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Background Paper

PREDATORS OF THE DEEP:
HUNTER-KILLER AND ATTACK SUBMARINES

by
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Major Tim Dunne (retired) is a communications consultant, lecturer, writer and practitioner with more than 40 years Canadian and international experience; professionally accredited, award-winning communicator, international public affairs instructor and educator, consultant for senior representatives of government and international agencies; conducted programs with large and small media groups; written articles about military affairs, media relations, crisis communications, and journalism; established media centre for the 1998 crash of SWISSAIR 111, developed the proposal for the founding of the DND public affairs instructional center in Ottawa; and, as a sub-contractor of the Oslo-based firm, Medialøven, assisted with the establishment of the Public Affairs Regional Centre, Skopje, Former Yugoslav Republic of Macedonia and the training of the instructional staff.

He retired from the Canadian Armed Forces Public Affairs Branch as the longest-serving military public affairs officer in the history of the Canadian military.

He has written extensively about military affairs, NATO and the United Nations; experienced crisis and emergency communicator with NATO; and has worked with military, media and NGOs in troubled regions, ie- UN High Commissioner for Refugees, Office of the UN Special Representative, and the International Committee of the Red Cross. He received his Master of Arts (history and political science) from the Royal Military College of Canada.

His awards include The National Award of Excellence from the Canadian Public Relations Society (1988), citation from the Privy Council of Canada (1991), the International Association of Business Communicators Silver Leaf and Gold Quill awards (1998), the Bulgarian Order of Loyal Service (2001), United Nations peacekeeping medals for service in the Middle East (1978) and the Balkans (1995) and military service medals for Bosnia Herzegovina, Kosovo and Macedonia (2002 to 2004).

He was appointed the Military Affairs Advisor for the Province of Nova Scotia in 2007, a first in Canada. He retired from the Nova Scotia Public Service in 2009 and established his communication consultancy that specializes in public sector communications and military affairs writing. He is a research fellow with Dalhousie University's Department of Political Science the military and security affairs op-ed columnist with the Chronicle Herald, the Atlantic Canada correspondent with the Frontline family of magazines, and communication instructor at Mount Saint Vincent University.

Tim describes his military service as having worked in many places where "walking through a minefield is more than a metaphor."

Submarines have been panned, penned and punned since 1580 when English innkeeper William Bourne wrote that “a Ship or a Boate may goe under the water unto the bottome, and so come up again at your pleasure”. He envisaged a vessel with leather chambers that could be drawn inwards to flood and outwards to expel the water.

Dutchman Cornelius Drebbel may have been the first to develop a working model when he demonstrated his “submarine” in 1623. The enclosed rowboat with near-neutral buoyancy submerged through forward momentum, making a submerged transit down the Thames River at a depth of about 4.5 metres (15 feet). James I purportedly witnessed the event.

The concept of the submersible underwent numerous tests, prototypes and designs until American David Bushnell’s “Turtle” became the first submarine to attack an enemy ship during the American Revolution. His version was designed to submerge and surface by a valve that pumped water into and out of a bilge tank below the deck. Movement was by two hand-operated propellers, one to move forward and the other to move vertically.

Intended to be towed into the vicinity of the attack, it carried 91 kg (200 pounds) of lead ballast that could be released to increase buoyancy and had a speed about five km/hour (three miles/hour). The vessel was operated by one person and contained enough air for about thirty minutes.

In the early morning of 7 September 1776, Sergeant Ezra Lee navigated the Turtle toward a British warship, believed to be HMS Eagle, in New York harbour and attempted to drill into the hull to attach a 60 kg (150 pounds) gunpowder charge. He failed and was spotted by a British lookout, but escaped.

An array of vessel shapes, designs and capabilities were adapted into a variety of prototypes until the submarine reached its early stage of maturity in the beginning of the 20th century. On the eve of the First World War, Great Britain had the largest submarine fleet with 74 in service and 31 under construction; France had 62 in service with nine under construction; Russia had 48; Germany 28 in service and 17 under construction; and the United States had 31 in service and 17 under construction.

Prior to WW1, the United States focused its submarine fleet on coastal defence. It was Germany’s First World War U-boat that influenced the design of follow-on submarines, with its streamlined hull allowing faster running. In 1943 Germany began to add double-tube snorkels to their submarines. Based on the design of Dutch submarines captured during Germany’s occupation of the Netherlands, one tube took air to the engine and the other vented exhaust gases and foul air from the diesel engines.

The United States launched the first nuclear powered boat, the USS Nautilus, which first sailed on 21 January 1954. This began the process of replacing all USN diesel-electric boats with nuclear-powered submarines. Installing a nuclear power system exponentially increased range and manoeuvrability, and radically altered naval strategy and tactics. Nautilus was the first submarine to sail under the Arctic ice, reaching the North Pole on 3 August 1958, an impossible feat for the conventionally-propelled boats of that time.

Submarines are variously called “boats”, a shortened form of the original name, “submarine boats”.

First World War

On 5 June 1914, British Admiral Percy Scott wrote to The Times, “As the motor has driven the horse from the road, so will the submarine drive the battleships from the sea.” The press and the Admiralty described Scott

as suffering from “an attack of midsummer madness” and that his vision was nothing more than “a fantastic dream.”

Three weeks later, on 28 June, the Serbian anarchist Gavrilo Princip assassinated Archduke Franz Ferdinand of Austria, heir to the Austro-Hungarian monarchy, and his wife Sophie, Duchess of Hohenberg. This started the tumble of dominoes of declarations of war by the European powers that ended the Concert of Europe and began the First World War.

One month later, on 28 July, Austria-Hungary declared war on Serbia and within days Germany declared war on France and Belgium, provoking Britain’s declaration of war on Germany. By 14 August the land war began and on 28 August the Royal Navy attacked German ships in the Battle of Heligoland Bight, the first naval battle of the war.

Eight days later, on 5 September, the German submarine U-21 torpedoed and sank the British cruiser HMS Pathfinder. The following week, the British submarine HMS E-9 sank the German light cruiser SMS Hela with two torpedoes. The submarine war escalated with the U-17 stopping and searching the British 866-ton merchant ship SS Glitra on her way to Stavanger, Norway. The crew was ordered into lifeboats and the Glitra scuttled. On 26 October, the same submarine torpedoed the French ferry SS Amiral Ganteaume in the strait of Dover.

The exploitation of the oceanic sub-surface began 100 years ago with those initial operational deployments of submarines during the First World War, changing the nature of naval warfare forever. Since then, surface invisibility allows a submarine to operate close to and even within an adversary’s naval force, to avoid perimeter defences, observe without being seen and attack with near invulnerability. From its earliest military operations during the First World War, the submarine could invisibly observe or engage the enemy vessels and escape in the resulting chaos.

What do submarines do?

Naval submarines fall into two basic types.

The ballistic missile submarine, nicknamed *boomers*, carry intercontinental ballistic missiles (ICBM). While the United States and Russia dominate, smaller fleets of boomers are in service with Great Britain, France, China and India. In general, these strategic submarines are loners and remain submerged for long periods using the oceans to mask their presence, allowing them to launch their missiles as an effective second strike weapon in the event of a strategic attack of one on the other.

The *hunter-killer*, or *attack*, submarines are tactical vessels specifically designed to use the oceans for stealth as they patrol to protect allied shipping and warships, to conduct their various missions and, when necessary, to attack and sink an adversary’s submarines and ships. They can carry a variety of munitions, including their principal weapon, the torpedo, but some can also launch naval cruise missiles and use guns.

“Attack” normally denotes nuclear-powered and “hunter-killer” is the term applied to diesel-electric (conventionally powered), however the two terms can be used interchangeably. While nuclear-powered submarines can remain submerged almost indefinitely, new innovations in air-independent propulsion (AIP) promise to allow conventional boats to remain submerged for longer periods. Submarines, even the older and noisier that have fewer protection technologies, can be surprisingly effective in a number of tactical and operational roles.

Intelligence, surveillance and reconnaissance (ISR): A submarine can remain in a specific location for extended periods and covertly trail other submarines and surface ships. Multiple sensors allow monitoring of surface and sub-surface activity to investigate if the activities of the vessels under observation pose a threat or a danger. It is both a “force multiplier”, providing early detection of suspicious or threatening activities and events; and a “force enabler”, giving pinpoint directions for over-the-horizon forces to engage otherwise unseen targets, and directing land and constabulary forces toward adversarial or illegal personnel landings. Simply put, they alone can conduct extended operations in areas and circumstances inaccessible to other platforms or systems to support both military and anti-criminal objectives.

For example, at a time when the global fisheries biomass is critically stressed, the submarine’s capacity to remain on station and observe the practices of foreign fishing fleets is critical. Visible observation changes the behaviour of those being observed, but a submarine can observe unseen and monitor the fishing operations and when necessary, either intervene or call on over-the-horizon enforcement officials to address illegal behaviour.

Submarines can enter an area prior to a conflict and conduct a range of ISR activities, gain an understanding of the geospatial features of an operational area, the patterns, doctrine, tactics and capabilities of an enemy and remain on station until hostilities have ceased.

Power projection, in the naval context, is a nation’s capability to employ defensive or coercive force beyond its own littoral waters to meet a threat or to influence activities or events in other areas, and can employ defence, deterrence and diplomacy. In its military form, it can involve various profiles of force, from implied to lethal.

In general, submarines can launch torpedoes or submarine launched cruise missiles (SLCM) through vertical launch silos or their torpedo tubes. The U.S. Navy’s Ohio class nuclear submarines are converted ICBM strategic boats that can launch up to 144 Tomahawk cruise missiles from their modified vertical SLCM tubes (silos). The Royal Navy’s Astute class and the U.S. Navy’s Los Angeles class nuclear submarines can launch SLCMs through their torpedo tubes. The U.S. Navy is replacing the Los Angeles class with the *Virginia class* nuclear-powered fast attack submarines. Designed for a wide array of missions in both open-ocean and littoral missions, they can carry a payload of Tomahawk cruise missiles, an undersea unmanned vehicle and, potentially, conventional medium range ballistic missiles.

The Virginia class has a number of futuristic systems and features that contribute to its stealth, effectiveness and resiliency.

Power projection leads to sea control, the freedom to use a maritime area and to deny its use to an adversary, including the airspace above (air defence) and the undersea to the seabed below (waterspace management). This allows a navy to protect sea lanes of communication and deny access to the enemy ships, submarines and aircraft, and to prevent mine-laying in areas of particular interest or concern.

Sea control is essential for maritime nations whose trade and sovereignty depend on safe and secure use of the high seas. The U.S. Navy speaks of the “70-80-90 paradigm,” 70 per cent of the world’s surface is covered by water, 80 per cent of the world’s population lives within 100 miles (160 km) of a coastline and 90 per cent of the world’s commerce travels on the oceans. Ocean transport satisfies a vast majority of commercial and strategic shipping requirements. Submarines are critical sea control platforms with anti-submarine warfare and anti-surface capabilities.

They proved to be major threats to sea transportation and in both world wars. The German U-20 attacked and sank Cunard's ocean liner RMS Lusitania on 7 May 1915, as she secretly carried munitions to Britain for the war. She sank in 18 minutes, 18 km (11 miles) off County Cork, Ireland, killing 1,198, and 761 surviving. This was a major factor in the United States entering the war against Germany.

During the Second World War, German U-boats preyed on ships crossing the Atlantic to the United Kingdom to bring vital supplies to the British population and the allied forces preparing for D-Day. In the Pacific theatre, USN submarines sank over 5.5 million tons of Japanese shipping.

Sea control establishes the environment for more direct effort in relation to the land. Maritime forces can shape, influence and control the environment, as well as deliver combat forces ashore, working in concert with maritime power projection.

Sea Denial is a critical component of sea control and is used by navies against merchant and naval shipping. Deploying a submarine into an area of operations dramatically changes how opposing naval forces conduct their operations. Locating a submerged boat can divert ships, aircraft and other submarines from other missions, and consume incredible quantities of resources, making its search and pursuit a strategic decision.

The Second World War's Battle of the Atlantic, the war's longest battle, lasted virtually the entirety of the war, from 1939 to 1945, some 2,075 days. Allied naval and air forces conducted more than 100 convoy battles and 1,000 single ship engagements against the submarines and warships of the German and Italian navies. As many as 125 merchant ships were at sea at any one time. Escorted and guarded by allied warships, merchant vessels carried more than 180 million tonnes of cargo to Europe, essential to the war effort. Germany's effort to block allied shipping came at a huge cost for both sides 3,500 merchant ships and 175 warships were lost, and 783 U-boats were sunk.

During the Falklands War Britain deployed one aircraft carrier, 11 destroyers, five nuclear submarines, one diesel-electric submarine and 25 helicopters to anti-submarine warfare. They depleted all their sonobuoys and anti-submarine weapons, and asked the United States to replenish the British inventory, all against one small Argentinean diesel-electric boat, the ARA San Luis.

In 2004, the two-day search for an old and noisy Chinese Han class nuclear submarine in Japanese waters required an entire US Navy P-3 Orion maritime patrol aircraft squadron, Japanese Defence Force P-3s, a number of nuclear submarines and surface ships and a T-AGO surveillance ship with towed sonar.

In response to the 5 April 1986 fatal bombing of Berlin's popular "La Belle" nightclub, the U.S. launched Operation El Dorado Canyon, U.S. air strikes against Libya ten days later. Modern US Navy submarines deployed into the area during the pre-strike and post-strike positioning of the U.S. Sixth Fleet caused Colonel Muammar Qaddafi to keep Libya's fleet of six Soviet-built diesel submarines in port.

Operational stealth: Submarines excel at non-conventional military operations: covert mining; clandestine mine reconnaissance; precise placement of maritime mines for maximum effect; and stealthy insertion and extraction of special forces. In short, modern submarines are multi-mission platforms, fitted with specialised suites of equipment and particular operational characteristics that enable them to operate covertly when required.

When it operates below the sea surface it is immersed in a naturally hostile environment that favours counter-detection sensors. A submarine remains virtually invisible to all but the most capable anti-submarine forces. The significance of a submarine's operational stealth grows as countries develop their own national ocean

surveillance systems, which build a wide-area maritime picture for using space, airborne, surface, sub-surface and land-based systems.

Operating without being detected is a fundamental capability to the submarine's military effectiveness. In times of political tension or crisis, the boat's covert nature provides a hidden and potentially lethal asset that can exacerbate or escalate the political scenario without notice.

In 1977, the Argentinean government was pressing the British government to pass over control of the Falkland Islands. The British did not want to complicate the negotiations by visibly deploying forces, but wanted to be prepared in case Argentina seized the islands. A task force of two frigates and one submarine deployed but only the submarine was permitted into the immediate vicinity of the islands. The frigates remained more than 1,000 miles away. The Royal Navy submarine deployed into the region without the Argentines being aware of the deployment, allowing the British government to employ the submarine's full range of ISR and combat capabilities or recall the boat as circumstances dictated.

The element of surprise is an option in the commanding officer's arsenal of operational alternatives, if and when he or she decides to reveal the boat's presence to the enemy. During the Falklands War the Argentine submarine, ASA San Luis, operated in the main areas of the British task force during the 36-day patrol, at some times firing shots against the British fleet. There was no effective counter attack. The British fired more than 150 weapons without a hit, and Britain was considered NATO's anti-submarine warfare specialist at the time.

Operational endurance: Among the submarine's most important attributes is its ability to linger, submerged, silent and invisible, for relatively long periods, periodically raising the periscope and snorkel. During their times on-station, they can observe and develop their intentions to address tactical and operational situations.

US Navy attack submarines, all of which are nuclear powered, usually deploy for 90 days and can remain on station and submerged for 60 days or more. Australian Collins class are said to be designed for 70 day patrols. Small conventional submarines, such as Pakistan's Agosta 90B air independent propulsion (AIP) submarines have an endurance of 60 days; Germany's Type 214s and French Scorpenes can deploy for 50 days or more; Argentina's San Luis, a German Type 209 submarine, could remain deployed for 60 days before needing refuelling and resupply. Canada's Victoria class boats have a patrol endurance of 56 days.

Freedom of Movement, derived from stealth and endurance, is the ability to covertly move with relative impunity and to access any chosen area within the area of operations, including those closed to surface vessels or aircraft. It can shift positions within the area of operations as the operational and tactical situation changes and while submerged, and are generally unaffected by rough seas and poor weather.

Flexibility: Stealth, secrecy and silence are their advantages. The submarine has a wide range of sensor and communications equipment, effectors and an ability to operate covertly and independently across the full spectrum of maritime operations. A force commander can task a submarine with a number of different mission types as the strategic, operational or tactical situation changes. At the operational level, a submarine might arrive in an area to insert special forces, conduct intelligence, surveillance and reconnaissance assignments, maritime mine-laying operations, launch cruise missiles against land-based targets, and engage enemy shipping and submarines with torpedoes and anti-ship missiles.

In recent times, submarines have shifted away from absolute lethality in their payloads to allow greater flexibility and relevance in lower level conflicts. The flexible range of activity and weapons against an enemy

force at tactical and theatre levels allows the commander to monitor, harass, engage and destroy maritime targets with virtual impunity.

New technologies

The enhanced technologies being integrated and retrofitted into submarines are giving these vessels a variety of futuristic characteristics.

Air independent propulsion-equipped submarines have significant operational advantages over both conventional diesel-electric engines and nuclear powered submarines. These systems allow submarines to stay submerged far longer than their diesel-electric counterparts, which must either surface more frequently or ascend to snorkel for air, revealing their positions. They also run much more silently than nuclear-powered submarines, which continuously pump coolant through their nuclear reactors, generating noise that can betray their presence.

Sweden's Gotland class diesel-electric submarines, designed and built by the Kockums shipyard, are the first to have Stirling engine air-independent propulsion systems, which extends their underwater endurance from a few days to weeks.

Hunter-killer and attack submarines can carry torpedoes against ships and other submarines, and cruise missiles against land targets up to 1,000 miles away.

The USN Virginia class submarines are designed for the full spectrum of blue-water and littoral missions. Twin AN/BVS-1 telescoping photonics masts replace the traditional periscope, eliminating the periscope tube that protrudes from the steel pressure hull, increasing watertight integrity and limiting risks of water leakage in the event of damage. The photonics mast exchanges the mechanical, line-of-sight periscope with high-resolution cameras, light-intensification and infrared sensors, an infrared laser rangefinder, and an integrated electronic support measures array. Information from these sensors is carried through fibre optic data lines to the control center with visual data displayed wirelessly on LCD monitors. The boat uses pump-jet BAE Systems propulsors that reduce cavitation and are quieter than traditional bladed propellers, a fibre optic *fly by wire* ship control system and an updated AN/BSY-1 integrated combat system by General Dynamics AIS (previously Raytheon).

According to news media reports, the Royal Navy's HMS Ambush, Britain's newest Astute class nuclear powered attack submarine, has a sensor package that can "hear" vessels 4,800 kilometres (3,000 miles) away, carries 38 Tomahawk cruise missiles, and can travel up to 800 km (500 miles) per day.

In 2020, Singapore will operate the Indo-Pacific's most advanced non-nuclear powered submarines. Thyssen, the German shipbuilder, has been contracted to construct two Type 218G U-boats that will maintain Singapore's submarine fleet's interoperability with western navies.

China is dramatically expanding its fleet of nuclear and conventionally-powered hunter-killer submarines in quality and quantity. Russian news media reports the development of a fifth-generation submarine class, which may be made available to China. The Kalina-class will feature a made-in-Russia air-independent propulsion (AIP) system to be developed by 2017 with the first boat fitted with the system by 2018.

Japan, South Korea, Vietnam, Indonesia, Australia, the Philippines and Pakistan all maintain programs to start, modernize or expand their submarine fleets. South Korea has already purchased German submarines.

Small countries which do not have the resource base, the economy or the capacity for large, expeditionary naval fleets can be expected to respond to China's increasing capabilities by expanding their submarine fleets.

Today, modern submarines can deny access and can hunt almost with impunity. With 40 nations employing more than 400 boats of all types, the need for these specialized vessels will grow with the development of technologically sophisticated weapons, and information and detection systems. Future adversaries will have more access to relatively inexpensive, high-tech systems, such as space-based surveillance and targeting systems, quiet diesel-electric submarines, low-cost maritime mines, information warfare tools, tactical ballistic missiles, cruise missiles and weapons of mass destruction.

A submarine's operational survivability will certainly be affected by emerging weapon systems, which will be employed defensively by submarines against surface ships and anti-submarine helicopters, and by ships and helicopters against submarines. A non-nuclear electro-magnetic pulse generator and high intensity microwave weapons could affect or destroy microcircuits, computers, radar, sonar, communication and other critical electronic systems. Thermobaric weapons, explosives that generate an intense, high-temperature explosion and blast wave, are under development. Hoistable mast-mounted guns are presently under development.

Current submarines are generally invulnerable to such weapons, and their lethality will be enhanced with the integration of wire-guided missiles, such as IDAS or AIM 9X, which will be integrated into German and U.S. submarines to eliminate anti-submarine helicopters.

Narco-submarines

But future adversaries may not all be nation-states. Columbian drug cartels have developed special-purpose submarines, in one case, a camouflaged boat 22.5 metres (74-feet) long with twin propellers and a five-foot conning tower. The ocean-going, self-propelled "narco-submarines" are built by drug traffickers to smuggle cocaine from Colombia to Mexico, and which is then brought overland into the United States. First detected in 1993, the early vessels were semi-submersibles and could not dive. Most of the vessel was submerged with only the cockpit and the exhaust pipes visible above water. Newer narco-submarines are fully submersible, designed specifically to be difficult to detect visually or by radar, sonar and infrared systems.

Moving up to 330 tonnes of cocaine per year, they cost up to two million dollars each to construct. But they can move enough cocaine in a single trip to bring in more than \$100 million in profits.

Conclusion

Submarines contribute to all areas of maritime operations, including warfare, sea control, sea denial and maritime power projection. Many are equipped to conduct land strike operations to take out enemy command and control, enemy air control capabilities, conduct mine countermeasures operations and traditional anti-shiping and anti-submarine operations, and to support blue force operations ashore.

Simply stated, modern diesel-electric submarines with a full complement of sensors, a weapons package that includes torpedoes, submarine launched cruise missiles, anti-ship and anti-air missiles, a hoistable, mast-mounted gun and air independent propulsion are the best effective defence against similarly-equipped adversary submarines.

They are an essential component in a nation's naval fleet mix.