispatching the tools of defence.

The message of the present challenge in Ukraine could not be more clear. Even if it is restrained in its aggression in Ukraine, the present Russian regime will look elsewhere for its next assault. The only way that next aggressive lurch can be diverted or diluted is through armed deterrence that reduces strategic or tactical options upon a would-be aggressor in any theatre.

If Canada is to be part of the collective deterrence and constraint on Russian aggression, it simply needs more tools to do the job. This means a larger and more versatile navy, with unmanned deployable capacity, more women and men in uniform in all four services, and enhanced Special Forces' deployment range. It may be comforting for folks in present military and bureaucratic ranks to assure politicians that they are doing all they can with available funds. It is as if the present diminished defence budget is fixed in stone and all other variables must bend to that cornerstone of inadequacy. But this is less than acceptable.

As we discovered during the height of the pandemic and in the initial rush to supply Ukraine, budget numbers are there to serve the public interest, not the other way around. There is very little possibility that Canada's public interest in the next two decades will not require more robust defence and military capacity. We can already see risks of continued Russian aggression and armed adventure to the East and North of Canada, on and under the seas, on land and in the air. As well, there are more robust if uncertain Chinese territorial ambitions to the West, not to mention ongoing domestic requirements for military aid to the civil power in the face of natural disasters at home and abroad. This means that the pace of operations for the RCN and other services will not slow. That increased operational rhythm is unsustainable with our present mix of complement and operational platforms. This is why it is time for 'action this day' – a massive and focused rebuild and expansion of the Canadian Armed Forces.

In any of the areas of potential kinetic engagement with an aggressor, Canadians of all stripes and dispositions would prefer a diplomatic and non-violent sort out of issues if possible. However that is not always possible. The role of a strong armed force and a broadly deployable, battle-capable and muscular naval presence world-wide is to signal to a potential aggressor the futility of military adventurism. NATO's great success from its creation in 1949 to the fall of the Berlin Wall in 1989 was its capacity to send that signal from deployments and ballistic capacity on the land, sea and air. The new Russian aggressive desire to 'build back the Empire' requires upping Canada's capacity.

The supply and materiel alliance between NATO countries, including Canada, and Ukraine must not be time limited. Furthermore, we cannot assume for a moment that left unrestrained the Russian leadership would not try other 'Empire recapture' missions in neighbouring former members of the Soviet Union and/or the Warsaw Pact, whatever happens in Ukraine.

The authoritarians are convinced that democracies cannot stay the course. This means that Moscow and Beijing may make bad decisions as a result. The most constructive measure we can pursue in the interest of peace is efficiently and convincingly – and aggressively, if necessary – proving them wrong. ⚓

Hugh Segal

Notes

1. Canadian Lord Beaverbrook took over fighter aircraft manufacturing.

Sea Change: Australia's Naval Ambitions

Justin Burke

Credit: Lt. j.g. Emilio Mackie

*The modernized **ANZAC**-class frigate HMAS **Perth** fires an Evolved Sea Sparrow Missile while operating in the Philippine Sea during Exercise Pacific Vanguard 2022, 31 August 2022.*

When the former Commander of the Royal Canadian Navy (RCN) Vice-Admiral Craig Baines addressed Australia's Sea Power Conference earlier this year, his introductory remarks centred on his beloved Toronto Maple Leafs and their long-term Stanley Cup drought. His jokes were met with friendly laughter, despite the fact that those present were likely more familiar with actual drought than with ice hockey. We laughed because Australians are fond of Canadians – and like to think the feeling is mutual. Our many national similarities, including systems of government and increasingly multicultural societies, as well as the many occasions we've fought side-by-side in war, amongst other things, make our interactions easy and familiar.

But this fondness may sometimes lead us to minimise or overlook our differences. The direction of travel for our respective navies appears to be a case in point, with the pursuit of nuclear-powered submarines (SSNs) under the Australia-United Kingdom-United States (AUKUS) agreement perhaps the best demonstration of Australia's vaulting naval ambition.

This article will illuminate the Australian naval position for a Canadian readership: what we have; what we want; how we plan to get it; and what we plan to do with it. And in a reciprocal gesture, an article by Rob Huebert and Hugh Segal will appear in a forthcoming *Australian Naval Review* explaining the Canadian experience.

The Fleet in Snapshot

The Royal Australian Navy (RAN) currently comprises more than 16,000 personnel, and a fleet set to exceed 50 vessels for the first time in decades. The backbone of the fleet commissioned between the mid-1990s and early 2000s – all due to be replaced – includes eight *ANZAC*-class frigates (118m long with approximately 3,600t displacement), a dozen offshore patrol vessels, six *Collins*-class diesel-powered submarines, as well as various mine-hunters, oilers and survey ships. In the last 10 years, two Spanish-built *Canberra*-class amphibious assault ships (Landing Helicopter Docks (LHD)) have joined the fleet. At more than 230m long and 27,000 tonnes, they are the largest ships ever commissioned in the RAN; larger than the aircraft carriers last featured in the 1980s. Three new Spanish-designed but Australian-built *Hobart*-class Air Warfare Destroyers have also been commissioned, featuring the Aegis Combat System, SM-2 missiles and an embarked helicopter amongst other capabilities. In normal circumstances, this would be more than sufficient. But Australia faces a dramatically changed strategic environment because of China's economic growth, enhanced military capability (especially of its navy) and increasingly aggressive foreign policy.

The situation bears closer examination. Domestically, there have been increasingly overt attempts to force Australia to accept Beijing's preferences. Notably a campaign

by China of unofficial trade sanctions on copper, cotton, lobster, timber, wine and coal – previously worth more than AUD$20 billion a year[1] – was enacted in 2020 after Australia called for an independent inquiry into the origins of COVID-19, and continues to this day. An infamous list of "14 grievances" handed by Chinese officials to the media in Canberra in late 2020 also mentioned the ban on Huawei from the rollout of Australia's 5G network, the new laws prohibiting foreign political interference, and criticism of human rights violations in Xinjiang.[2] (This list was reportedly circulated at the 2021 G7 Summit to general consternation.)

In the Pacific Islands – Australia's near abroad – China has signed a controversial security pact with Prime Minister Manasseh Sogavare of the Solomon Islands. Despite the energetic efforts of Australian intelligence chiefs, diplomats and ministers to dissuade Prime Minister Sogavare, and the longstanding security arrangements with Australia which have included several multi-billion-dollar deployments of police and defence personnel during the last two decades, the pact was signed. Assurances have been given to Australia and the United States that there will be no Chinese military base, long-term presence, or power projection capability located in the country, but since the presence of an adversary in these islands has long been considered a strategic nightmare, this will be watched closely.

Further afield, Australia has national interests in the maintenance of the free and open Indo-Pacific region, which includes crucial maritime thoroughfares for Australian exports of energy and minerals, and imports of refined fuels, among other things. China's unilateral moves in the South China Sea and threatening behaviour to Taiwan are concerning, as are the increasingly frequent unprofessional and unsafe actions from the Chinese military towards Australian ships and planes.

These adverse developments have affected Australian public opinion towards China. According to annual polling by the Lowy Institute, an astonishing 75 per cent of Australians say it is very or somewhat likely that China will become a military threat to Australia in the next 20 years, an increase of 29 points since 2018.[3]

Towards Bold Horizons

It is a rare day indeed when the Australian navy makes international news. But the tripartite announcement of the AUKUS pact on 15 September 2021, by US President Joe Biden, then-UK Prime Minister Boris Johnson and then-Australian Prime Minister Scott Morrison, brought unprecedented attention to the plan to acquire nuclear-powered submarines (SSNs) for the RAN. It would be imprecise to describe AUKUS as merely a plan to sell SSNs to Australia, as Canadian Prime Minister Justin Trudeau put it.[4] It also involves enhanced cooperation on a range of advanced defence technology areas including cyber, artificial intelligence, quantum technologies and undersea capabilities. Later, hypersonic weapons were added, while the pursuit of nuclear power and nuclear weapons was specifically excluded. AUKUS is also frequently misidentified as an alliance, which it is not, although it is necessarily a pact built upon the foundation of a variety of longstanding security and intelligence-sharing arrangements.

The AUKUS agreement prompted the cancellation of Australia's deal with the French company Naval Group (formerly DCNS) which was contracted to design 12 so-called *Attack*-class diesel-powered boats which were to be built in Adelaide. The French government reacted with outrage, to put it mildly, matched only by its preceding

Credit: LSIS Daniel Goodman

Former Commander Royal Canadian Navy, Vice-Admiral Craig Baines, speaks at the Sea Power Conference at Indo Pacific 2022 in Sydney, Australia, 10 May 2022.

*HMAS **Sydney** sails in the Pacific Ocean as part of Exercise Pacific Vanguard, 22 August 2022.*

nonchalance as the project experienced delays, cost increases and fluctuating commitment to Australian industry content.

Aside from the changed strategic environment, there are also operational reasons for seeking SSNs. Australia has run a fleet of six diesel-powered submarines since 1965: first the British-designed *Oberon*-class (which several countries including Canada also operated); and then the Swedish-designed Australian-built *Collins*-class submarines which have been in service since around the start of this century. The *Collins*-class boats are expected – with the near-certainty of life-of-type extensions, including the possibility of being fitted with Tomahawk land-attack missiles for the first time – to continue in service to around 2040.

Rear-Admiral Matt Buckley, Head Nuclear-Powered Submarine Capability, described the rationale for SSNs to the Sea Power Conference earlier this year. According to him, "[s]ubmarines are a bit like a queen in a game of chess … when you bring a nuclear-powered submarine into the mix it is like having additional moves you can play on the chess board, you add enormous mobility, increased speed, increased range and increased firepower."[5] Former Chief of Navy Vice-Admiral Michael Noonan highlighted other operational concerns to the Goldrick Seminar in Canberra, shortly after the AUKUS announcement. He noted that changes in the Indo-Pacific strategic environment, in particular the oft-discussed point at which the oceans become "transparent," was a prime consideration. "Certainly, the ability to operate a conventionally powered submarine within the first island chain undetected rapidly diminishes from the late 2030s onwards," he said.[6]

An 18-month consultation period of the various task forces of the three states is due to conclude with a report in March 2023. The key announcements will relate to which SSN design Australia is seeking to obtain, where it will be manufactured, when the submarines will be delivered, and how much they will cost. It seems likely that the design of either the British *Astute*-class or American *Virginia*-class will be chosen, or their intended replacements SSN (R) or SSN (X) respectively. The task force may also indicate the preferred location for a new Pacific Ocean-facing submarine base to balance the existing base in Perth on the Indian Ocean. Port Kembla – south of Sydney – is a possibility, as are the port cities of Newcastle or Brisbane. Lavish attention to the notion of 'nuclear stewardship' can be expected. Australia operates one nuclear facility for scientific research and the production of medical isotopes in Sydney, and recent comments from Vice-Admiral Jonathan Mead, RAN's Chief of Joint Capability, emphasised that a "nuclear mindset … must reflect unwavering commitment to safe and secure stewardship of nuclear propulsion

technology."[7] Estimates put the costs at AUD$70 billion or AUD$116B inflation-adjusted (CAD$65B or CAD$104B inflation-adjusted) as a minimum.[8]

AUKUS faces many challenges. It has survived the recent change in Australian government, and the public remains supportive. A recent Lowy Institute poll indicated that 70 per cent of Australians were "somewhat" or "strongly" in favour of acquiring nuclear-powered submarines, with a majority saying AUKUS will make Australia safer.[9] But the alignment of international politics is at least as significant, and whilst the UK's role in AUKUS is considered important, the US role is critical. Australia has examined the possibility of nuclear-powered submarines in the past, with sources anecdotally reporting a US attitude of "don't ask, as refusal may offend."[10] But the administration of President Joe Biden has been receptive, with key National Security Council officials expressing the view that Australia had been a good ally of the United States over time, has not wilted in the face of Chinese coercion, and its capability ambitions should therefore be supported.[11] It is yet to be seen whether a change of personnel or party in the US Congress or White House will prove problematic.

Another challenge is the timelines. Australia has wrestled for too long with how to replace the *Collins*-class. By most reasonable assessments, even with the *Collins*-class life-of-type extensions, a capability gap may occur around the late 2030s or early 2040s. Various options to fill such a gap have been canvassed, from an interim conventionally-powered submarine class, to homeporting US and/or UK SSNs in Australia, to co-crewing US or UK vessels with Australian submariners. Australia's new Defence Minister Richard Marles has publicly acknowledged that strategic demands are more important than local construction per se, which may unlock faster pathways and minimise a potential gap.[12]

An emerging challenge is the issue of nuclear proliferation, which has not been mitigated by Australian assurances. International Atomic Energy Agency (IAEA) representatives have recently visited Australia to discuss regulatory safeguards with senior officials and political leaders.[13] But with US Navy SSNs using highly-enriched uranium (HEU), which can also be used in weapons, China has been campaigning to have AUKUS branded a proliferation threat. China has had some success in enlisting Australia's neighbours such as Indonesia, which is now lobbying the 120 states of the Non-Aligned Movement. How serious this challenge becomes is yet to be seen.

In the future, AUKUS could expand beyond the original three partner states. Kurt Campbell, the Indo-Pacific Affairs Coordinator on the US National Security Council, described it as "open architecture."[14] With Canada nestled within similar security and intelligence-sharing alliances, its already privileged status within US defence export control system, its forthcoming Indo-Pacific Strategy, and its nascent efforts to replace the conventionally-powered *Victoria*-class submarines, it would seem like a prime candidate.

Submarines are not the sole focus of the RAN's fleet expansion plans. Australia is also seeking to replace the eight aging *ANZAC*-class frigates with nine *Hunter*-class frigates, which – like the RCN's Canadian Surface Combatant – are based on BAE System's Global Combat

Credit: POIS Christopher Szumlanski

*The amphibious assault ship HMAS **Canberra** returns to home port of Fleet Base East in Sydney, 4 September 2022, after its regional presence deployment.*

Credit: Jay Cronan

Chief of the Defence Force General Angus Campbell (background) and Secretary of Defence Greg Moriarty during a press conference to announce the AUKUS partnership and nuclear submarine acquisition plan at Parliament House, Canberra, 16 September 2021.

Ship/Type 26 frigate. Expected to cost approximately AUD$50bn adjusted for inflation,[15] the *Hunter*-class will feature Australian-developed CEA Phased-Array Radar and the US Navy's Aegis Combat Management System, boasting stealthy anti-submarine warfare characteristics and significant air and surface warfare capabilities.

Since the announcement of the *Hunter*-class plan in June 2018, a process of customising the 'immature' design has run into difficulties and delays (first steel cut in 2024; first ship to be delivered 2031). Growth in the size of the vessel from around 8,000 tonnes to over 10,000 tonnes has raised questions over speed, power and performance. Safety issues have been raised for crew members who could become trapped below deck by floodwaters in "credible damage conditions."[16] The former Defence Minister Peter Dutton said earlier this year that concerns had been raised, and were being addressed, and having looked carefully at the project, the government would proceed.[17]

Made in Australia?

With these two major acquisitions of frigates and submarines, plus an array of smaller vessels required, the government attempted to kill multiple birds with one stone by introducing a Naval Shipbuilding Plan in 2017. It came after a report by the RAND Corporation which indicated that Australian shipbuilding experiences a 30-40 per cent cost premium compared to the United States mostly due to the 'boom and bust' cycle.[18] The plan consolidated naval shipbuilding at Osborne in South Australia and Henderson in Western Australia, with several other uneconomic shipyards (such as BAE System's Williamstown shipyards in Melbourne) closing and many smaller coastal shipyards excluded.

The Naval Shipbuilding Plan began with high expectations of being able to supply naval platforms, deliver certainty to industry and value to the taxpayer. It "gives the most detailed and long-term guide for the defence industry, government and the defence apparatus, both uniformed and non-uniformed, of any such plan in our nation's history," wrote former Minister for Defence Industry, Christopher Pyne.[19] According to Pyne,

> It gives everyone involved confidence about the future of our continuous shipbuilding program. A drumbeat of new vessels at least every two years for decades to come is something Australia has never enjoyed before. As these projects come to fruition, new governments will make decisions to build further classes of naval vessels, ensuring that our ship- and submarine-building and sustainment and maintenance will become a significant part of our strategic industrial base for the foreseeable future.[20]

Five years later, and the report card is decidedly mixed. The Osborne shipyard, the physical assets of which are owned by the federal government, occupies more than 100 hectares of the Lefevre Peninsula in South Australia. Osborne South has undergone significant upgrades to enable BAE Systems Maritime Australia to prototype and eventually start building the *Hunter*-class frigates. Now free of the cancelled *Attack*-class, Osborne North's submarine construction yard is currently responsible for full-cycle dockings of the *Collins*-class, will be responsible for the life-of-type extensions of the *Collins*-class, and is currently being expanded from 20 hectares to 65 hectares while undergoing assessment as a possible SSN manufacturing facility.

There has been a decidedly higher tempo of ships produced – albeit smaller naval vessels – at Henderson shipyards in Western Australia, produced at facilities funded by both the Commonwealth and state governments which host a number of commercial operators. Australia's current *Armidale*- and *Cape*-class patrol boats are being replaced with a single class of *Arafura*-class Offshore Patrol

Vessel (OPV), with German shipbuilder Luerssen Australia building the final 10 vessels at Henderson (after the first two were built in South Australia). They will primarily have constabulary and border patrol duties. In addition, 22 steel patrol boats are being constructed – 39.5m long and capable of traveling at 20 knots – and given to Australia's Pacific Island neighbours under the Pacific Patrol Boat Replacement Project to increase regional capability to protect fisheries, address transnational crime and undertake search and rescue. The first vessel was delivered to Papua New Guinea in 2018, and other states since then including Tuvalu, Tonga, Samoa and Fiji. Henderson, where an AUD$4.3 billion large-vessel dry berth was announced earlier this year,[21] is also currently conducting the *ANZAC* frigate mid-life upgrades, which are expected to conclude next year, and in the coming decades various mine-hunter and survey ship replacements are expected to be built.

As delays to the *Hunter*-class frigates materialised and the *Attack*-class was cancelled, it has become apparent that the budget is not being spent. Reports suggest that for the four years from 2020-21 to 2023-24, the navy's acquisition spend will be AUD$5.3 billion less than the AUD$17.8 billion it was aiming for.[22] No formal government reporting on the progress of the Naval Shipbuilding Plan has been conducted.

Maritime Strategy

It is crucial when discussing increased capabilities that the purpose is clear. What is Australia going to do with this biggest navy in decades? The 2020 Defence Strategic Update characterised the armed force's mission as "Shape, Deter, Respond."[23]

In the navy's case, an obvious manifestation of *shape* has been task group-sized naval diplomatic activities across the region over the last five years under the banner of Indo Pacific Endeavour (IPE), Australia's annual defence-led international engagement activity. Beyond the regular engagement navies foster with each other, IPE has done several explicit things. First, it served a key role in introducing the *Canberra*-class amphibious assault ships to the region, providing reassurance that a ship with 'assault' in its name is equally suited to performing humanitarian and disaster relief. Second, it has contributed to the popularisation of the term Indo-Pacific over older constructs such as Asia-Pacific. But perhaps less successfully, it carried a message to the Pacific island states that Australia should remain the security partner of choice. With the Solomon Islands recently exercising this choice by signing a security pact with China, and with IPE22 once again overlooking the Solomons and other Pacific Islands for an Asian itinerary, an ambivalence about the ability of the navy to shape the strategic environment seems evident.

Australia has used its capabilities to help *deter* revisionist powers – China, in particular – from efforts to change the status quo illegally or unilaterally in the Indo-Pacific region. For example, despite China's attempts to enclose the South China Sea within its nine-dash line, the RAN has continued to sail through these international waters as permitted by law, as it has done for the best part of a century. It has not, however, gone as far as the US Navy

Credit: LSIS Richard Cordell

*The **Collins**-class submarine HMAS **Rankin** conducts helicopter transfers in Cockburn Sound, Western Australia, 12 February 2021.*

*A computer-generated graphic of the Australian navy's future **Hunter**-class frigate. The **Hunter**-class will use the same Type 26 hull as the Canadian Surface Combatant but with major changes to incorporate the Australian CEAFAR2 radar suite and Saab Australia combat system.*

with formal freedom of navigation operations within 12 nautical miles of disputed or artificial features.

As far as Australia's willingness to *respond* in the maritime domain, former Defence Minister Peter Dutton said last year that if the United States sought to defend Taiwan, "it would be inconceivable that we wouldn't support the US."[24] The 2022 Lowy Institute Poll indicated a slim majority of Australians agree, with 51 per cent in favour using the Australian military if China invaded Taiwan and the United States decided to intervene.[25] Many have speculated that an upgrade to SSNs may also oblige the RAN to commit to a frontline undersea combat role alongside the US Navy, rather than distant blockade and choke-point patrol as is sometimes ascribed to the *Collins*-class now.

Conclusion

Australia has recognised its changed strategic circumstances and responded ambitiously. Details of the plan for nuclear-powered submarines are due early next year, at the same time as a defence strategic review of force posture and force structure concludes. But turning ambitions into capability – or more precisely, hulls – is a process almost always accompanied by difficulty and delay.

Walter Cronkite once said of Australia, "[t]oo many reporters, not enough news."[26] Into the current vacuum, commentary of varying quality pours in. Those vexed by delays in frigates swing between cancelling the *Hunter*-class, arming offshore patrol vessels or restarting the Air Warfare Destroyer production line. Some portray AUKUS as a beauty pageant between the UK and US boats, endlessly speculating on which is the best. Some even suggest Australia should return cap in hand to France for a conventional or nuclear design and invite France to join AUKUS. (Surprisingly, a truly tripartite submarine deal, wherein the United States, UK and Australia arrive at a common AUKUS-class design and jointly manufacture the boats across the three states much like the F-35 joint strike fighter, has not been properly discussed.)

If the Australian government is willing to match its ambitions with resolve, and nurture the support that the public is already offering (according to the polls), Australia will assuredly get the future navy it needs and deserves.

Notes

1. Will Glasgow, "Whatever Happens with Coal, Beijing's Coercion Campaign Won't be Forgotten in Australia," *The Australian*, 11 July 2022.
2. Jonathan Kearsley, Eryk Bagshaw and Anthony Galloway, "If You Make China the Enemy, China Will be the Enemy: Beijing's Fresh Threat to Australia," *The Sydney Morning Herald*, 18 November 2020.
3. For more, see Lowy Institute, "The Lowy Institute Poll 2022: China."
4. Prime Minister Justin Trudeau quoted in Robert Fife and Steven Chase, "Canada Caught Off Guard by New Security Pact between US, Australia and Britain," *The Globe and Mail*, 17 September 2021.
5. Rear-Admiral Matt Buckley (RAN), "Keynotes and Introduction," Sea Power Conference 2022, Day 1, Session 1, 10 May 2022.
6. Vice-Admiral Michael Noonan (RAN), "Perspectives on Maritime Operations: Keynote," ANI Goldrick Seminar 2021, 1 October 2021.
7. Vice-Admiral Jonathan Mead (RAN), "Keynotes and Introduction," Sea Power Conference 2022, Day 1, Session 1, 10 May 2022.
8. Andrew Nicholls, Jackson Dowie and Marcus Hellyer, "Implementing Australia's Nuclear Submarine Program," Australian Strategic Policy Institute, 14 December 2021, p. 5. Note: in September 2022 the Canadian dollar was worth $1.13 Australian dollars.
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The Future Prospects for the National Shipbuilding Strategy

Jeff G. Gilmour

Credit: Timothy Choi

*A **Halifax**-class frigate, MV **Asterix** and the Arctic and Offshore Patrol Vessels **Harry DeWolf** and **Margaret Brooke** are seen alongside CFB **Halifax** on 2 June 2022 with Irving Shipbuilding's facilities in the background. Under protective coverings, another **Halifax**-class frigate sits in the graving dock for refit work.*

In 2010 the Conservative government made a decision to support Canada's marine industry and build vessels for the Royal Canadian Navy (RCN) and the Canadian Coast Guard (CCG). In addition to recapitalizing the RCN and CCG fleets, the purpose of the National Shipbuilding Strategy (NSS) is to develop a long-term shipbuilding plan that benefits the marine industry in Canada.

The strategy has three main objectives. First, it was to renew the federal fleet in a timely and affordable manner. Second, it was to create and support a sustainable marine sector in Canada. Third it was to generate economic benefits for Canada. There are three main elements: large vessel construction; small vessel construction; and repair, refit and maintenance. This article will focus on the first of these objectives – renewing the fleets in a timely and affordable manner – in particular focusing on large vessel construction.

Sourcing arrangements for the NSS were initially established with two Canadian shipyards: Vancouver Shipyards (later to become Seaspan Shipyards); and Irving Shipbuilding in Halifax. In 2012, Public Services and Procurement Canada (PSPC) entered into umbrella agreements with these two companies. The original plan was to build more than 50 ships for both the RCN and the CCG over a 30-year period. In 2019/2020, the government added more ships to the NSS – the Multi-Purpose Vessels, Non-Combat Patrol Vessels and Heavy Icebreakers – for a total of 66 ships. (See Table 1.)

In August 2019, PSPC announced a competitive process to select a third shipyard to build icebreakers for the CCG. In December of that year, the Liberal government announced that Chantier Davie Canada Inc. in Levis, Quebec, had pre-qualified to become Canada's third shipyard.

The Procurement Process

An interdependent Deputy Minister (DM) committee chaired by the DM of Public Services and Procurement is responsible for the implementation of the NSS. Unlike many other NATO countries which have one Minister responsible for procurement for such projects, in Canada there are three. PSPC is the contracting authority, Innovation Science and Economic Development Canada negotiates the shipyards' obligations to generate economic

Table 1. Projected Fleet Renewal under the NSS

	Ships	Numbers	Shipyard	Estimated Cost	Estimated Completion Date
1	Interim Icebreakers From Converted Norwegian Ships	3	Davie	$610 M	First Delivery 2018
2	Offshore Fisheries/Science Vessels	3	Seaspan	$687 M	Completed 2019/2020
3	Oceanographic Offshore Science Vessel	1	Seaspan	$1 B	2022
4	Non-Combatant Patrol Vessels	10	Seaspan	$3.3 B	?
5	Multi-Purpose Vessels (MPV)	16 2	Seaspan Irving	$15.7 B	?
6	Medium Icebreakers	6	Davie	?	?
7	Arctic and Offshore Patrol Ships (AOPS)	6 (+2 for the CCG)	Irving	$4.3 B	2020 Official Delivery to RCN (first ship)
8	Joint Support Ships (JSS)	2	Seaspan	$3.4 B	2025 (first ship)
9	Canadian Surface Combatants (CSC)	15	Irving	$77.3 B	2030-2047
10	Heavy Icebreakers	2	Seaspan/ Davie	$7.25 B	2030 +

benefits by monitoring and evaluating their performance according to their obligations, and the Ministers of National Defence and Fisheries and Oceans are responsible for the projects relating to their department.

In its 2021 report the Auditor-General (AG) reported on a variety of matters, one of which was the NSS. The AG audit focused on the procurement of large vessels over 1,000 tonnes displacement. The audit covered the period from 1 January 2018 to 1 January 2020 and focused on whether the large vessel fleets of the RCN and the CCG were being renewed in 'a timely manner.' Overall, the audit found that the NSS has been slow to deliver both the combat and non-combat ships that are needed to meet Canada's domestic and international obligations.[1] The report noted that the delivery of many ships has been significantly delayed, and further delays would result in several vessels being retired before new vessels are operational.

A difficulty of getting the NSS off the ground has been attempting to work with the 2014 Defence Procurement Strategy which aims to deliver new ships for the RCN and the Coast Guard in an "efficient, timely and streamlined process."[2] In over a decade since the implementation of NSS, many would argue that the current procurement process is a bust. The NSS, according to one critic, "to no one's surprise – is floundering amidst heavy delays and unfathomable cost increases."[3] Without a more efficient and effective procurement system, there will be continual delays in the construction of ships identified under the NSS.

NSS Progress Report Projections

As with any business contract, the longer it takes to initiate agreement between the shipbuilders and the federal government, the more the estimated costs for building the ships increase. For this reason alone, we can estimate that the initial costs for each NSS project yet to be completed will increase as each project is finally approved, contracts let and construction begins in the three shipyards.

Of the 66 ships listed in the NSS to be built over the next three decades for both the RCN and the CCG, how many will be actually built within this time frame? How many actual contracts will be finalized between each of the three shipbuilders and Ottawa? There is currently competition for government attention and funds amongst the various government departments, and amongst the other military services, particularly because of the recent spending spree of the federal government as a result of COVID-19.

This article will flag some of the reasons why contracts under the NSS are being postponed or delayed. First, many critics have argued for decades that defence issues have never been a high priority with the federal government. As noted in January 2022 by Derek Burney, who served as Canada's Ambassador to the United States, "using often unserviceable equipment, our military has become a national, if not a global embarrassment. Australia is lifting

its defence expenditures to 3.0 percent of GDP. Canada is stuck at 1.4 percent, well below our NATO obligations."[4]

Based on the current global threats and risks, the government may need to place a higher priority on defence. As well, it is probably a good time to look at writing a new defence strategy for this country. As events in the Black Sea during the conflict between Russia and Ukraine have demonstrated, state-based conflict in the maritime arena is once again possible. Based on changing global circumstances, the RCN will require a modern fleet to confront new threats, sooner rather than later.

In addition, if the Arctic is transforming from an area of cooperation to an area of conflict, Canada will need to increase its presence there. The CCG's limited fleet of icebreakers is becoming obsolete. For example, Canada's heavy icebreaker *Louis St. Laurent* is over 50 years old, well beyond its intended operational lifespan. The earliest this ship will be replaced is in 2030 – a date which could still be optimistic. The Parliamentary Budget Officer recently noted that the cost to build the two heavy icebreakers will be an estimated $7.25 billion (B).[5] The government estimated in 2013 that it would cost $1.3 B to build one ship.

Second, given the number of projects for each shipyard, one has to question the capacity of these yards to build the ships. For example, Irving will be busy completing the six AOPS ships for the RCN (and then two more for the CCG) up to 2030 when it is anticipated that work will begin on building the 15 Canadian Surface Combatants (CSC) to be completed by 2047. Does Irving have the capacity to build the large CSC? Can the pace of shipbuilding be kept up for this extended period? The much-smaller AOPS program has faced delays and spending increases. Under the original timetable, the first AOPS was to be delivered in 2013, with Arctic operations set for 2015, however the first ship, *Harry DeWolf*, wasn't delivered until July 2020.

At Seaspan, having completed the three Offshore Fisheries Science ships, the shipyard is now focusing on building Offshore Oceanographic Science Vessel and the first of two RCN Joint Support Ships (JSS). For these reasons, the earliest a heavy icebreaker could be built at this shipyard is 2030. Unfortunately, *Louis St. Laurent* might not last until the end of this decade for operations in the Arctic. The shipyard is experiencing delays in its builds for the RCN. At one point, the first JSS was supposed to arrive in 2012. That time frame has been changed a number of times with the federal government hoping for a 2018 delivery and then a 2019 arrival for the first ship. The Department of National Defence (DND) then revised that delivery to 2022 or 2023. The government recently announced that the JSS will face further delays.[6] The first ship will not be delivered until 2025 and the second will not arrive until 2027. Are these delays related to the capacity of the shipyard?

Third, given current low unemployment rates and high demand for shipbuilding, there are questions about personnel, which ties back to capacity of the shipyards. A December 2021 article in *The Economist* discusses how the United States wants to compete with China in building new ships for the US Navy but is constrained by the number of proficient ship workers available. As well as finding experienced workers, there are limited numbers of shipyards able to build the ships needed as forecasted by the US Defense Department.[7] Finding new workers may drain personnel from other shipyards, or from supplier companies, neither of which will speed up the shipbuilding process. Worker training appears to be a substantial problem in the United States to meet the demands now placed on shipyard contracts with government. It is reasonable to assume that the same problem exists for Canada's three shipyards. Are there enough workers in Canada with the expertise to build the number of ships proposed under the NSS, and to be divided amongst three shipyards?

Credit: Seaspan

A November 2020 aerial photo shows Seaspan Vancouver Shipyards.

Credit: Ana at Seaspan

The first Joint Support Ship is seen here receiving its midships replenishment-at-sea control station in a photo taken 25 May 2022 at Seaspan Vancouver Shipyards.

Fourth, as noted earlier, many critics argue that Canada's military procurement system needs a major overhaul. As an example of the time it takes to replace military hardware, one only has to look at the debacle in replacing the CH-124 Sea King helicopters, which took decades. One might also point to the ongoing process to replace Canada's F-18 fighter jets.

The 2021 AG's report referred to earlier concluded that the various federal departments involved in making the decisions involving capital acquisitions for the military have not managed the process in a timely manner. This will leave the country with a capability gap, leaving both the RCN and CCG with insufficient ships to perform critical operations in the waters of Canada's three oceans and internationally.[8] As Richard Shimooka noted, "the causes of Canada's [procurement] problems are manifold, with few obvious fixes."[9] One of the problems, as Shimooka points out is that, "[d]espite there being only one realistic supplier for many capabilities, the overriding preference has been to run competitions, increasing program costs and delaying capability delivery."[10] Most analysts agree that the procurement process needs to be fixed – what is less clear is how that can be done. If it is not done, as Shimooka concludes, "the government will continue its disappointing track record of procurement outcomes, with the Canadian public and the military bearing the consequences."[11]

Fifth, the biggest cost program under the NSS is the contract with Irving to build 15 of the Canadian Surface Combatants (CSC) to replace the *Halifax*-class frigates. The costs for these ships have escalated with time. The government initially estimated the costs at $14 to 26.2B, which has now increased to $62B. The Parliamentary Budget Office released its cost estimate of $77.3B in 2021 which increased to $82.1B if the program is delayed a further two years.[12] As noted in the AG's report, timing for the construction of these ships has been a problem. The first ship was originally due to be delivered in 2020, but a new schedule now shows the first ship to be delivered in 2030 and the final one delivered in 2047.[13]

The question we could ask is why the costs have increased so significantly. The answer is in part because of delays and design changes, and in part because of how the CSC program was designed/managed. As noted earlier, Irving Shipbuilding became the prime contractor for the CSC project. The government then had to make a decision concerning the design of the ships. Prior to the eventual decision, 88 amendments were made to the tender, two years before the actual outcome was made between the various bidders.[14]

In 2018, the BAE Systems/Lockheed Martin team was selected as the winner for its bid of the Type 26 design. The outcome was challenged by a losing competitor which caused further delays.[15] The theory was that the competition would involve a mature design, but DND has acknowledged that significant modifications will be made, and adapting the British design to meet Canadian expectations is not due to be completed until late 2023, early 2024.[16] In March 2021 a DND spokesperson stated that since 2014, $696.32M has been spent on five recent contracts worth $1,022,066.[17] In 2014 two contracts worth nearly $20M were let by the government to help determine the future CSC design competition. In July 2015, another $136M contract was let to help Irving define the tasks ahead. In February 2019, Irving received a further $865,682,440 contract for the Type 26 design phase.

Credit: Department of National Defence

A computer-generated graphic of the Canadian Surface Combatant as posted by the Department of National Defence Twitter account on 14 January 2022.

Credit: Canadian Coast Guard

*The converted icebreaker CCGS **Jean Goodwill** shown at an unknown location in this photo posted by the Canadian Coast Guard on 24 August 2022. **Goodwill** and its two sisters were converted by Davie Shipyards under the NSS refit and maintenance pillar.*

Some people have questioned the wisdom of the arrangement for managing the CSC build. As noted in a 2021 article by Ken Rubin, "Irving would get to take profit from being both the shipbuilder and the prime contractor while also being able to select subcontractors and their pricing. How this profit level would be monitored was not revealed by PSPC."[18] Rubin also notes "this comes about as the government allowed a private-sector party, Irving Shipbuilding Industries, to run a government procurement project in what is the biggest-ever procurement project."[19] By choosing the Type 26 ship to be built exclusively at Irving's Halifax shipyard, the government has placed responsibilities with Irving to design an untested model, adding costs, while delaying the delivery of those ships by several more years.

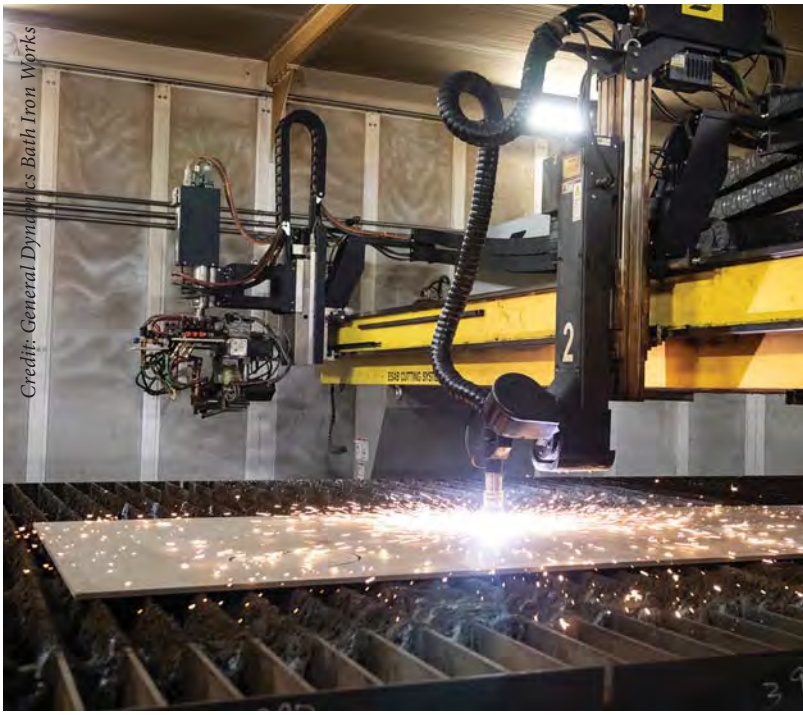
It has become clear the government has fallen short in exercising oversight on the CSC project. The government claims to have oversight risk mitigation tools in place, but the 2021 AG's report found that the risk mitigation tools in the shipbuilding program were very weak. In an interview in 2021, Alan Williams, the former Assistant Deputy Minister Materiel (ADM MAT) at DND, stated he was shocked in 2015 when the federal government delegated the prime contractor role in the CSC program to Irving, rather than retaining this role itself.[20] He noted that it was the first case he was aware of in which the government decided that industry would make all the key decisions, including who it would partner with and what the design of the ship will be.[21] In a 2021 opinion piece in *Canadian Defence Review*, Williams further reflects:

> It is hard to imagine the Government being more surprised and embarrassed than it is now from the nightmare of the CSC fiasco. On a regular basis, new revelations surface regarding the schedule and cost impacts of this fatally-flawed process the Government was asked to approve.... It did not envision ships arriving two decades later at a cost in excess of a quarter-trillion dollars.[22]

The saga with Irving shipyard continues. It was reported in June 2022 that the President of Irving Shipbuilding, Kevin Mooney, requested $300 million from Ottawa to upgrade the shipyard in order to build the 15 CSC ships.[23] Even though the company was selected to build the new fleet under the NSS program in 2010, and intimately involved in the design discussions, it now argues that it is a "larger and more complex ship than originally proposed."[24] Mooney stated that "we have to upgrade portions of the shipyard to be able to handle both the capability and the capacity," and that it needs these additional funds from the federal government to stay on schedule to start building the first ship in 2024.[25] To date, there has been no word from Ottawa on this request.

Conclusions

There is no doubt that the NSS is an ambitious program based on the number of ships promised for both the RCN and the CCG – even for a 30-year window. Both the RCN and the CCG need ships, the sooner, the better. In the



Credit: General Dynamics Bath Iron Works

*A steel-cutting machine begins work on the Flight III **Arleigh Burke** destroyer USS **Quentin Walsh** to mark that ship's start-of-fabrication on 17 November 2021. Despite modern shipbuilding technologies, US shipyards like Bath Iron Works still pose competition for Canadian shipyards in the quest for trained personnel.*

case of the *Halifax*-class frigates, they will have to operate for at least another decade before the first CSC will be built.[26] The CCG urgently needs heavy icebreakers for operations in the Arctic, but the first of these ships will not be available until 2030 at the earliest. In December 2019 the federal government announced that the Quebec shipyard Chantier Davie was the only company to qualify in the construction of six much-needed medium icebreakers for the CCG. More than two years later, no contracts have been let or costs announced for the vessels.[27] The CCG had to retire a 59-year old science vessel, leaving Canada without a dedicated platform for ocean research until the new ship is built at Seaspan.

There is a question of capacity, of how many different types of ships can be built in each of the three shipyards, and the possibility of experienced workers spread thinly amongst the three competing companies. From a timing and scheduling perspective, any delays in construction result in increased costs. The military procurement process has been flawed for decades and must be streamlined if these construction delays are to be remedied. Canada should look at other NATO countries to learn lessons from their experience and to develop a more efficient and effective procurement process to construct the ships in the NSS.

Credit: Canadian Coast Guard

*Built by Seaspan, CCGS **John Cabot**, the third and final Offshore Fisheries Science Vessel, departs Victoria in January 2021 on the way to its new home port of St. John's.*

In addition to all this, a concern for both the RCN and the CCG is how long the NSS will remain in the budget now that the federal government has increased debt because of its response to COVID-19. Since defence issues have never been a high priority for Canadians, in the past it was easy for governments to shift financial priorities to other things. Time will tell if the NSS remains in place for the next three decades.

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Autonomous Underwater Vehicles and Submarines

David Dunlop

Credit: Jacek Szymanski, Canadian Armed Forces

*HMCS **Windsor** is seen in this April 2018 photo off Crete, Greece.*

Canada has just stood up its Submarine Acquisition Process to replace the aging *Victoria*-class diesel-electric submarines with a new fleet of submarines. As complex platforms, they're extremely expensive, and it will be a long and painful process before Canada has them (assuming a decision is made to procure them). Given the rapid pace of technological change, they could very easily be obsolete soon after they're built. And by this, I mean not just the technology on the submarines, but *manned* submarines themselves could be obsolete. There are already unmanned (also referred to as uncrewed) submarines, with more being developed world-wide. Canada could become a leader in this technology. At any rate, this is something to consider before setting aside money to build new submarines.

Roles, Technologies and Options

It has become clear in recent years, that Unmanned Underwater Vehicles/Autonomous Underwater Vehicles (UUVs/AUVs) can be very useful for navies and for civilian agencies as well. (For the purposes of this article, Unmanned (or Uncrewed) Underwater Vehicles (UUVs) and Autonomous Underwater Vehicles (AUVs) are considered the same, with the names often differing depending on whether they are civilian or military. We will use the term AUV here.)

Utilizing AUVs for missions simply continues the trend established by other unmanned vehicles in the air and on the ground. Although Predator aerial strikes in Afghanistan, for example, are public knowledge, fewer people are aware of the work done by their counterparts in the waterways. The role of AUVs as force multipliers is about to get much more widely appreciated. It involves vehicles which can sense, track, identify, target and destroy enemy submarines or mines – all autonomously – and tie in with the full network-centric battle-space. The US Navy's (USN) Master Plan identifies the following missions:

- intelligence, surveillance, and reconnaissance;
- mine countermeasures;
- anti-submarine warfare;
- inspection/identification;
- oceanography;
- communication/navigation network nodes;
- payload delivery;
- information operations; and
- time-critical strikes.[1]

As the technology develops, multiple types and sizes are being produced. The USN Master Plan divides them into four classes:

1. Man-portable vehicle class: 25-100 lb displacement; 10-20 hours endurance; launched from small water craft manually (eg., Mk 18 Mod 1 Swordfish UUV);
2. Lightweight vehicle class: up to 500 lb displacement; 20-40 hours endurance; launched from RHIB using launch-retriever system or by cranes from surface ships (eg., Mk 18 Mod 2 Kingfish UUV);
3. Heavyweight vehicle class: up to 3,000 lb displacement; 40-80 hours endurance; launched from submarines;
4. Large vehicle class: up to 10 long tons displacement; launched from surface ships and submarines.

As a global naval power, the US Navy needs large, long-range and long-endurance AUVs to operate across vast tracts of ocean. As we will discuss below, Canada's needs as a medium power are somewhat different.

It is possible that advances in artificial intelligence (AI), detection systems and signal processing, combined with swarming autonomous unmanned systems, could make it effectively impossible for manned submarines to maintain their stealth. Future submarines will require capabilities to counter AUV drone swarms. They can't expend their limited supply of torpedoes to pick off underwater drones, and they lack close-defence weapons found on surface warships. However, they could deploy interceptor drones from torpedo tubes. One could envision a high-end recoverable drone designed to rove ahead of submarines and intended to track and disable less-agile drones or static surveillance systems. These might be complemented by cheaper, single-use interceptor drones released in a burst that could also attempt to decoy torpedoes.

With area denial expected to become more likely – and more extensive – the pressure will grow on a traditional naval doctrine that relies on access to the littorals regions for the projection of power on shore. That will inevitably influence naval structure and, in the long run, means the role of the AUV as a force multiplier is about to increase significantly. As well, the growing volume of data gathered by unmanned vehicles will create demand for increasingly sophisticated analysis of that data. Unmanned vehicles will need to make use of the latest data analytics technologies to process incoming sensor data. Additionally, AI enables 'continued learning' for AUVs through machine-learning techniques which in turn enable complex capabilities such as autonomous navigation and obstacle recognition and avoidance.

Credit: Paul Pinner, Boeing

The Boeing Echo Voyager is seen in this 2016 photo at an unspecified location.

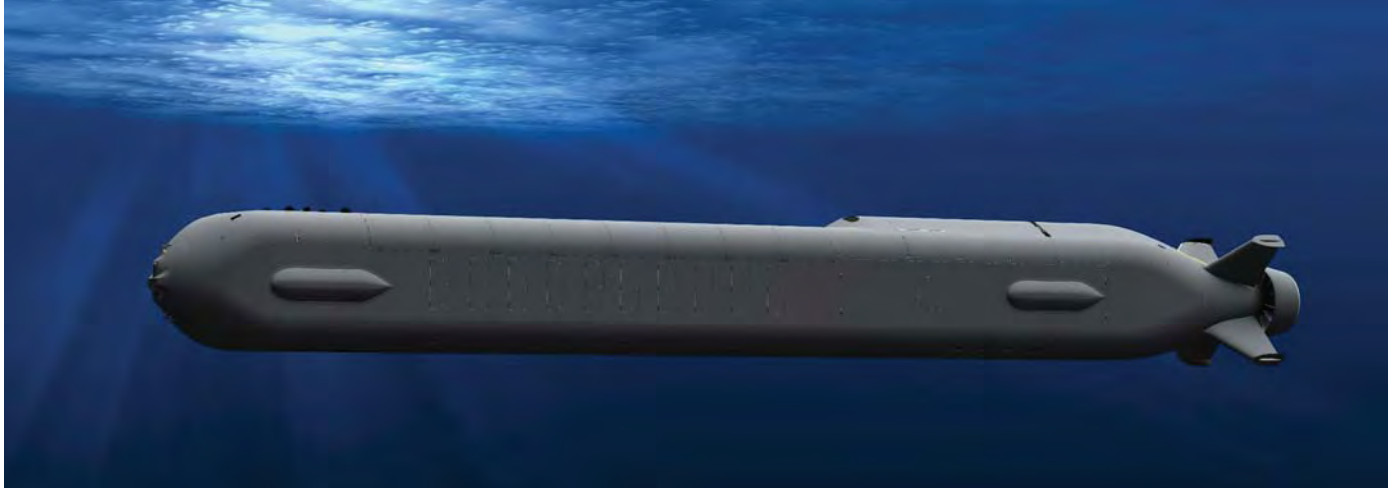
Advanced sensors are increasingly receiving funding, and these sensors have significant military applications. Advanced inertial sensors allow AUVs to estimate an object's position, direction and speed without a requirement for external references. Global positioning systems (GPS) cannot be used underwater, therefore, submarines and AUVs require an inertial navigation system (INS). Technologically advanced sensors can also provide significantly better information about potential naval threats including mines and anti-submarine warfare (ASW) capabilities. Communication technology will need to be further developed to communicate with AUVs, and will be a major focus for defence organizations in coming years. Advanced communication technologies will be necessary to communicate securely with submerged objects such as submarines and AUVs.

Anti-collision technologies ensure safer navigation when AUVs are used where maritime traffic is dense. Different types of sensors, such as vision, sonar, inertial and pressure sensors are used on AUVs to avoid obstacles and navigate safely. The sensors can be used individually or in combination with one another. Some AUVs also use surface awareness sensors to avoid other marine traffic during communications with remote operating centres.

Since radio waves do not propagate well under water, and because secure communication is crucial, many AUVs incorporate Acoustic Modems to enable remote command and control. These modems typically utilize proprietary communication techniques and modulation schemes. Most Extra-Large AUVs already have the capability when deployed to communicate to their home base through satellite communications. They have to rise near the surface and deploy SATCOM antenna at specific way-points to receive updates on their programmed mission and send back data that has been collected.

Most AUVs in use today are powered by rechargeable batteries (lithium ion, lithium polymer, nickel metal hydride) or hydrogen fuel cells. An emerging trend is to combine different battery and power systems with supercapacitors.[2] These have a capacitance value much higher than other capacitors, but with lower voltage limits, and that bridges the gap between electrolytic capacitors and rechargeable batteries. They can store more energy per unit volume than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerate many more charge/discharge cycles than rechargeable batteries.

Active sonar works by emitting sound waves and detecting the reflected waves, or echoes, using hydrophones. The incorporation of active sonar on AUV platforms allows for the exploitation of this capability without risk to military personnel and greatly increases the range over which data can be collected. The unmanned nature of



Credit: Boeing Defence

A computer rendering shows the Boeing Orca XLUUV, posted on Boeing Defence's Twitter account on 7 May 2019.

these systems substantially decreases the risk associated with both the emission of sound waves (telegraphing position) and travel in hostile waters. Advanced AUV trackers may also employ synthetic aperture sonar, which incorporates sonar data to develop landscapes of the surrounding space. The detection range for active sonar depends on the speed and design of the AUV, sonar frequency, ocean conditions and sophistication of the synthetic aperture sonar sensors and post-processing algorithms. Submarine drone technology complements existing passive sonar, hydrophone and wake detection systems to enhance maritime situational awareness.

Current Examples

Here are some examples of AUVs currently in production or operation around the world. The USN is beginning to deploy early models of its Razorback medium-sized AUV. The first version of the Razorback is deployed and recovered from a submarine's dry deck shelter, carrying with it environment-sensing payloads that help submarines have eyes in more places underwater. Those UUVs are being delivered now, and a request for proposals has been issued to develop the next iteration that would be launched and recovered from submarine torpedo tubes.[3]

Another AUV being developed is the extra-large Boeing 50-ton Echo Voyager XLUUV/XLAUV. It is intended to operate extended deep-sea missions at a depth of up to 3,350 metres (11,000 ft) with a range of up to 12,100 km (7,500 miles).[4] It can theoretically last as long as six months at sea. Echo Voyager is powered by a hybrid diesel-electric system – submerged, the vehicle uses lithium-ion batteries for propulsion, which are recharged by a diesel-powered generator while it is surfaced – and can travel submerged for several weeks at a time. The 16 m (51 ft) vessel is designed to be adaptable for military operations. Echo Voyager however, is no speedster with a maximum speed of 14.5 kilometres per hour (9 mph), and a sustainable cruising speed of just 4.8 kph (3 mph). For navigation, Voyager relies primarily on depth sensors and gyrometric inertial navigation systems. However, when near the surface it can also raise a satellite mast to acquire GPS coordinates and send back near real-time mission data or receive mission updates/changes.

In February 2019, the USN awarded Boeing a $350.3 million CAD contract to build five 15.5 m-long Orca XLUUV completely autonomous vehicles, about $70 million CAD each.[5] The modular design will enable current and future payloads, sensors and other systems to be integrated over the vehicles' life-cycle The publicly available details on the Orca suggest it could prove a highly-capable platform and could be used for mine countermeasures, anti-submarine warfare, anti-surface warfare, electronic warfare and strike missions. Orca appears very similar to Echo Voyager except that it has a shrouded pump jet propulsor rather than Voyager's conventional propeller. That suggests the Orca will be quieter and possibly faster than its cousin.

The US Navy's Orca may not be the biggest autonomous fish in the ocean for long. The Royal Navy's MANTA XLUUV is ready for deployment. The UK Ministry of Defence (MOD) Science and Technology Laboratory launched a two-stage £2.5m competition in April 2022 seeking solutions to confirm the future capability and employment of completely autonomous Extra-Extra Large AUVs. The first stage will carry out research and development of an autonomous control system using existing platforms (MANTA), and the second stage will

Credit: Naval Sea Systems Command (NAVSEA) Facebook page

Dorothy Engelhardt, Director, Unmanned Systems, Deputy Assistant Secretary of the US Navy (Ships), christens the Orca XLUUV Test Asset System during a ceremony in April 2022 in Huntington Beach, California.

Credit: Cellula Robotics

The Canadian-built Solus-LR UUV is shown in this August 2019 photo from the Cellula Robotics' website.

test these over two years. Ultimately the MOD is looking for a 33.3 metre (100 ft) long AUV to operate independently at long distances, carry payloads, carry out covert intelligence gathering and provide an anti-submarine, anti-surface and land-attack missile capability.

In Australia, Cellula Robotics, with Trusted Autonomous Systems (TAS), is six months into the Sea Wolf project to develop a fuel-cell-powered XLUUV. Funded by the Royal Australian Navy (RAN), Sea Wolf is set to debut the first XLUUV hull in late 2022 or 2023. The project builds on Cellula's existing Solus-LR system and uses the Solus control architecture and software. The project includes a mission range of over 5,000 kms powered by a state-of-the-art fuel-cell power system and two modular 2,500 liter flooded payload bays. It will have a 12-metre by 1.7-metre hull, which means it can be shipped in a single 40 ISO container.[6]

Other states are also investing in AUVs in a big way. Not surprisingly, China and Russia are heavily invested in developing powerful UUVs/AUVs.[7]

Canada and UUV/AUV Advancements

Where is Canada in all this? The Royal Canadian Navy (RCN) has diverse needs and requires flexibility and adaptability in its platforms and systems. With an AUV, the navy requires a collaborative multi-purpose system capable of naval mine countermeasures (NMCM), anti-submarine warfare (ASW), anti-surface warfare (ASuW) and a cold-water Arctic capability. Flexible AUVs will have to be deployable from ashore or a ship, in support of both military and civilian operations. The technical challenges are significant but this kind of next-generation system represents the future of naval operations. Some of Canada's needs could be met from research at international facilities – the NATO Undersea Research Centre (NURC) in Italy, for example – but here we will examine efforts in Canada.

In the years since the RCN began work on AUVs, a series of small-scale experiments has been undertaken. The RCN acquired its first REMUS 100 AUV in 2018 and these small commercial systems can be used for surveillance and mine hunting. Defence Research and Development Canada (DRDC) is also testing the larger Thunder Fish AUV built by Kraken Robotics. The purpose of these commercial systems is ultra-high-resolution seabed imaging and mapping applications, although the defence applications are clear. These craft might one day fulfill the role of NMCM, allowing support ships to remain at a safe stand-off while the AUV conducts its survey for mine-like objects. Moving from these limited systems to something more capable is the next step.

In July 2022, Cellula Robotics demonstrated, to the RCN, DRDC and Australian representatives, its Solus-LR hydrogen fuel-cell-powered AUV off British Columbia. The mission demonstrated the autonomous launch of a micro-AUV from Solus-LR while submerged and underway. It also demonstrated the ability to communicate as the AUV surfaced and transmitted a status message via satellite, illustrating near real-time, over-the-horizon communications from a submerged AUV.[8]

For the RCN, apart from ASW, an AUV must also be able to perform underwater surveying and engineering, and execute maritime security operations in the North where the RCN has been increasingly active. Conducting military and civilian underwater operations in the High Arctic is difficult but current AUVs offer the promise of new capabilities and efficiencies. Canada's existing capabilities are adequate but not ideal. Surveys undertaken by icebreakers are slow and the ships cannot easily navigate thick multi-year ice, and helicopters are limited by weather and seasonal restrictions. By their very nature, AUVs would be desirable assets. Unmanned, with long endurance, they could theoretically replace some of the government's manpower-intensive platforms.

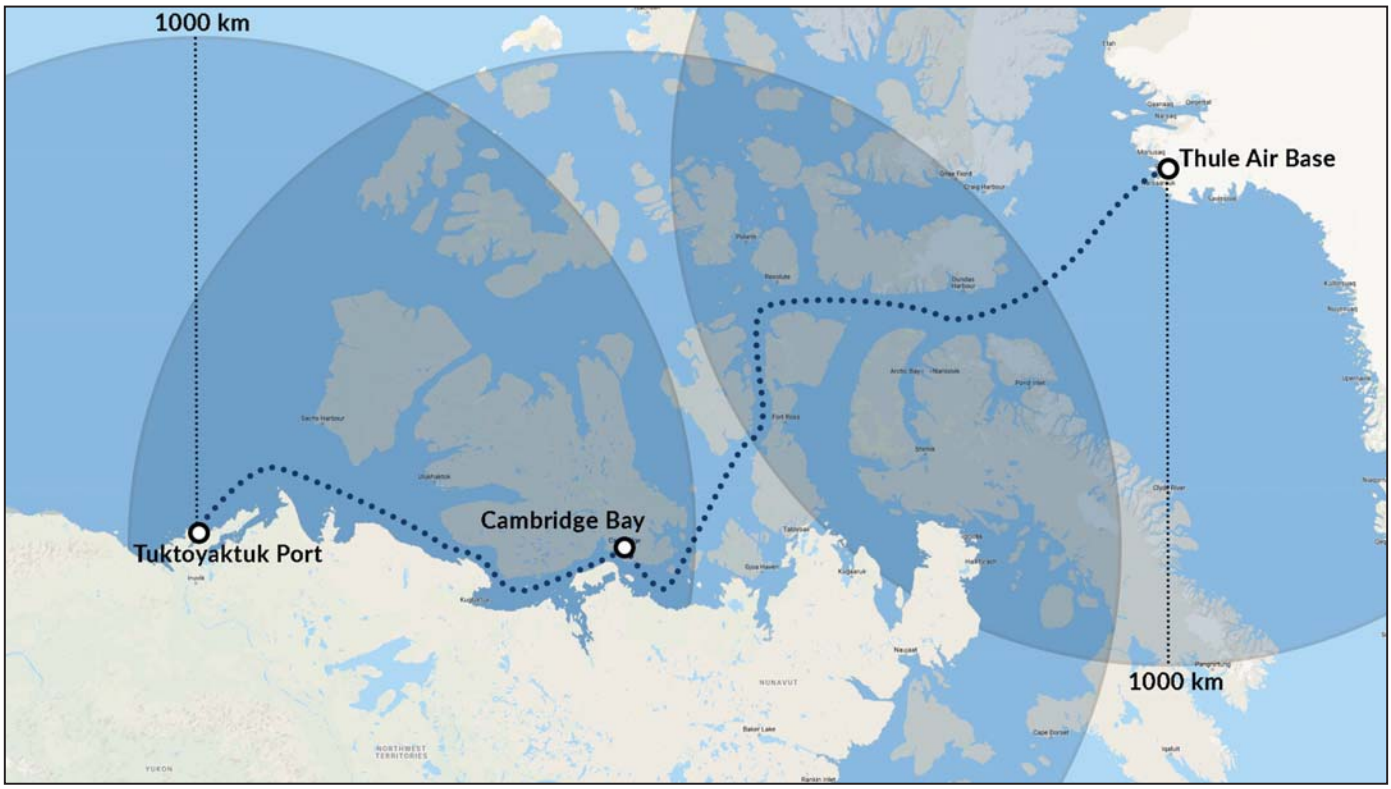
A notable example is the International Submarine Engineering (ISE) Explorer AUV, a system that was deployed under Canadian Arctic ice to perform bathymetric surveys.

It has an endurance of hundreds of kilometres and 10 days of in-water operation. It was used, for example, to collect data for Canada's United Nations Convention on the Law of the Sea (UNCLOS) claim. While not a defence asset, it offers clear evidence that AUVs can be adapted to under-ice operations. Explorer does not, however, meet all of the RCN's requirements with respect to flexibility in operations. For example, it does not have the ability to conduct NMCM operations, nor is it easy to operate from a ship with limited crew. It weighs over 1,800 kg and is almost 7.5 m in length, making it difficult to operate from ships. In addition, it requires the services of a Remotely Operated Vehicle (ROV) to inspect and reconfigure it between missions, making it inefficient for ship-based operations.

Despite these limitations, Explorer has potential for future development in the RCN. First, DRDC has significant experience in researching and developing AUV technology in conjunction with Canadian private industry. In 1996 for instance, DRDC collaborated with ISE in creating the Theseus AUV. This model laid 200 km of fibre-optic cable out to the edge of the continental shelf under the ice, and autonomously returned to where it was launched for recovery. Since then, DRDC and ISE have built upon this technology. Based on the positive results observed during Canada's UNCLOS mission in 2010, DRDC and ISE built an AUV that surpassed all previous known records for continuous operations, distance travelled and operational risk.

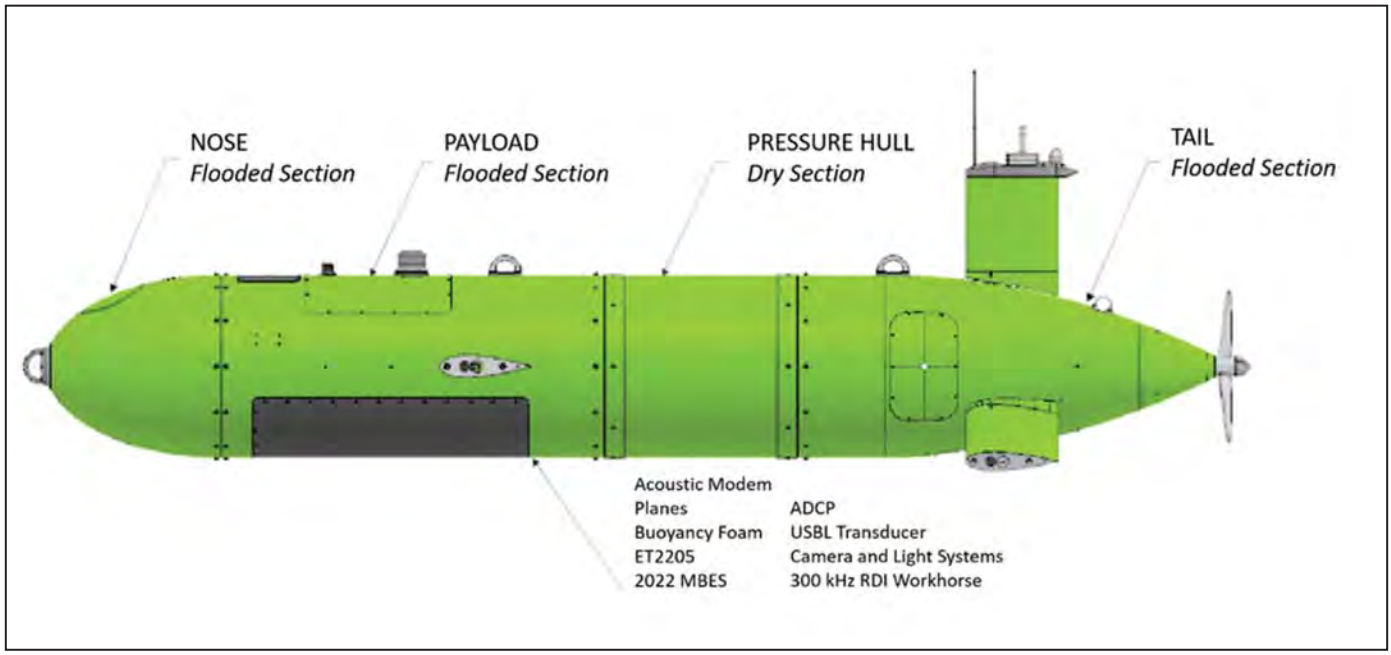
Second, Explorer is constructed with a robust communication and sensor suite, conducive to conducting naval operations in the North. Recognizing the limitations of inertial navigation systems in Arctic navigation, DRDC developed long- and short-range homing systems capable of transmitting out to ranges in excess of 100 km under the ice. And third, the RCN has some experience operating with this type of AUV. In 2014, DRDC scientists and RCN personnel traveled to the Arctic to deploy the AUV Arctic Explorer in a successful search for the lost Franklin expedition ships. Therefore, it is conceivable that the RCN could work with DRDC to design an AUV capable of conducting specific maritime security operations.

The RCN has made it clear that it intends to incorporate these systems into the fleet and as a means of providing safer, more cost-effective solutions in mine-hunting, surveillance and ASW. Much research has gone into AUV prototypes with military applications. Despite this, there does not appear to be a Canadian AUV on the market capable of executing naval operations in harsh Arctic conditions. In order to meet goals of conducting expeditionary and domestic maritime security operations, sovereignty operations in the Arctic and humanitarian missions with other government agencies, the RCN needs to continue its research and development with an eye towards a truly robust and versatile AUV system. This work can be undertaken collaboratively with DRDC and other research facilities and private industry.



Credit: Cellula Robotics

A map showing the Solus-LR's advertised range as posted on Cellula Robotics' website, August 2019.



Credit: International Submarine Engineering

An undated graphic of International Submarine Engineering's Explorer AUV which was used under ice to help map Canada's extended continental shelf in the Arctic.

Conclusions

Imagine a future in which modern Canadian submarines can deploy AUV drones to locate and possibly confront hostile submarines. AUVs could shake modern anti-submarine warfare to its core, making existing platforms vulnerable or obsolete. That future is becoming a reality. Many states, both friend and foe, have pursued the potential of UUVs/AUVs. They offer enhanced capabilities to track and destroy submarines, even the quiet diesel-electric submarines.[9] They can operate more quietly than manned submarines, and remain submerged for greater periods of time.

The newest thinking combines AUVs with submarine torpedoes. The USN launched a program in 2017 to develop small AUVs, capable of being launched from torpedo tubes, to create the same kind of picture of the undersea space that satellites, radars and Unmanned Aerial Vehicles (UAVs) can create in airspace.[10] Using both passive and active sonars, Canadian AUVs could deploy from submarines and explore the relevant area, detecting threats and relaying that information to their 'mother ship' submarine. In effect, AUVs have the potential to expand the lethal reach of submarines.

Despite the progress that has been made recently, AUVs are still a novel technology. However, improvements in technology have quickened in recent years as engineers from around the world compete to bring this technology to its full potential. The world's major navies have invested in this research and made clear that their interest in AUVs is a long-term priority. Canada has established that it is interested in following suit, experimenting with minor craft and developing the underlying technology. Canada's diverse maritime security requirements and its enormous ocean space should make this initiative a priority.

Will these technological marvels mean the end of the plan to acquire new submarines for Canada? The answer is probably not in the near term. However a blend of both manned and unmanned vehicles could be a consideration. A fleet of modern Canadian air-independent propulsion (AIP) submarines using torpedo tube AUVs to increase submarine detection ranges seems plausible. For over-the-horizon underwater detection ranges, acquisition, tracking and engagements of potential hostile forces, a fleet of fully autonomous XLUUVs would be ideal for high Arctic deployments and sovereignty missions where modern AIP submarines cannot go.

Notes

1. US Department of the Navy, "The Navy Unmanned Undersea Vehicle (UUV) Master Plan," US Navy, 9 November 2014; and "Orca XLUUV: Boeing's Whale of an Unmanned Sub," *Naval Technology*, 1 July 2019.
2. A capacitor is a device that stores electrical energy in an electric field.
3. Megan Eckstein, "Navy Releases RFP for Medium Unmanned Underwater Vehicle," *USNI News*, 22 May 2020.
4. Boeing, "Echo Voyager," Product Sheet.
5. "Orca XLUUV: Boeing's Whale of an Unmanned Sub."
6. Cellula Robotics, data sheet, "Solus-LR Autonomous Underwater Vehicle," no date. It is interesting to note that Cellula headquarters is in Burnaby, BC. Plans are underway to establish an Australian Cellula entity that will be closer to the enterprises in Australia already working on design and manufacturing of UUVs for RAN.
7. Russia, for example, has developed Poseidon Status 6 or Doomsday Torpedo, an autonomous, nuclear-powered UUV, capable of delivering both conventional and nuclear payloads.
8. Phoebe Grinter, "Hydrogen Fuel Cell Powered AUV Completes Successful Demonstration Missions," *Unmanned Systems Technology*, 16 August 2022.
9. Franz-Stefan Gady, "US Navy to Deploy Robot Ships to Track Chinese and Russian Subs: Work on the US Navy's New Anti-submarine Drone is Progressing and That's Bad News for Diesel-electric Subs," *The Diplomat*, 30 June 2015.
10. Steven Stashwick, "US Designing New Unmanned Vehicles to Help Its Subs Detect Adversaries: UUVs would give US Subs Active Sonar Without Revealing Themselves," *The Diplomat*, 19 July 2017.

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The LPA: The RCN's Arctic Linchpin?

Major (Ret'd) Les Mader[1]

Since the publication of *Canadian Naval Review's* (*CNR*) first issue, amphibiosity and expeditionary operations have been recurring topics in its pages. To date, at least 31 articles have been written on various aspects of them, including 19 which have considered the types of amphibious/expeditionary ships that the Royal Canadian Navy (RCN) should procure. Seven of these articles expressed support for the employment of modern amphibious assault ships (LHA/LHD) and/or Landing Platform Docks (LPD). The remainder discussed the amphibious/expeditionary use of various other vessel types.

Having examined elsewhere myself the shape of an LHD/LPD type of capability for Canada,[2] I now believe that such ships are not the most relevant amphibious/expeditionary platforms for the navy in the international situation currently faced. Instead, I feel that the RCN should procure amphibious ships that are designed for polar operations, a Landing Platform Arctic (LPA). Having described this concept briefly in earlier *CNR* issues,[3] I will now expand on the ideas presented there and consider the feasibility of putting such a vessel into service.

Before discussing the LPA we must outline the future operational environment that the RCN will confront. It will be driven by the combined effects of climate change and a geopolitical environment that was increasingly fraught even before Russia's 2022 invasion of Ukraine shattered many existing 'certainties' about international behaviour. These trends greatly increase the likelihood of challenges to Canada's Arctic sovereignty, with the consequent need for the Canadian Armed Forces (CAF) to be able to contain and confront polar intruders when required. In such confrontations, operational conditions could be similar to those that dominated the 1982 Anglo-Argentine Falklands War. In this conflict small forces operated, with limited outside support, over a vast, hostile terrain with minimal or no local infrastructure, at the limits of tenuous logistics chains, and depended on the quality, capability and luck of their forces and the survival of their key platforms for success.[4]

Facing similar conditions in the Arctic, Canada must be able to deploy self-sufficient, very capable presence naval task groups to protect its northern sovereignty. These groups must contain modern warships that are carrying capable aircraft and quality landing forces. These would provide the groups with the performance and staying power, not offered by fleetingly available fighter aircraft and other forces,[5] needed to undertake a range of on-site kinetic and non-kinetic responses, as an Arctic crisis and an intruder's actions evolve. The LPA would be the key platform of these task groups.

A reading of past *CNR* issues makes clear that an LPA that could also accomplish other roles would be a very valuable asset for Canada. The four most significant LPA roles, ranked in decreasing order of military importance (which does not necessarily indicate their likelihood of occurrence), are:

1. Transport, land, support and recover a militarily relevant amphibious force in the Canadian Arctic during the annual polar navigation season;
2. Carry out non-combatant evacuation operations;
3. Carry out the sealift of vehicles, equipment and stores for the CAF; and
4. Carry out humanitarian assistance and disaster relief (HA/DR) operations.[6]

Credit: Joost J. Bakker, via Wikimedia Commons

*HNLMS **Johan de Witt**, a Dutch Landing Platform Dock, in a 2009 photo at Den Helder. The ship might be a suitable starting point for a Canadian Arctic amphibious ship, the author suggests.*

Credit: Sheldon Gillis, Royal Canadian Navy

*The landing craft of HMCS **Margaret Brooke** transports supplies and personnel in the Canadian Arctic during **Operation Nanook** in this image posted by Captain (N) Sheldon Gillis on 29 August 2022.*

The following paragraphs will look at the major operational capabilities that an LPA able to carry out these four roles must have. This discussion is summarized, and quantified where possible, in Table 1.

Given that this vessel will be operating in Canada's Arctic archipelago during the normal polar navigation season, its speed, endurance, range and sea-ice capability must be at least as good as those of the new Arctic and Offshore Patrol Ships (AOPS), with which it will be operating. Since it will likely have to transit to/from the archipelago during winter months, via the North Atlantic and/or Bering Sea, it will have to be very seaworthy in order to keep its embarked marine infantry as fresh and combat ready as possible.

Based on the operational concept that, in the Arctic, relatively small groups of well-trained, properly supported soldiers can have a strategic impact out of all proportion to their numbers, a marine infantry task force of some 350 personnel would be a valuable quantity of troops for the LPA to be able to carry, deploy, support and recover. Such a force does not have to have a fixed composition; its structure could be adapted to the nature of the actual or expected crisis.[7] Whatever the task force's specific configuration, the LPA must provide its marine infantry with the facilities that they need to maintain their physical strength, endurance and combat skills while at sea for weeks. As a minimum, facilities are required for marching, strength training, stamina maintenance and weapons handling. As well, although it is impossible to know how many evacuees might have to be embarked during an evacuation or HA/DR mission, the LPA must have the additional cooking and ablution facilities required to support at least several hundred such persons. Operational research studies would help identify the optimum landing force structure for each of the Arctic amphibious, evacuation and HA/DR roles and a reasonable planning figure for the number of evacuees who might require the additional facilities.

In the same way that the LPA's four possible roles dictate the configuration of its landing force, they also drive the need to be able to transport vehicles and equipment. The Arctic amphibious and evacuation roles do not involve the quantity of vehicles that modern amphibious ships can typically carry. Arctic deployments will normally only really require the all-terrain vehicles needed to transport the landing force's heavy weapons and equipment and to provide it with logistics support ashore, while the non-combatant evacuation role will likely necessitate

Credit: S1 Justin Spinello, Canadian Armed Forces

*A CH-148 Cyclone helicopter sits on the deck of HMCS **Harry DeWolf** during the night-time portion of Phase 4 Shipboard Helicopter Operating Limits off the coast of Nova Scotia on 8 June 2021.*

Table 1. Key Characteristics HNLMS** Johan de Witt **and Representative LPA

Criteria	Key Operational Characteristics L801 HNLMS *Johan de Witt*	Suggested Key Operational Characteristics LPA
Displacement (Full Load) (tons)	16,680	>16,680. Will grow, perhaps to 20,000, when provided with an ice-capable hull.
Length (metres) (m)	176.35	176.35
Beam (m)	29	32.53 (from AOPS' 103/19 length/beam ratio, which is linked to its ice-capable hull form)
Speed (knots) (kts)	19	At least 17 (from AOPS)
Endurance (days)	42	About 120 (from AOPS)
Range (nautical miles)	10,000 at 12 kts	At least 6,800 at 14 kts (from AOPS)
Sea-Ice Performance	None	At least Polar Class 5 (from AOPS)
Crew	146	About 150
Passengers	555 troops. Surge capacity of 100 more passengers.	About 550, including: marine infantry task force, aviation squadron or flight, landing craft flotilla, and additional support personnel: cooks, medical, etc. Ablution and cooking facilities to support several hundred evacuees.
Marine Infantry Training Area	Not mentioned	Required
Cargo	1,770 m^2 Ro-Ro deck with space for about 32 MBTs or a larger number of smaller vehicles. 4,170 m^3 cargo/ammunition storage.	Similar vehicle deck(s) which can be reconfigured, as required, for northern amphibious, evacuation and HA/DR roles. Similar storage capacity.
Helicopters	Hangar for 6 x NH90s or 4 x Chinooks. 58 m x 25 m flight deck with two landing spots.	8-12 x Cyclones. At least two flight deck landing spots. Multiple helicopter securing and traversing systems per landing spot. Use vehicle deck(s) for temporary hangar space when additional helicopters are required.
Landing Craft	35 m x 15 m well-deck with 2 x LCUs. 4 x LCVPs in davits.	2 x LCUs or 1 x LCAC(H) or 1 x LCAC(M) in well-deck. 4 x LCVPs or 4 x LCAC(L)s in davits.
Weapons	2 x Goalkeeper Close-in Weapon System (CIWS)	Greatly enhanced. Include anti-air, anti-surface and anti-missile systems.

Sources: Information compiled from: Bohdan L Kaluzny et al, "An Application of Data Mining Algorithms for Shipbuilding Cost Estimates," Journal of Cost Analysis and Parameters, Vol. 4, No. 1 (January 2011), Figure 3; Complete list of ship data for the Rotterdam and Johan de Witt LPDs, researchgate.net; Marineschepen.nl, "Johan de Witt Landing Platform Dock;" and Major (Ret'd) Les Mader, "The LSI(A): An Arctic Sovereignty Protection Option?" CNR, Vol. 17, No. 1 (2021), Table 1.

a quantity of light armoured vehicles and perhaps some cargo trucks. The vehicles, stores and equipment required by an HA/DR mission are essentially unknowable, as they depend on the nature of the disaster. However, they should be less than the quantities called for by the sealift role, which could involve the transport of a significant number of military vehicles, including possibly main battle tanks (MBT) and heavy engineering equipment, to operational theatres around the world. These very large vehicles will make demands of the ship's structure and parking decks that do not arise with the other roles; being able to carry out sealift missions will ensure that the LPA has sufficient parking and cargo capacity to fulfil other tasks. Thus, representative possible sealift loads should be identified using operational research.

The Canadian Arctic's enormous distances, near-impassible terrain, risk of sea-ice in all seasons and lack of land transportation infrastructure mean that helicopters will be the primary method for transporting the LPA's passengers off-ship. Using a 75% operational helicopter availability rate, the LPA must be able to carry at least eight transport-configured Cyclone helicopters for its Arctic amphibious role. This quantity would be sufficient to allow the movement of a marine infantry company in one lift, in order to contain an intruder quickly.[8] Depending on the specifics of a crisis, these transport Cyclones may well need to be escorted by offensively armed helicopters (gunships). Such an escort requirement will almost certainly arise in the chaotic conditions that can be encountered

during some evacuation missions.[9] The ability to carry up to 12 Cyclones during some crises would allow the launching of four of them configured as gunships (two pairs) and five more operating as transport helicopters, or another combination, as required.

Such a quantity of aircraft raises the question of whether the LPA should have a full-length flight deck, such as found on LHDs, or a smaller stern flight deck. I have opted for a stern deck in this article, as the protection from the Arctic winds offered by a forward superstructure is more important than the ability to launch a few more helicopters at a time. I believe, though, that the stern flight deck must allow simultaneous operations from at least two landing spots. Additionally, in order to speed up launches/recoveries, each landing spot should be connected by two or more separate helicopter securing and traversing systems to the aircraft hangar. The preferred helicopter complement for each role, the use of Cyclones as gunships, and the optimal flight deck configuration should all be analysed using operational research.

Despite having helicopters as its primary personnel transport means, the LPA must be able to deploy a number of landing craft in order to land/recover the vehicles and equipment required by its marine infantry task force. For Arctic operations, due to the risk of sea-ice, these vessels should be hovercraft (Landing Craft, Air Cushion (LCAC)), of the light (L), medium (M), or heavy (H) types.[10] Operations in non-Arctic waters may not require the special capabilities offered by LCACs. In such circumstances, it may be preferable to use traditional utility landing craft (LCU) and smaller vehicle and personnel ones (LCVP), which can have a higher payload than the comparable LCACs.[11] The use of LCUs and LCACs(M)/(H) will require the LPA to have a fairly large well-deck.

In view of its size, operational importance and number of embarked personnel, the LPA must be able to defend itself against air, surface and missile attacks. This is particularly true given that it is unlikely to have many, if any, heavily armed escorts to protect it once it enters Arctic waters and that an authoritarian adversary's forces could start shooting based simply on their leader's whim.

It might seem that any ship capable of meeting all of these criteria would be unaffordable for Canada. However, I believe that HNLMS *Johan de Witt* LPD in the navy of the Netherlands offers a valuable starting point for assessing the LPA's feasibility. *Johan de Witt* is a fairly typical modern LPD, which emphasizes, however, helicopter operations to a degree uncommon for such vessels.[12] It has: an aircraft hangar for six medium (or four heavy) transport helicopters with a stern-located flight deck; a large well-deck linked to vehicle parking decks; and accommodation for up to 555 marines. Its key characteristics are described in Table 1. Some of them have been used to quantify representative values for the suggested LPA. While HNLMS *Johan de Witt* is not able to operate in sea-ice, it allows us to consider what can be achieved within an ice-capable hull form that has its length as the starting dimension.

Table 1 makes clear that a very capable LPA could be built inside such a hull. Since *Johan de Witt* is designed for amphibious operations, an LPA based on it should not have any problem supporting the envisioned quantity of marine infantry. As well, the vehicle deck(s) that are part of its design could provide a reconfigurable space that would facilitate the accomplishment of the LPA's four roles. Some alternative uses of these deck(s) include: marine infantry training areas; additional aircraft hangar space; and austere berthing for evacuees for short voyages. The optimum configuration of the vehicle deck(s) to meet all of their possible uses should be investigated using operational research.

Overall, it is clear that LPAs that match *Johan de Witt's* key characteristics would be very valuable, multi-purpose crisis response assets for Canada. It seems certain, though, that in the current circumstances they will probably never be purchased. This is due to: the massive costs of the COVID-19 pandemic; the government's current defence

Credit: Corporal Parker Salustro, Canadian Armed Forces

Canadian Armed Forces members at an observation post in Nunavut during ***Operation Nanook-Nunakput****, 20 August 2022.*


Credit: Lieutenant Miguel Moldez, Joint Task Force (North), Canadian Armed Forces

Land task force members make their way across the Arctic tundra during ***Operation Nanook-Nunalivut****, 24 February 2022.*

focus on the Russian-Ukrainian war; the impending huge costs of the F-35 fighter purchase and the Canadian Surface Combatant (CSC) program; the federal bureaucracy's finite capital equipment procurement capacity; the backlog at the National Shipbuiding Strategy (NSS) shipyards; and the pressure from numerous, existing, distant-future-funded equipment projects.

However, these circumstances could be changed by the current, or a future, government. For example, the simple decision to emphasize coastal (Arctic) defence more than has been traditionally the case, and thus to rethink/downsize the CSC program, could free up the large sums of money needed for the LPAs, and their supporting Cyclones and LCACs, as well as the necessary shipyard capacity. Given that no one can foretell the future, let alone what successive Canadian governments will choose to do over time, the CAF and RCN should undertake now the operational research and other analysis needed to produce an LPA concept of operations and a statement of operational requirement. Provided with these documents, and other information, the CAF and RCN would be in a good position to present a convincing LPA proposal to the government should circumstances require it. Assuming that this effort has been made, an initial LPA capability could be deployed 10-15 years after the government has given its authorization.


Credit: Timothy Choi

The fitness facilities on HMCS ***Margaret Brooke****. Similar facilities would be required to help future shipboard troops maintain their fitness levels.*

Canada's Arctic sovereignty will be challenged sooner or later. Naval presence task groups built around Arctic-capable amphibious ships will be an essential part of Canada's response to such challenges, as they will afford the ability to deploy to a crisis area and remain there for lengthy periods to contain, and even confront, Arctic intruders. Given the distances involved and paucity of on-site Canadian capabilities, these presence forces must be very capable and multi-faceted. LPAs, such as described here, would provide the critical element of such task groups. They would also offer the ability – currently lacking – to undertake other roles, including some peacetime ones, that should enjoy strong public support.

Notes

1. The author would like to thank Guy Lavoie for his editorial advice.
2. Major (Ret'd) Les Mader, "Reviving the Princes: Some Thoughts on a Canadian Standing Contingency Task Force," *Canadian Military Journal*, Vol. 7, No. 2 (Summer 2006), pp. 57-64.
3. For example, Major (Ret'd) Les Mader, "A Suggestion for an Intermediate Level of Arctic Amphibious Capability," *Canadian Naval Review*, Vol. 16, No. 1 (2020), pp. 33-34.
4. For some insights into these operational conditions, see Edward Hampshire, *The Falklands Naval Campaign 1982: War in the South Atlantic* (Oxford, UK: Osprey, 2021); and Douglas C. Dildy and Pablo Calcaterra, *Sea Harrier FRS 1 vs Mirage III/Dagger: South Atlantic 1982* (Oxford, UK: Osprey, 2017).
5. See Major (Ret'd) Les Mader, "3rd Special Service Force: A Paratroop/Marine Infantry Arctic Contingency Force for Canada?" *Canadian Army Journal*, Vol. 19, No. 2 (2021), p. 70 for a discussion of these other forces.
6. For further discussions of the non-combatant evacuation, HA/DR and sealift roles, see: Mader, "Reviving the Princes"; David Dunlop, "Strategic Canadian Amphibious Sealift Capability," *Canadian Naval Review*, Vol. 13, No. 4 (2018), pp. 10-15; and Brian K. Wentzell, "A Necessary Capability," *Canadian Naval Review*, Vol. 8, No. 4 (2013), pp. 31-33.
7. See Colonel (Ret'd) Brian K. Wentzell, "Arctic Amphibious Capabilities for Canada?" *Canadian Naval Review*, Vol. 15, No. 2 (2019), p. 37 for one possible task force structure.
8. This number is based on a Cyclone being able to carry up to 22 passengers depending on their equipment and the weather. Lockheed Martin, "CH-148 Cyclone Canada's Maritime Helicopter."
9. Mader, "Reviving the Princes," p. 62.
10. See Major (Ret'd) Les Mader, "Hovercraft for the Royal Canadian Navy," *Canadian Naval Review*, Vol. 18, No. 1 (2022), Table 1, for a discussion of these types.
11. See Edward Hampshire, *British Amphibious Assault Ships: From Suez to the Falklands and the Present Day* (Oxford, UK: Osprey, 2019), p. 10.
12. Neither the British *Albion*-class of LPDs nor its precursor *Fearless*-class has an aircraft hangar, although they can carry and support helicopters on their flight deck. *Ibid*., p. 22; and Royal Navy, "Albion Class Landing Platform Dock."

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Making Waves

[Note: The commentaries included in Making Waves represent the opinion of the authors.]

The Harry DeWolf-class Vessels in Hostile Environments

Kevin Wang and
Acting Sub-Lieutenant HengLiang Wu*

The commissioning of the *Harry DeWolf*-class Arctic and Offshore Patrol Vessels marks a renewed effort by the Royal Canadian Navy (RCN) to re-establish its operational capabilities in the Arctic region, where sovereignty disputes and resource competitions have the potential to increase.

According to the government, the *Harry DeWolf*-class ships have the following tasks:

- Provide increased presence and conduct surveillance operations throughout Canada's waters, including in the Arctic;
- Support Canadian Armed Forces (CAF) sovereignty operations;
- Participate in a wide variety of international operations, such as anti-smuggling/piracy or international security and stability;
- Contribute to humanitarian assistance, emergency response and disaster relief domestically or internationally;
- Conduct search and rescue and facilitate communications among other ships;
- Support CAF core missions including capacity building in support of other states; and
- Support other government departments to enforce their respective mandates.[1]

The ships should be well able to fulfill these tasks. But there has been some concern about the lack of armament on the ships. The authors propose additional armaments to the vessels. This is not done because of concern about direct confrontations in the Arctic, but because of concern about a shortage of deployable combat vessels after the retirement of the *Halifax*-class frigates. The armament program proposed here would separate the *Harry DeWolf*-class into two types with different levels of firepower and protection, intended for different mission types ranging from peacekeeping to combat support for the frigate fleet.

Despite the delays and budget over-runs that have become synonymous with the Canadian procurement process, it has been a great joy to see the new *Harry DeWolf*-class (HDW) Arctic and Offshore Patrol Vessels entering service in the RCN. The addition of modern vessels to the RCN fleet will emphatically increase Canadian presence in the Arctic, fulfilling their purposes of sovereignty patrol, surveillance, presence and search and rescue in the North.

The Canadian Arctic is a vast area of great strategic importance, both financial and geopolitical, and is known to possess large deposits of natural resources and rich fishery resources. The federal government has passed a variety of laws governing conduct in the marine environment

Credit: Cpl. Kuzma, Canadian Armed Forces

*HMCS **Margaret Brooke** fires its 25mm gun during gunnery exercises off the coast of Cape Breton, Nova Scotia, 3 August 2022.*

Credit: Sgt. Ghislain Cotton, Royal Canadian Navy

*The **Halifax**-class frigate HMCS **Vancouver** fires its MASS decoy launcher on 14 July 2022 during RIMPAC 2022 in the Pacific Ocean. The authors argue that similar decoy systems could be fitted onto the **Harry DeWolf**-class ships to enhance defensive capabilities.*

of the North, from pollution control to fishing and resource extraction. However, the government has had little capability to enforce these laws. There are many examples around the world illustrating that government policies can be disregarded in the face of the near impossibility of enforcement. To prevent this from happening in the Arctic, the new patrol vessels will provide robust capabilities to enforce, for example, the 2016 ban of oil and gas drilling in the region. The legacies of the Cold War have also driven home the critical role of the Arctic in the strategy of nuclear warfare.[2] Amidst rising global tensions and increasingly hawkish foreign policies, the commissioning of the HDW-class is certainly well timed. The HDW-class also complements Defence Minister Anita Anand's March 2022 announcement of a plan to release a "robust package" to modernize NORAD.[3]

Although there are few reasons for Canada to escalate the current administrative disagreements in the Arctic, such as the one in the Beaufort Sea, into sovereignty conflicts, the possibility of unilateral actions taken by other parties against Canada cannot be ignored. The protection and proper management of the Canadian Arctic will be closely associated with the trajectory of this country for the decades to come. However, given the anticipated retirement of the *Halifax*-class frigates in the 2030s and the distant commissioning date of the Canadian Surface Combatants, there will likely be a capacity gap in the RCN in its combat-oriented role. It would be a best-case scenario if this capacity can be filled, even if only temporarily, to deter any attempts of aggression. Hence, this article outlines improvements for the HDW-class such that it would operate more efficiently with Canadian frigates and be more capable to perform its current duties.

It is important to acknowledge the roles of the HDW-class within the RCN. The ships were designed as patrol vessels, which means a main purpose is to observe. Some may argue that an organic boarding enforcement capability is readily available, but such is not the case when the RCN is operating alone – which would likely be the case in Canadian sovereignty patrols, and the ships are expected to commit to single-ship missions. Furthermore, the HDW-class vessels were designed to specialize in Arctic operations, hence the Polar Class 5 icebreaking capability. However, as mentioned above, due to the coming retirement of the *Halifax*-class frigates, the roles of the HDW-class may need to be expanded from observation to a combined observation-enforcement stance to enable the RCN to fulfill its mission of generating a combat-capable, multi-purpose maritime force while the Canadian Surface Combatants (CSCs) are built and commissioned.

In their current state, the HDW-class vessels are armed in such a way that renders them only capable for patrols. They do not have the means to assist the RCN frigate fleet in any meaningful combat-related role, nor can they fulfill any part of the mission spectrum currently covered by the frigates. For example, an HDW-class vessel would be limited in its capacity to evict a foreign counterpart, such as a Russian Project 23550 patrol ship armed with an AK-176 MA naval gun and eight 3M-54 Kalibr missiles. The Russian ship not only out-guns the ships but also leaves

them with no effective countermeasure against missiles. The lack of any close-in weapon system (CIWS) and decoy systems would prove a major obstacle in expanding the mission spectrum for the HDW-class.

Aside from any Russian ships, the HDW-class is also under-armed compared to NoCGV *Svalbard*, the Norwegian Coast Guard ship upon which the class is based. Although it has a similar speed to the HDW-class, *Svalbard* is armed with a Bofors 57mm naval gun, larger and more effective in a within-visual-range combat situation than the 25mm Bushmaster chain gun aboard the Canadian version. The Bushmaster chain gun has proven effective in combat against soft targets on land and small watercraft, but it is questionable if it would be useful against any ships larger than 200 tons in displacement. Furthermore, *Svalbard* is capable of being armed with a Simbad surface-to-air missile. No such equivalent can be found aboard the HDW-class vessels.

The question of the utility of the HDW-class could be raised in terms of its participation in a variety of operations. If the only combat-related task in which the ships would ever participate is counter-narcotics operations – such as *Operation Caribbe* – it may be argued that no modification is required. However, this is not necessarily the case. Proven to be high-sea capable, they may be tasked to undertake patrols in the Mediterranean, or off the coast of West Africa. Thus, self-protection capabilities may warrant reconsideration.

In the spirit of increasing survivability in frigate-supporting roles with minimal engineering work, the authors propose the following considerations. The bow deck gun position, currently occupied by the Bushmaster, should be replaced by a naval gun of larger calibre, such as an OTO Melara 76mm or a Bofors 57mm. The Bushmaster should be retained and moved to a secondary firing position at the stern to achieve a 360-degree firing arc with the bow armament. The authors believe the possibility of installing a CIWS system on every HDW-class ship is slim because it is expensive and may require extensive engineering work. Instead, it is more advisable to install a BAE Shield Mark 2 decoy launcher on the ships for defensive purposes. It is further suggested that a heat-seeking surface-to-air missile system be installed, such as the Crotale, on half of the HDW-class fleet. The Crotale has been successfully implemented on F67-type frigates of the French Navy and is capable of intercepting both aircraft and missiles.

To reduce cost of equipment acquisition, the upgrade work of each HDW-class vessel could be conducted simultaneously with the decommissioning of a *Halifax*-class frigate. During this process, any weapons systems from the frigate, such as the Bofors 67mm Mk3 gun, could be reinstalled in a HDW-class vessel, thereby avoiding unnecessary purchase of new equipment.

This would lead to two types of ships in the class: the patrol type; and the enforcement type. The patrol type would primarily be tasked with routine patrols within immediate cover range of the Royal Canadian Air Force (RCAF) and would assume a strictly observation role, such as inspection of merchant vessels. The enforcement type, armed with the additional short-range anti-air anti-missile capability, would cruise outside of the immediate coverage of RCAF fighter aircraft. The ships could take on greater roles including presence in a combat-supporting or peacekeeping scenario, as they would be more capable of protecting themselves. Some examples of relevant situations include the operation in 2011 following UN Security Council Resolution 1970 in relation to the situation in Libya, and the UN maritime task force which has been deployed since 2006 to support the Lebanese Navy

Table 1. Two Types of HDW-class Arctic and Offshore Patrol Vessels

Type	Armament addition	Minimum estimated cost/time *(All figures are per ship; for cost calculations see Table 2)*	Deployments
Patrol	1 >50mm calibre main gun 1 anti-missile decoy system	6.5 million CAD in total cost 3-6 months of engineering work	Any patrols in the Americas, or within RCAF fighter radius of action (537 km for CF-18). Not for anti-submarine warfare (ASW) missions.
Enforcement	1 >50mm calibre main gun 1 anti-missile decoy system 1 short range surface-to-air missile system	20.5 million CAD in total cost 6-9 months of engineering work	Any patrols and low intensity combat missions involving possible aerial threats. Not for ASW missions.

Table 2. Cost of Modifications

	Patrol Type	Enforcement Type
Material Costs (CAD)		
OTO Melara 76mm or Bofors 57mm	33.85 million (M) (None if reinstall guns from retired *Halifax*-class ships) (1)	
BAE Shield Mark 2	(None if reinstall systems taken from *Halifax*-class's FELEX program)	
Crotale missile system	—	10 M (2)
Ancillary systems (Estimate)	1 M	3 M
Installation Costs (CAD)		
Design costs (Estimate)	0.5 M	0.5 M
Engineering costs (Estimate)	5 M	7 M
Total Cost	6.5 M	20.5 M

Sources: (1) "Israel – 76mm Naval Gun and Technical Support," Defense Security Cooperation Agency, 28 April 2017; (2) Crotale (missile), from https://en.wikipedia.org/wiki/Crotale_(missile).

in monitoring its territorial waters and building naval capabilities.

In short, the goal of enforcement-type HDW-class modifications is to resemble the combat effectiveness of a frigate for within-visual-range combat situations and be able to achieve a positive operational outcome should a low-intensity engagement take place. Strategically, this would free up the frigates to be deployed to areas of hotter conflict. Of course, should naval combat be imminent, the HDW-class vessels of both types should strive to remove themselves and be replaced by frigates.

Naturally, upon implementing the modifications to the vessels, the crew will need to be increased, especially in the case of the enforcement type where the surface-to-air missile system will need to be manned by a new professional section. The authors believe that the maintenance crews should always be onboard, but the weapon officers may be drawn from a rotation of specially trained reservists who could accompany the ships for deployment. These reservists would spend their shore training dedicated to the specific weaponry concerned and ideally would need no additional technical training at the time of boarding.

In addition to the concerns about crewing, there are also concerns about the cost of modifications. The estimated costs are outlined in Table 2.

In conclusion, the commissioning of the *Harry DeWolf*-class Arctic and Offshore Patrol Vessels is a significant first step to increase Canadian presence in, and surveillance of, the Arctic. It is also a step to keep up with potential opponents and rivals in the Arctic region. Although its original design is to provide observation, surveillance and presence, the class has the capability to widen its operational spectrum to support RCN global missions with some modifications.

The RCN will soon approach a crossroad where its main battle equipment will be retired and replaced. Therefore, it is imperative that RCN forces be prepared when the moment comes, and the modified offshore patrol vessels may be part of the solution.

Notes

* This commentary represents the opinions of the authors. Acting Sub-Lieutenant HengLiang Wu notes that none of the content represents the opinion of the unit/CAF, nor did ideas come from the unit/CAF.

1. Government of Canada, Department of National Defence, "Arctic and Offshore Patrol Ships," no date.
2. See Julian E. Barnes, "Cold War Echoes Under the Arctic Ice," *The Wall Street Journal*, 25 March 2014.
3. See Steven Chase and Robert Fife, "Canada to Unveil 'Robust Package' to Modernize Norad, Defence Minister Anita Anand Says," *The Globe and Mail*, 12 March 2022.

Why Are Canadian Warships so Expensive?

Roger Cyr

Regardless of the type of ship being built for the Royal Canadian Navy (RCN), the ships appear to be more expensive than what other countries are paying for similar ships. Is it because of excessive alterations being made to the original design? Is it because of lack of shipyard capacity? Or it is because the political and bureaucratic process in Canada leads to delays and increases the cost?

Let us look at the Arctic and Offshore Patrol Ships (AOPS) being built by the Halifax Shipyard. The design is based on the Norwegian Coast Guard Ship *Svalbard*. The Norwegian ship is fitted with a Bofors 57mm gun and Simbad surface-to-air missiles. The cost for each of the Canadian version is about $400 million (M) per ship. Yet, it is described as a non-war fighter since it is not fitted with combat systems. Instead, it is fitted with a constabulary gun (M242 Bushmaster) which is used as a close-range defensive weapon to provide protection against attack boats and shore-based targets. The ship has no real naval weapon systems.

In comparison, Russia started constructing the first of

two vessels in its Project 23550 patrol ships in 2016. These vessels are based on the Norwegian *Svalbard* class, and are almost the same length, displacement and endurance. They will also be able to travel through roughly the same depth of ice. However, the Russian vessels will be more heavily armed than the Canadian AOPS, with either a 76 or 100mm main cannon, an anti-missile gatling gun and launchers for eight cruise missiles. There is no cost available for these ships.

The AOPS project was criticized from the start for its high costs. The builder, Irving/Halifax Shipyard, was awarded a CA$288M design contract for the vessel in March 2013.[1] The Norwegians spent less than $100M to design and build the first ship in 2002.[2] Aside from the fact that 20 years have passed, this significant cost differential is attributed to a major Canadian redesign. This redesign took a combat-capable ship design and converted it to a non-combatant by removing naval weapons. Surely Canada could have come up with a naval ship that has more capability, and one that would be able to perform force projection in the Arctic. The original Norwegian version with its combat systems could have been bought off-the-shelf and the ships built in Canadian yards.

There is also the example of the Joint Support Ships (JSS), the RCN replenishment ships being built by Seaspan in Vancouver. The JSS is based on the German *Berlin*-class support ship design. Canada acquired this design and modified it to meet the requirements of the RCN. A proven design was selected, and then it was intensely modified, resulting in a complete redesign. For instance, the original German design has a roll on-roll off (RO-RO) capability for carrying vehicles. The Canadian variant does not have that capability. Instead, the RCN ship will employ a modular pontoon system called a sea-to-shore connector which will allow for the transfer of material, including people, vehicles and supplies ashore, or be modified to create temporary jetties in locations that could not ordinarily support a ship. The cost of the Canadian variant is estimated by the Parliamentary Budget Officer (PBO) at about $2 billion (B) per ship.[3] The PBO questions the high cost, as compared by the German original model. The two Canadian ships will not be operational until 2027, so there may well be an escalation in costs.

Australia has two new replenishment vessels now in service, HMAS *Supply* (commissioned in April 2021) and HMAS *Stalwart* (commissioned November 2021). The design for these ships was based on the Spanish replenishment ship *Cantabria*, and the ships were built in Spain. The cost was AU$1.4B for each of the two ships (CA$1.3B).[4] Is the Canadian version more capable than the German or Australian ships? Does this justify the higher cost?

*HMCS **Margaret Brooke** sails through Canadian Arctic ice during **Operation Nanook** in an image posted on Captain (N) Sheldon Gillis's Twitter account, 20 August 2022.*

The Canadian Surface Combatant (CSC) is the major ship construction project on the horizon, and it is considered the Crown jewel of the National Shipbuilding Strategy. However, it is behind schedule and its cost keeps growing. The project is to acquire 15 frigates to replace the current *Halifax*-class frigates as the backbone of the navy. The ships were originally expected to cost $14B. That figure soon became $26B. Currently, the government estimates the cost of the CSC project could be up to $60B. However, the PBO now estimates the fleet of frigates based on the Type 26 design will cost $77.3B to build, which works out to over $5B for a single frigate. An additional one-year

Credit: Petty Officer 3rd Class Matthew Abban, United States Coast Guard

*HMCS **Margaret Brooke** (right) and Royal Danish Navy HDMS **Triton** lead the respective sides of a naval formation for a photo exercise in the northern Atlantic Ocean during **Operation Nanook**, 6 August 2022.*

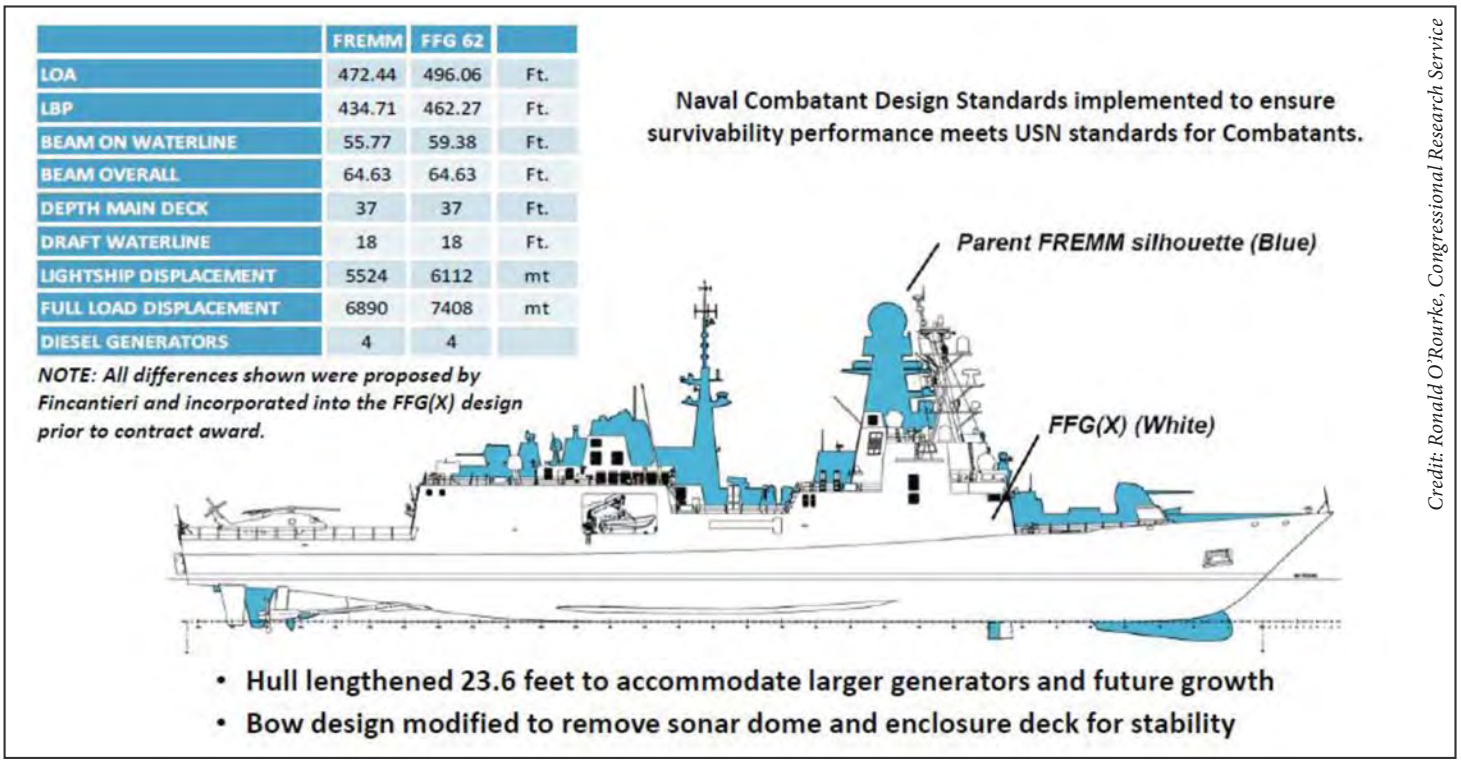
delay would increase the cost to $79.7B and a two-year delay would increase the cost to $82.1B.[5] There certainly are cheaper options in the marketplace today.

Like Canada, the Australian government opted for the Type 26 frigate. In June 2018, the Australian government announced it had tendered the SEA 5000 Future Frigate program. The nine *Hunter*-class frigates will be based on Type 26 Global Combat Ship currently under construction for the Royal Navy. The frigates are scheduled to enter service beginning in the late 2020s. Like the CSC, the *Hunter*-class is billed as an anti-submarine warfare (ASW) vessel. Yet, its cost is predicted to be somewhat less than Canada's. The cost is estimated to be AU$35B (CA$31.5B) for nine frigates, or AU$4B (CA$3.6B) per ship.[6] The CSC, the Canadian Type 26, cost will be over CA$5B per ship. There are no final costs available from the UK since the build is not completed. The Ministry of Defence in the UK envisages that *Glasgow* will enter into service in 2026, but it is attempting to bring this to 2025, with implications for costs.

An option that was available to Canada for its CSC was the Frégate Européene Multi-Mission (FREMM) frigate. It is a class of multi-purpose frigates designed by Naval Group and Fincantieri for the navies of France and Italy. The US Navy selected a FREMM variant as an off-the-shelf frigate for its new *Constellation*-class, to be built by Fincantieri. The USN has awarded Marinette Marine Corporation with the construction contract for 10 Guided Missile Frigates. The contract is for US$6B, or CA$10B, or CA$1B per frigate, five times cheaper than the Canadian frigate.[7] The FREMM frigates will have the capability to conduct air warfare, anti-submarine warfare, surface warfare, electronic warfare and information operations.

In April 2013, the French government showcased the FREMM-class in Halifax with the hope of selling this frigate for the CSC project. Canada's Defence Minister at the time, Peter MacKay, commented "I have never seen such an impressive vessel."[8] In September 2017, a variant of the FREMM was offered directly to Canada. This direct bid included fast-delivery in 2019 for the first ship and a fixed price of $30B for all 15 ships, versus the $77B or more that is now estimated for the Canadian frigates.[9] However, the offer was rejected because of the unsolicited nature of the bid. Accepting the bid, the government stated, would have undermined the competitive procurement process that had been set up. Yet this offer could have produced the 15 frigates for less than half the price they will now cost.

Why is it so expensive to build warships in Canadian yards, as compared to builds in other Western countries? Why are the costs so high when an offshore ship design is built in Canada? Obviously, Canada does not have the mega shipyards that Western states such as the USA, UK, Italy and France have. These countries are dominant in the West in terms of warship design and build. The lead



*The American **Constellation**-class frigates, like the Canadian Surface Combatants, are based on a parent design, in this case the Italian version of the FREMM which will receive some modifications as illustrated in this briefing slide provided by the Navy Office of Legislative Affairs, 18 August 2021.*

shipyards, such as BAE, Naval Group, Austal and Fincantieri, produce a superior design, market it to the world, and build either in their own shipyards or in a yard of the purchasing country. Canada's yards must be content to build on an offshore design that is picked by the government, and substantially modified by the navy.

It would be economically sensible for Canada simply to pick a design that meets operational requirements, stick to it, and have it built in Canada without years of delay. Even the United States, with dozens of mega shipyards, is buying designs and building as is. So, why does Canada not do the same and save billions of dollars?

There are various issues that affect building costs. The timeline must be agreed to before project start and constantly followed, regardless of any interference. It takes decades for a major ship construction project to get from initial approval to actual ship in the water, and it must not be allowed to slip from its schedule. There has to be a realistic budget allotted to the project. The operational requirement for the project must be clearly defined. If an offshore design is to be sought, then it must completely meet the requirements. A design should be selected that meets Canadian naval mission requirements and then proceed to build. The temptation to redesign to make it fit Canadian whims must be resisted. The building phase should take place where it is most cost-effective. And, finally, the entire procedure for major procurement projects is in serious and urgent need for an objective review, without any political interference.

Notes

1. Emerald Bensadoun, "Ottawa Announces $288-million Contract for Irving to Design Arctic Patrol Ships," The Canadian Press, 7 March 2013.
2. "Canada's Arctic Patrol Ships: A $250M Mystery," CBC News, 13 May 2013.
3. Office of the Parliamentary Budget Officer, "PBO Pegs Total Cost of the Navy's Joint Support Ship Project at $4.1 billion," 17 November 2020.
4. Australia, Minister for Defence Peter Dutton, and Minister for Defence Industry Melissa Price, "HMAS Stalwart Joins the Royal Australian Navy Fleet," Joint Media Release, 13 November 2021.
5. Office of the Parliamentary Budget Officer, "The Cost of Canada's Surface Combatants: 2021 Update and Options Analysis," 24 February 2021.
6. "SEA 5000 Hunter Class Future Frigate," *Defence Connect*, no date.
7. David B. Larter, "Here's the Latest on the US Navy's New Constellation-class Frigate," *Defense News*, 12 January 2021; David B. Larter, "5 Things You Should Know about the US Navy's New Frigate," *Defense News*, 5 May 2020.
8. "FREMM Visits Halifax," *Frontline Defence*, 15 May 2013.
9. David Pugliese, "Liberals Reject Warship Proposal that Companies Said Would Save Taxpayers as Much as $32B," *National Post*, 5 December 2017.

Maintaining Seal Integrity on Warships

Chloe Barker and Daniel Dobrowolski

Warships have great operational pressures placed on them and are intended to cope with conditions and environments far more extreme than commercial vessels. Failure in these conditions can have catastrophic consequences. Due to their unique requirements, a lack of regular comprehensive servicing and high-quality maintenance can rapidly cause a warship to deteriorate, endangering naval operations and lives. Preventative maintenance is imperative for

Credit: Maersk Line, via Danish Maritime Accident Investigation Board

Sea water entered from the propeller shaft tunnel into the main engine room via burst cable penetration sealings in the bulkhead, viewed from the port side of the engine room of the containership ***Emma Maersk*** *on 1 February 2013.*

ship security, and an aspect of this – the maintenance of weather-, water- and air-tight seals – is woefully underestimated in terms of safety at sea.

As one of the main causes of vessel loss is sinking, the maintenance, testing and monitoring of watertight hatches, doors and multiple cable transits on vessels is essential. A watertight hatch cover is designed to prevent the passage of water in either direction. Many mariners may think hatches are robust, monolithic structures, but they fail to appreciate the small tolerances on panel alignment and gasket compression that affect watertight integrity. It is better to think of hatches as complex, finely made structures, to be handled with care. All types of seals experience stresses as part of their operational lifetime. For example, 4mm wear on the steel-to-steel contact is sufficient to damage rubber sealing gaskets beyond repair, and 5mm sag along the cross-joint can cause a large gap between the compression bar and gasket. These tiny gaps or sags can have major implications if water is pressing against the structures. Continually maintaining seal integrity should take a more prominent position in ship maintenance scheduling.

Ineffective seals surrounding cable transits are a particular problem. The International Association of Classification Societies (IACS) Z28, which came into effect in 2021, requires that all offshore structures must keep a log of all the Multiple Cable Transits in the structure, referred to as a Cable Transit Seal System Register.[1] This must include information on each cable transit installed, the certification and instruction, drawings and other relevant information from the manufacturer on the seal itself. It must also include inspection information and details of any subsequent repair or modification made to the cable transits.

The case study of container ship *Emma Maersk* exemplifies the danger of improper installation of cable transits. A severe leakage occurred on the ship in February 2013 when it was loaded with 14,000 containers. The leakage was caused by the mechanical break-down of a stern thruster, causing the shaft tunnel to flood, as well as leading to ingress of water in the aft part. This led to flooding of the main engine room. This was caused by non-effective cable penetration sealings. Four cable penetration sealings in the watertight bulkhead gave way to the water pressure leading to a massive ingress of sea water. Shortly after this, the other three cable penetration sealings also failed, resulting in an even larger ingress of water into the engine room. This led to approximately USD $45 million worth of damages and towage cost.

Traditional methods of testing seals – chalk and hose testing – are inefficient for warships. During chalk testing, chalk is applied to the compression seals and the hatches are closed, sealed and reopened. Any irregularity in the chalk pattern implies that improper sealing is occurring in that section. This type of testing is ineffective, as even if seals are touching there is no way of indicating if there is sufficient pressure between them to create a complete seal. Chalk testing also cannot be performed on cable transits or air vent seals which cannot be easily opened and closed manually (or at all).

During high pressure hose testing, a surveyor is present inside the hold. A jet of pressurized water is aimed all the way round the hatch-cover. Any water ingress which occurs will be seen by the surveyor. This test is time-consuming and inefficient. It requires two crew members for testing and significant clean up. Hose testing provides almost no indication of the severity and/or location of leaks, and provides no recordable, verifiable readings and ecological concerns have been raised concerning polluted run off.

A third method of checking seals has been developed

A device is used to detect leaks through a watertight hatch using ultrasound.

– Ultrasonic Technology (UT) – and is being rapidly adopted as a safe, easy and accurate method of identifying seal leak sites. It has now been in service for 10 years in the Royal Navy to identify any incorrectly installed cable transits. This technology is also being utilized by the Canadian Coast Guard and Department of Fisheries and Oceans.

Using UT, the exact location and severity of leaks in seals can be identified. This is more efficient than high pressure air or water tests, and is both more accurate and cheaper. The most advanced watertight quantifiers can be stationed onboard, and used as a digital storage and inspection platform, allowing vessels to comply with Z28, and to record and export water flow rate data.

At the cutting edge of ultrasonic quantification instruments is the capability to calculate the water flow rate through structures in the event of compartment flooding, in order to enhance damage control and safety and survivability in warships and submarines. This has been developed with the purpose of contributing to the internal 'damage control battle' of naval warships to save the ship at the moment of damage. The system is designed to be used to identify, measure and remedy potential leak sites in and around vehicle-carrying compartments, crew compartments and the engine compartment. Ultrasonic quantifiers can measure the leak area during inspection and calculate the total flow rates of water which would enter the ship under different water pressures and sea states. This gives a unique ability to quantify the risk to specific areas in a structure.

Models of equipment vary, but in general UT equipment consists of two main units – a generator and a receiver. The generator produces an ultrasonic modulated tone, usually at a frequency of around 40kHz, and is positioned on one side of the seal. The receiver is then used by the operator from the far side of the closed seal. If at any point the seal is imperfect, the ultrasonic signal will be able to pass though the seal via the air leak, and be detected by the receiver. If there is no imperfection, then the ultrasound will reflect from the structure and no detectable signal will penetrate.

Some models of ultrasonic watertight integrity testers are capable of detecting leak apertures as small as 0.06± 0.02mm in size and recent advances in technology have shown that it is possible accurately to quantify the cross-sectional areas of leaks as small as 0.5mm in diameter. The most advanced ultrasonic instruments are therefore able to give readouts in terms of percentage of ultrasound penetrating, acoustic pressure level in decibels, cross-sectional leak area in square millimetres (or inches), and flow rate of sea water in cubic metres (feet) per hour.

Use of UT is far more efficient than the alternative methods, taking less time, requiring no clean up and requiring only a portable, light-weight model for ease of use. Due to their convenience, UT tests can be conducted more frequently and can contribute to safety management and preventative maintenance procedures onboard, in all sea conditions. Moreover, the accuracy of this method is unrivalled, and leak sites can be identified and located quickly by the operator. Furthermore, ultrasonic indicators use safe and green technology that does not violate any environmental codes, which also means there are no International Air Transport Association (IATA) transportation restrictions.[2]

Seal integrity has been shown to be of vital importance to all marine vessels, but it plays a very significant role for warships that are subject to especially harsh and sensitive conditions. The importance of continually maintaining seal integrity has been undervalued, and should take a more prominent position in ship maintenance scheduling. Traditional means of integrity testing are insufficient, putting crew members and marine operational activities at risk. Ultrasonic technology is leading the way as the most practical and accurate form of leak site detection and seal testing.

Notes

1. Note that this applies to warships as well.
2. The IATA is an *air* transport association but the concern is that some technologies were radioactive and therefore banned by IATA, which meant that it was very difficult for them to be supplied globally and into the military.

A View from the West:

Growing Sino-Russian Cooperation Complicates Japan's Security Horizon

Brett Witthoeft*

The announcement of Russia and China's 'no limits' partnership, mere weeks before Russia's latest invasion of Ukraine and bolstered by China's support for Russia, has created concern of continent-spanning collaboration between the two anti-Western states. While Russia's military and geopolitical focus has clearly been in Europe during its war on Ukraine, Moscow is still devoting energy to its eastern flank. Thus Russia is continuing and even expanding military cooperation with China in the northern Pacific Ocean.

In October 2021, the Chinese and Russian navies conducted their inaugural joint patrol of the western Pacific Ocean, demonstrating the determination of Beijing and Moscow to "maintain peace and stability in the Asia-Pacific region and also protect … maritime economic activity."[1] While their joint exercising in Asia was not new – they began the Peace Mission anti-terrorist drills in Vladivostok in 2005, and have conducted the Joint Sea Exercise series since 2012 – this was the first instance in which the Russian Federation Navy (RFN) and People's Liberation Army Navy (PLAN) together transited the Tsugaru Strait separating the Japanese home islands of Hokkaido and Honshu. In June 2022, the two navies continued their pressure – albeit in separate groups – with the RFN circumnavigating Japan, including sailing near the southern end of Japan near Taiwan. The purpose of this Sino-Russian cooperation was confirmed in July when the two countries agreed to increase their "strategic deterrence against Japan," including notifying each other about their maritime activities near the Senkaku/Diaoyu (Japanese/Chinese name) and Kuril Islands, both of which have contested ownership with Japan.[2]

These bilateral efforts have reawakened Tokyo not just to the Russian threat itself, but the challenge that an unfriendly – if not outright hostile – China and Russia partnership would pose as they work together to complicate Japan's maritime environment. For example, Tokyo is embroiled in a dispute with Beijing for control of the Senkaku Islands, and Russia's cooperation with China in the area would increase the challenges for Japan.[3] The Japanese Ministry of Defense took notice of this growing danger in its 2022 defence White Paper, noting that Russia can now be considered an "aggressor nation" and that its cooperation with China near Japan is now a significant concern.[4]

It was not always this way. Japan downgraded the Russian threat in its defence White Papers in the aftermath of the Cold War. Japan characterized Russia as a threat until 1992, then changed it to a "factor of instability" until 1996 when Tokyo began to view Moscow as a potential security partner.[5] Japan remained optimistic about potential cooperation with Russia until 2008 when its defence White Paper noted that Russia was rebuilding its military power.[6]

Russia's 2014 annexation of Ukraine's Crimea region caused Japan to pay more attention to Russia but, even so, the 2015 defence White Paper noted an increase in Russian military activities but did not sound the alarm.[7] Japanese concern increased in 2017 with Russia's deployment of troops and missiles to the Kuril Islands, and again in 2019 over Russia's large-scale Vostok Exercise. Japan's attention, however, remained firmly (and, arguably, correctly) fixed on China, and the possibility of Sino-Russian cooperation was only raised in 2021.[8] It took Russia's outright war on Ukraine and joint manoeuvres with China to convince Japan that Russia is again a significant threat.

For its part, Russia had little reason to raise the security temperature on Japan. Bilateral relations and business were cordial but underwhelming, with Russia providing

Credit: Japan Ministry of Defence

*A PLAN Type 054A frigate (left) sails with a Russian **Stereguschiy**-class corvette as part of a task force off the northern coast of Japan on 4 September 2022.*

Credit: Japan Ministry of Defence

*A Russian **Udaloy**-class destroyer is photographed by a Japanese Self-Defence Force aircraft off southern Japan on 19 June 2020.*

Japan about 10 per cent of its oil, natural gas and coal in exchange for cars and parts, worth about USD $15 billion in 2020.[9] The most challenging bilateral issue relates to the Kuril Islands, which Japan claims but Russia controls. Negotiations effectively ended in 2020 after Russia made it illegal to give up any of its territory to a foreign state.[10]

The lukewarm relations between Russia and Japan changed when Japan imposed unprecedented sanctions on Russia for its invasion of Ukraine and expelled Russian diplomats. This strong reaction came as Japanese Prime Minister Kishida has drawn comparisons between Russia's aggression against Ukraine and a potential Chinese invasion of Taiwan, a key Japanese security interest.[11] Now Moscow has incentive to push back against Japan, and likely sees the value in cooperating with Beijing to complicate Tokyo's maritime security environment.

As it stands, Russia's ability to play the spoiler against Japan at sea is somewhat limited. The RFN's Pacific Fleet is one of two commands that feature nuclear-powered submarines, including new *Borei*-class ballistic missile submarines (SSBNs), that ensure a second-strike capability, and it has a notable number of surface warships and submarines to protect that leg of the nuclear triad. The Pacific Fleet also makes regular shows of strength to highlight Moscow's reach into the Pacific, especially amid the strain of the Ukraine war, such as a 40-plus-ship exercise in early June. However, in many ways the Pacific Fleet is less than it seems. Aside from the handful of nuclear boats and smaller surface warships, its ships hail from the 1980s and 1990s, which limits how much of a challenge they pose to the Japan Maritime Self-Defense Force (JMSDF), although joint actions with Russia's shore-based weapons could at least bloody the JMSDF's nose. Russia's ambitions for the Pacific are outlined in its July 2022 maritime doctrine which sets the goal of developing Russia's Pacific marine resources and increasing naval forces there to protect regional wealth.[12] This involves posting newer *Gremyashchiy*-class corvettes, upgraded *Udaloy*-class destroyers and *Yasen-II* land-attack submarines to the Pacific. While the RFN in the Pacific is a work-in-progress for now, Moscow is serious about rebuilding its Pacific Fleet into a potent regional force.

Despite the JMSDF currently having number and technological advantages over the Russian Pacific Fleet, the RFN's joint operations with the PLAN create the potential to divide Tokyo's resources. Thus, Japan's naval forces would need to focus north even as China creates increasing challenges in the East China Sea and south near Taiwan. The United States could similarly have its attention stretched because, while Washington remains focused on China in the maritime arena, Japan's security concerns about Russia and the US-Japan mutual defence treaty could force Japan to demand an American response.

While the East and South China Seas continue to be the main flashpoints in the Indo-Pacific region, the 'no limits' partnership between Russia and China heading out to sea is also worth watching. ⚓

Notes

* The views expressed in this article are those of the author, and do not reflect the policies of the Royal Canadian Navy or the Department of National Defence. The author would like to thank Dr Michael Petersen, Director of the Russia Maritime Studies Institute at the US Naval War College, for his input on this article.

1. Vasco Cotovio, "Russia and China Hold First Joint Patrol in the Western Pacific, Russian Defense Ministry Says," CNN, 23 October 2021.
2. "China, Russia Apparently Agree to Boost Surveillance around Japan," *Kyodo News*, 7 July 2022.
3. One headline by Japan's *Kyodo News* summarized Japanese anxieties, stating "Chinese Warship Chases Russian Frigate near Japan-controlled Senkakus," which highlighted potential China-Russia coordination in which China increases its administrative claim to the Senkakus by driving a Russian warship from the waters. "Chinese Warship Chases Russian Frigate near Japan-controlled Senkakus," *Kyodo News*, 4 July 2022.
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6. Ministry of Defense, Japan, "Defense of Japan 2008," p. 3.
7. Ministry of Defense, Japan, "Defense of Japan 2015," p. 3.
8. Ministry of Defense, Japan, "Defense of Japan 2021," p. 20.
9. The Observatory of Economic Complexity (OEC), One World, "Japan-Russia Economic Relations," 2020.
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11. Tsuruoka Michito, "Why Japan is Getting Tough on Russia Now: Kishida's Response to the War in Ukraine has been Surprisingly Robust," *The Diplomat*, 3 June 2022.
12. Ministry of Defence, Russian Federation, "Maritime Doctrine of the Russian Federation," 31 July 2022, pp. 21-22.

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Dollars and Sense: The 2022 Canadian Defence Budget Increases

Dave Perry

The new strategic circumstances created by Russia's invasion of Ukraine on 24 February 2022 are quickly reshaping Canadian defence. Within four months of the invasion, the government of Justin Trudeau had already made two multi-billion dollar defence spending increases while pledging a second review of Canada's defence policy which may increase spending further. Between Budget 2022 and the 20 June announcement by the Minister of National Defence of a package of continental defence modernization initiatives, along with some previously identified funding, just under $40 billion on an accrual basis has been added to the budget of the Department of National Defence (DND) over the next 20 years.

Expectations for an increase in defence spending ahead of Budget 2022 were higher than any other budget in recent memory. Russia's invasion of Ukraine created more interest in defence and security issues in the span of a few weeks than Canada had experienced in years. In March Prime Minister Trudeau gave the impression that the invasion had made his government "open to raising Canada's military spending."[1] Speculation ratcheted up even further when the Minister of National Defence stated in an interview that "I personally am bringing forward aggressive options which would see, potentially, exceeding the 2% level, hitting the 2% level, and then below the 2% level."[2] It was unusual language for a Cabinet Minister ahead of a budget, but fit with the tenor of discussion from many NATO countries at the time.

The ensuing Budget 2022 delivered a modest increase to defence spending, a promise to review Canada's defence policy, and the government's first expenditure reduction exercise. The budget provided an overall increase of $8 billion (B) (on an accrual basis) over five years to "strengthen Canada's contributions to our core alliances, bolster the capabilities of the Canadian Armed Forces; continue to support culture change and a safe and healthy working environment in the Canadian Armed Forces and reinforce Canada's cyber security."[3] According to data provided by Department of Finance officials, the additional funding would result in an annual increase in spending of 3% in 2022/2023[4] rising to 8% by 2026/2027. With inflation running at a multi-decade high, and many commodities critical to defence production experiencing dramatic cost increases, it is unclear how significant an annual increase the spending will produce once defence-specific inflation is factored in.[5] According to a senior government official, if the anticipated defence spending occurs as forecast and the budget's other assumptions hold, by the end of the budget's fiscal period, defence spending would reach approximately 1.5% of Gross Domestic Product (GDP).[6] The budget itself though, makes no mention of defence spending as a share of GDP, so this should not be construed as a spending target.

A full itemization of that $8B is provided in Table 1. The main areas of spending are: Reinforcing our Defence Priorities; Supporting Culture Change in the Canadian Armed Forces; Enhancing Canada's Cyber Security; Supporting Ukraine; and the Renewal of Operation Artemis. Let us look at that list in reverse order. The extension of *Operation Artemis*, a counter-terrorism and maritime

Credit: Anita Anand's Twitter

Minister of National Defence Anita Anand, Prime Minister Justin Trudeau, Minister of Foreign Affairs Mélanie Joly, and NATO Secretary General Jens Stoltenberg tour the Cambridge Bay North Warning System radar facility on 25 August 2022.

Table 1. Defence Commitments from Budget 2022 (in millions)

	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026	2026/ 2027	Total
Reinforcing our National Defence							
Reinforcing our Defence Priorities		100	1025	1475	1625	1875	6100
Supporting Culture Change	1	38	49	52	53	53	245
Less Departmental Resources	-2	-1					-3
Less reallocation of funding	1	-1					
Enhancing Canada's Cyber Security Addressing the Cyber Threat Landscape	0	88	128	187	223	249	875
Enhancing Canada's Cyber Security Research	0	1	1	4	6	6	18
Supporting Ukraine							
Expansion of Operation Unifier	0	116	112	109			338
Less existing Funds		-5	-2	-2			-9
Bolstering Ukraine's Fight		500					500
Renewal of Operation Artemis	37	43	38	2			120
TOTAL							**8184**

Note 1: Figures are taken from Budget 2022, Chapter 5, table 5.1, 145-146 and as that table indicates, they may not add up due to rounding. Note: The figures for ***Operation Artemis*** *were calculated by the author by subtracting funds sourced from existing departmental resources from the newly apportioned funds.*

security mission in the Middle East was renewed in August 2021, and will cost of $120 million (M) over three years. The defence portion of the support for Ukraine contains two major initiatives. The first is an extension of *Operation Unifier* ($338M from 2022/2023-2024/2025), Canada's military support mission for Ukraine, which has evolved from a focus on training Ukrainian forces to a broader set of activities supporting Ukraine's fight. The second component is $500M in 2022/2023 to provide additional military aid to Ukraine. This money will flow through DND but be used to obtain additional military supplies and provide them to Ukrainian forces, including additional electro-optical systems for Ukrainian drones. The government also announced that Canada would send 39 Armoured Combat Support Vehicles originally purchased for the Canadian Army to Ukraine.[7]

On the cyber front, several initiatives were announced, totalling $875.2M from 2022/2023-2026/2027 to enhance Canada's cyber defences, and $17.7M over the same time period to establish a cyber research chair program. The enhancements to cyber defences include: enhancing the ability of the Communications Security Establishment (CSE) to launch cyber operations to prevent and defend against cyber attacks ($263.9M); improvements to CSE's ability to prevent and respond to cyber attacks on critical infrastructure ($180.3M); funding for CSE to make critical government systems more resilient ($252.3M); and an expansion of cyber security protections for small departments, agencies and Crown corporations ($178.7M).

Support to Culture Change in the Canadian Armed Forces (CAF) includes $144.3M over five years to expand health services and physical fitness to be 'more responsive to women and gender-diverse military personnel.' It also includes $100.5M over six years for a range of initiatives including strengthening leadership in the Canadian Armed Forces, modernizing the military justice system, and engagement and consultation on culture change.

Finally, the most significant funding line in the budget for defence was $6.1B over five years, starting in 2022/2023, for "defence priorities, including our continental defence, commitments to our allies and for investments in equipment and technology to immediately increase the capabilities of the Canadian Armed Forces." Roughly half of this was subsequently identified as funding for continental defence modernization, discussed further below.

Looking forward, the budget also committed to two potentially consequential measures for defence. The first is the Trudeau government's second defence policy review, which will cover "amongst other things, the size and

Flanked by Labrador MP Yvonne Jones and Chief of Defence Staff General Wayne Eyre, Minister of National Defence Anita Anand announces at 5 Wing Goose Bay that it will be one of four northern locations that will be upgraded as part of Canada's NORAD modernization plan.

capabilities of the Canadian Armed Forces, its roles and responsibilities, and making sure it has the resources required to keep Canadians safe and contribute to operations around the world."[8] In her Budget Speech, Finance Minister Chrystia Freeland stated it would be "a swift defence policy review to equip Canada for a world that has become more dangerous."[9] The specific remit of the review is not yet clear, but a senior official indicated that it would be broad and examine the level of funding required to support the full array of Canadian defence commitments.[10]

The 'swiftness' of the exercise is likely subject to interpretation. Further, even if what seems to be an almost entirely internal exercise can be completed quickly, that does not mean the government will rapidly choose and announce its preferred option. At the time of writing in early September 2022, the window to have the exercise concluded in time for inclusion in the 2023 budget cycle was already narrowing considerably.

Finally, of note, the Trudeau government has entered into a period of more restrained fiscal policy. The budget committed to a review of previously announced spending with the objective of "reducing the pace and scale of spending that has yet to occur by up to $3 billion over the next four years,"[11] in other words, spending less than intended on previously announced initiatives. It is also launching a Strategic Policy Review, that aims to save $6B over the next five years, and $3B annually each year thereafter. No details were provided about these plans, but during the last round of expenditure restraint during the 2010s about one-fifth of the overall savings came from DND, proportional to DND's share of government operating expenses.

In June 2022 the Minister of National Defence presented the government's plan for modernizing continental defence, an even more consequential set of spending pledges than the budget. The plan includes investments in five areas: surveillance systems; command and control; advanced air-to-air missiles; infrastructure and support capabilities; and science and technology investments.[12] The funding arrangements for this announcement are complex, so much so that the Chief of Defence Staff indicated in an interview that he did not fully understand them a week after they were announced.[13] The full value of the announcement over 20 years is $38.6B on an accrual basis, comprised of $3B in funding announced in Budget 2022, $8.9B identified in the Fall Economic Statement in 2020, as well as new money.[14]

While the full details of this spending are not yet well understood, and may never be, given how complicated they are, when added to the Budget 2022 commitments, they represent significant new defence spending. Since Russia invaded Ukraine, the government has added approximately $35B in new funding to DND's budget over 20 years: $8.2B in Budget 2022, plus the $38.6B announced in June for continental defence, less the $3B from Budget 2022 and $8.9B in the Fall Economic Statement in 2020 that were included in the continental defence modernization announcement. For the sake of comparison, *Strong, Secure, Engaged* added an extra $53B to the defence budget on an accrual basis over 20 years in 2017. While the Trudeau government has certainly not made it easy to understand what it has been doing with the defence budget, it has increased it meaningfully.

Notes

1. Marieke Walsh, "Prime Minister Justin Trudeau Open to Raising Canada's Military Spending," *The Globe and Mail*, 7 March 2022.
2. Interview with Minister of National Defence Anita Anand, *Power and Politics*, 16 March 2022.
3. Her Majesty the Queen in Right of Canada, Department of Finance, Budget 2022, 7 April 2022, p. 133.
4. The increase for 2022/2023 includes the $500M for military aid to Ukraine. If this is removed, the increase roughly 1.5%.
5. World Bank, "Food and Energy Price Shocks from Ukraine War," Press Release, 26 April 2022.
6. This would also include the spending that occurs outside of the Minister of National Defence's portfolio that is included in the NATO-accepted definition of defence expenditures. This same point was also made in a pre-budget leak to the CBC's Murray Brewster. See "Defence Getting Billions of Dollars in New Money from Thursday's Budget: Source," CBC News, 6 April 2022.
7. Murray Brewster, "Trudeau Promises to Arm Ukraine with Modern Military Equipment," CBC News, 30 June 2022.
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9. Minister of Finance, Chrystia Freeland, "Budget Speech, Budget 2022," Department of Finance, 7 April 2022.
10. Senior Government Official, Media availability, Budget 2022 lock-up, 7 April 2022.
11. Budget 2022, p. 213.
12. Department of National Defence, "Minister Anand Announces Continental Defence Modernization to Protect Canadians," News Release, 20 June 2022.
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Warship Developments:
What Happened to RFS *Moskva*?

Doug Thomas

In my last column I mentioned the loss of *Alligator*-class Landing Ship Tank (LST) *Orsk* from the Russian Black Sea Fleet. At the time of my previous column, there was doubt as to the cause (it was also unknown how Ukraine would fare if it had attacked a Russian surface combatant), but it is now generally agreed that it was due to an attack by Ukrainian forces.

It is now known outside Russia that Russian Federation Ship (RFS) *Moskva*, the Black Sea Fleet guided-missile cruiser and flagship, was hit by two Ukrainian sea-skimming R-360 Neptune anti-ship missiles late on 13 April. They were fired from a mobile launcher on the shore near Odessa, about 65 nautical miles from *Moskva*'s position. The official Russian explanation was the kind of disinformation that we have become used to in recent months. Russian sources have rarely indicated that Ukrainian forces were responsible. The official Russian version is that it was an accident and that casualties were minimal. Russian sources claim that "a fire of unknown origin detonated the ship's stored ammunition and the resulting explosions left the Moskva with structural damage.... [T]he warship then sank amid rough seas as it was being towed to a nearby port."[1]

This large and impressive missile cruiser, the first of a class of three such ships, was 40 years old, and overdue for a major refit to update its weapons and sensors to deal with the modern anti-ship sea-skimming missile threat. To complicate matters for Russia, apparently there were many young conscripts among the ship's complement of about 500. Their ability to contribute to the fighting effectiveness and damage control readiness of the ship would have been limited. Russian authorities state that there was only one confirmed fatality and 27 missing sailors, however actual losses are rumoured to be in the order of 50 per cent.[2] It appears that *Moskva* was a 'paper tiger' – impressive to look at but well-beyond her best-before date!

Shortly after *Moskva* was sunk, a number of retired Indian naval officers commented on the loss. The Indian Navy has had a close relationship with the Soviet/Russian Navy for many years, and has purchased an aircraft carrier, destroyers, frigates and submarines from Russia as well as equipping indigenously-built warships with Russian weapons and electronics. Many individuals had also served in Russian ships while undergoing training, and attended command and technical training courses in that country. One of the commentators toured through *Moskva* during a 2010 port visit to Kochi, India. He noted

A Ukrainian Neptune antiship cruise missile is test fired at an undisclosed location in this April 2019 photo.

that even then the equipment was badly outdated, and that there was very little fire-fighting or damage control equipment in evidence.[3]

According to these commentators, *Moskva* may have been a potent naval platform until about 10 years ago, but in 2022 it was unfit for modern naval warfare. The ship was designed to counter threats to Soviet vessels or aircraft from US Navy or NATO naval forces during the Cold War, and was considered among the best of its type at that time. Unfortunately, time does not stand still.

From this incident we can state that there are a number of elements that go into successfully surviving an attack by sea-skimming missiles:

- Intelligence. Is there a threat? Apparently, the Russians did not believe that Ukraine had operational R-360 Neptune missiles. It is understood that this was its first firing from a land-based mobile launcher.
- Defence in depth. *Moskva* was the best-equipped Anti-Air Warfare Ship in the Black Sea, with a long-range missile capability designed to counter manned aircraft or large missiles. The ship had been employed up to this time in taking possession of Snake Island, firing large SS-N-12 missiles at land targets in Ukraine and conducting radar

Credit: George Chernilevsky, via Wikimedia Commons

*The Russian **Slava**-class cruiser RFS **Moskva** is seen in this 2009 photo in Sevastopol.*

surveillance of the skies over the conflict area between Odessa and the Crimean Peninsula. On paper, *Moskva* had excellent self-defence capabilities however they went unused. Western intelligence reports determined that there were no countermeasures employed against these sea-skimming missiles – no missile firings from the ship's area-air or point-defence missiles, no jamming of missile homing radar, no chaff fired to confuse the incoming missiles, and no engagement of missiles with the ship's many ADMG-630 rapid-fire guns (analogous to the Western Vulcan-Phalanx systems). It would appear that the Neptunes were never detected, or, even worse, all of the systems were unserviceable or unmanned!

- Training in anti-ship missile defence. A modern warship's primary threat, especially in coastal operations such as in the Black Sea, is from anti-ship missiles. There was no excuse for not knowing that the R-360 missile might be used and conducting training to counter it. It was inexcusable to do nothing to counter the attack. It appears that incompetence and lack of training led to the loss of this fine ship and likely hundreds of lives.

Credit: Alina Rakhmanova

*A close-up of the long-range SA-N-6 surface-to-air missile cells on RFS **Varyag**, sister ship to **Moskva**, during a port visit to Vancouver, BC, in November 2012. The seeming failure of **Moskva** to employ any of its anti-air defence systems throws into question the efficacy of the defence suites of other Russian warships.*

Conclusions

What can we learn from the sinking of *Moskva*? Even if we ignore the source of the fire (i.e., whether it was an accident or a missile strike), there were problems with fire-fighting/damage control on the ship and, if the Russian government account is true, the ship clearly had problems with ammunition storage – i.e., ammunition that is safely stored on a ship will not spontaneously explode. This reflects badly on the professionalism of the Russian Navy.

This incident is somewhat reminiscent of the loss of the Argentine cruiser *General Belgrano* in 1982 during the Falklands War. This impressive-looking gun-armed cruiser, a veteran of the US Pacific Fleet in World War II, was over 40 years old and also had many young trainees embarked. It was unable to withstand anti-ship torpedoes fired from a modern British nuclear-powered submarine. It may have been a good basic training platform for the Argentine Navy, but it was no longer an effective warship. This may have also been the case with *Moskva*.

Notes

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2. Tayfun Ozberk, "Analysis: Chain of Negligence Caused the Loss of the Moskva Cruiser," *Naval News*, 17 April 2022.
3. "Indian Naval Officers Reveal Truth about the Loss of Moskva," *The Indo-Canadian Voice*, 17 April 2022.

Book Reviews

Combat at Close Quarters: An Illustrated History of the U.S. Navy in the Vietnam War, edited by Edward J. Marolda, Annapolis, Maryland: Naval Institute Press, 2018, 346 pages, index, photos, ISBN 978-1-682-47195-1 (hard cover)

Reviewed by Ann Griffiths

The recent conflicts the United States fought in Afghanistan and Iraq mainly involved ground forces – naval forces played only a supporting role. This was not the case in the Vietnam War in which the US Navy (USN) played a significant, but little-known, role. If your knowledge of the USN in Vietnam is based on the movie "Apocalypse Now," *Combat at Close Quarters* will be a surprise.

The book was created in part to honour the 2,555 USN sailors who lost their lives in the war, and in part to outline the participation of the USN. It consists of four sections examining different roles the navy played. The sections are written by well-known, well-respected and knowledgeable analysts.

The first section is "Naval Air War: The Rolling Thunder Campaign," by Norman Polmar and Edward J. Marolda. This section discusses the role that the USN shared with the US Air Force – i.e., the bombing campaign Rolling Thunder against North Vietnam. The navy had aircraft carriers stationed off the coast and the USN conducted flights from the carriers. Warships were also responsible for rescuing air force personnel who had been shot down over the water.

The second section is entitled "Green Hell: Warfare on the Rivers and Canals of Vietnam," by Marolda and R. Blake Dunnavent. This is the chapter that will seem most familiar to viewers of "Apocalypse Now." Vietnam has long relied on its rivers – the Mekong is the river we call to mind – for transportation and development, and the river deltas for fertile agricultural land. The United States knew that weapons, supplies, ammunition and personnel were being moved along the rivers from North Vietnam, so riverine patrols were set up to intercept these deliveries. Before departing from Vietnam, the French had set up a Vietnamese Navy, and the US forces (naval and marine corps) utilized, augmented and, at times, replaced these forces. As well, USN boats were used to transport American troops to their mission areas.

The third section is entitled "Nixon's Trident: Naval Power in Southeast Asia, 1968-72," by John Darrell Sherwood. After Richard Nixon was elected President in 1968, the war changed. Nixon wanted peace talks but on his terms. To get this he upped the pressure on North Vietnam. Much of this was from the aircraft flying off the increasing number of carriers in the Gulf of Tonkin, from two up to six in 1972. But there were other USN warships which provided naval gunfire support to troops, and targeted onshore anti-aircraft guns, supply routes and North Vietnamese vessels. Naval units were also involved in mining harbours, especially Haiphong Harbour, to prevent external assistance (particularly Soviet) from reaching Vietnam.

The fourth section is entitled "Knowing the Enemy: Naval Intelligence in Southeast Asia," by Richard A. Mobley and Marolda. Not surprisingly, there were many US intelligence agencies in Southeast Asia at this time – the Office of Naval Intelligence was one of them. The section title is telling because, as the authors point out, despite the many agencies gathering intelligence, the United States did not know the enemy – particularly its willingness to take whatever was given to it, and continue to fight.

The chapters illustrate not just the roles of the naval forces, but also the political battles and difficult interactions between naval leaders in the Pacific, between naval leaders and army/marine leaders about riverine operations, and with political leaders in Washington.

This book is comprehensive and extremely interesting, but it is not an easy book to read. It is a book that has to be read and digested in small pieces. There are many, many details of sorties, ship names, dates, numbers and names which, while interesting, are a bit overwhelming. But it's an important book. As I noted, the role of the USN in the war in Vietnam is not well known, and this fills that gap.

However, while the discussion is precise and detailed, I was disturbed by the single-minded focus on the tactical level. Thus, for example, in the section on the naval air war, the authors discuss the success of missions, defined by bombs dropped, and planes and crews returned safely. Fair enough, that's how a commander would measure success. But by this, anyone reading the book would think the war was a tremendous success. No matter how many bombing runs were successful by this definition, however, the bombing campaign as a whole was a failure, and the authors don't even mention this. Interestingly, only the section on the intelligence agencies examines the operations from the strategic level and admits to failures.

These criticisms may be unfair – after all, the book's purpose is to give a history of the USN in the Vietnam War, and it does so. The best part of *Combat at Close Quarters* by far is the photos. It is full of photos, many of them credited to the Naval History and Heritage Command. I returned to the photos again and again. If the book was created to honour those USN personnel who died, these photos will help to do so.

Canada's Great Naval Battles, Marc Milner, Special Issue of *Legion Magazine* (Winter 2021), Kanata, Ontario: Canvet Publications, 95 pages, $14.95 (softcover magazine), ISSN 1209-4331

Reviewed Colonel (Ret'd) P.J. Williams

This book/magazine is one in a series of special issues of *Legion Magazine* called "Canada's Ultimate Story," which focuses largely on the two world wars and is published by Canvet Publications Ltd. (the publisher of *Legion Magazine*). The contributor of this issue is Marc Milner, one of Canada's foremost naval, indeed military, historians and whose work will be well known to *CNR* readers.

Book-ended by an Introduction and a Conclusion, the work is divided into four parts: The Age of Sail; The British Peace and the Great War; The Second World War; and Postwar to Present. Each part includes a "Profiles" section, giving further details about notable naval figures during this period. As befits a Canadian historical work, the contributions of Indigenous peoples, as well as the British and French, are highlighted in the text. There is also a section on Canadian naval and merchant marine memorials which exist across the country. Finally, for those wishing a deeper dive (pun intended!), there is a list of books on Canada's naval history.

Canada's Greatest Naval Battles is written largely for the lay reader. That said, Dr. Milner does not shy away from myth-busting, and indeed does so almost from the start. It was not, in his view, the Battle of the Plains of Abraham (which itself was preceded by a successful amphibious landing by the British), which shaped Canada's destiny, but rather the Battle of Quiberon Bay, some 5,000 km east, off the coast of France, which was decisive. In that naval engagement, fought some two months after Wolfe's famous battle, the French fleet was destroyed, thus ending the threat of an invasion of Canada.

Despite being somewhat familiar with Canada's naval history, this reviewer learned some new things while reading this volume, including:

- about the first Battle of Hudson's Bay in 1688-89, in which with a Canadian quirk, both French and British warships became frozen in the packed ice and fought each other statically over the winter;
- that Canada had a naval service as early as 1870, when an armed marine police was formed to protect the East Coast fishery. This was 30 years before the Naval Service of Canada was established;
- the level of German U-Boat activity off the East Coast in the *First* World War. The Second World War's "Battle of the St Lawrence" is better known, and I was not aware of attacks in the areas of Grand Manan, New Brunswick, and Shelburne, Nova Scotia, in August 1917.

This book/magazine is lavishly illustrated, with both paintings and photographs. For those wishing to add to their collections, reference numbers are provided at the back so that readers can order their own copy. I have a copy of *The Fight for Italy*, another work in this series, and can attest to the high quality of these publications. This work is a good reminder, if any were needed, about how events on the global commons continue to shape the course of our history.

Canada's Greatest Naval Battles is highly recommended for libraries in naval training institutions, for prospective sailors, naval and military museum gift shops, and indeed in units of the Royal Canadian Sea Cadet Corps, so that younger generations can learn of Canada's naval heritage.

When asked about Canada's greatest naval battles, some might first think of the late Canadian musician Stan Rogers' ballad "Barrett's Privateers." Spoiler Alert! One Joseph Barss was perhaps Canada's most successful privateer. He operated against both French and American shipping in the late 18th and early 19th centuries. Read all about him here.

Credit: Royal Netherlands Navy photo by Corporal (OR-4) Kars van Bemmel

The aircraft carrier HMS ***Queen Elizabeth*** *sails into the sunset somewhere in the North Atlantic on 23 September 2019.*

Queen Elizabeth II

1926 - 2022

Her Majesty Queen Elizabeth II greets members of the Royal Canadian Navy on 29 June 2010 in front of the museum corvette HMCS *Sackville* as part of the RCN's centennial International Fleet Review in Halifax.

Credit: Private Dan Bard, Formation Imaging Services