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Alliance Airborne Anti-Submarine Warfare

A Forecast for Maritime Air ASW in the Future Operational Environment

Joint Air Power Competence Centre

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Author
Commander William Perkins (USA N), JAPCC
Contributions: Commander Natale Pizzimenti (ITA N), JAPCC

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Published and distributed by
The Joint Air Power Competence Centre
von-Seydlitz-Kaserne
Römerstraße 140
47546 Kalkar
Germany

Telephone: +49 (0) 2824 90 2201
Facsimile: +49 (0) 2824 90 2208
E-Mail: contact@japcc.org
Website: www.japcc.org

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FROM:
The Executive Director of the Joint Air Power Competence Centre (JAPCC)

SUBJECT:
A Forecast for Maritime Air ASW in the Future Operational Environment

DISTRIBUTION:
All NATO Commands, Nations, Ministries of Defence and Relevant Organizations

The Russian Federation has increasingly been exercising its military might in areas adjacent to NATO Nations. From hybrid warfare missions against Georgia to paramilitary operations in Crimea, the Russian Federation has used its land-based military to influence regional events in furtherance of their strategic goals. Similarly, the use of their Naval capability has increased, notably through an increase in submarine deployments, the repositioning of highly capable submarines to new home ports in the Black Sea and the execution of submarine-launched cruise missile strikes into Syria.

NATO's Maritime Air element has a long history with Russian submarines, reaching from the earliest days of the Alliance and peaking during the Cold War years. Although signs do not portend a return of the Cold War, there are certain aspects of peacetime submarine monitoring which are beginning to challenge NATO's ability to maintain maritime situational awareness.

In this spirit, this study reviews the current and future capability of NATO's Maritime Air to conduct Anti-Submarine Warfare against potential future adversaries. It culminates with an environmental forecast outlining possible futures with which NATO's forces may need to contend and concludes with numerous recommendations for NATO's Maritime Command and other elements of the anti-submarine domain to address identified capability shortfalls.

We welcome your comments on our document or any future issues it identifies. Please feel free to contact the author, Commander William Perkins, USA N, at perkins@japcc.org, or any member of the Maritime Air section of the Combat Air Branch at ca@japcc.org.

Joachim Wundrak
Lieutenant General, DEU AF
Executive Director, JAPCC

JOINT AIR POWER COMPETENCE CENTRE
Joint Air Power Competence Centre | **centre de compétence de la puissance aérienne interarmées**
von-Seydlitz-Kaserne | Römerstraße 140 | 47546 Kalkar | Germany/Allemagne | Tel +49 (0) 2824 90 2201 | Fax +49 (0) 2824 90 2208 | www.japcc.org
NCN: +234 or 239 2201 | **E-Mail:** contact@japcc.org

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EXECUTIVE SUMMARY

As the Cold War ended and the Russian Federation's naval projection was challenged both by the internal politics of glasnost and the stark realities of their national economic situation, their submarine deployments throughout the NATO theatre nearly ceased. Many nations in the Alliance re-focused naval assets away from submarine tracking and monitoring to support emerging mission portfolios which supported NATO's new operational environment. The Alliance is today experiencing a resurgence in submarine patrols throughout much of the NATO Area of Responsibility and finds itself with limited ability, both in resources and, arguably, in a strategic imperative, to resume large-scale submarine prosecutions. As NATO struggles with many other challenges, the changing future with respect to increased non-NATO submarine operations should not be discounted.

Following a Request for Support from Allied Maritime Command (MARCOM), the JAPCC completed this study to investigate the current Maritime Air support capability for Anti-Submarine Warfare (ASW). The aim of this project is to define the current challenges experienced by ASW-capable air platforms in both today's operational environment and in a range of possible future environments assessing whether the Alliance has a capability shortfall in the ASW mission area. This will involve a review of environmental challenges, oceanography and NATO's Maritime Air history with this mission to set the stage for detailed discussions about the current and future challenges in the ASW domain. This will be followed by an analysis of current and projected Non-NATO submarine capability to include a review of national intent and a brief discussion about the use of submarines as an element of sea power. Finally, the project will examine current NATO Maritime Patrol Aircraft (MPA) and ASW helicopter force structure and explore procurement plans to meet future ASW challenges.

'Many assessments of what the Russian military can and cannot do have been inaccurate. This isn't just problematic for the facts' sake – more troubling, it risks skewing our assessment of how far Moscow will go … When Western analysts – and in turn, Western leaders – seek to discredit Russian military capabilities, Moscow will likely continue to take the opportunity to prove them wrong.'

Garrett Cambell, Brookings Institution

Since non-NATO submarine deployments nearly ceased in the mid-1990s, NATO now has a generation of officers and civilian leaders who did not grow up experiencing the 'cat and mouse' environment of submarine warfare which existed during the Cold War. NATO has conducted three major joint operations during since the end of the Cold War. None of these operations were conducted in an area challenged by the presence of an adversary submarine. Just as air chiefs fight the perception NATO will always have air superiority in any campaign, maritime leaders must also engage to challenge the perception that NATO's maritime forces will always have maritime superiority. This perception, coupled with inaccurate beliefs regarding the capability of the Russian Federation's maritime capability, has coloured maritime defence spending for decades. As a result, NATO has ceded much of the advantage it earned at the conclusion of the Cold War. Therefore, to dispute this prevailing theory, this study is intended to be read by a much broader audience than purely the maritime component.

Unlocated submarines present numerous problems for both the Maritime component and for NATO writ large. An adversary submarine which is not tracked from a theatre level will have freedom of movement to pose numerous threats to NATO forces and territories. A single submarine can effectively close a maritime choke point, such as the Strait of Gibraltar, preventing merchant traffic or naval forces from transiting. An unlocated submarine can lie in wait for a naval task force and effectively pick off the high value capital ships, removing in a single blow a significant part of the joint capability to project power (aircraft carrier, amphibious assault ship) or resupply naval forces at sea Adversary attack submarines (SSN) are charged with detecting and potentially engaging not only NATO surface ships, but NATO's ballistic missile submarines serving as the seaborne aspect of the nuclear deterrent. If those submarines are not tracked at a theatre level, it puts the nuclear deterrent force at risk. Furthermore, an unlocated submarine could establish a covert operating area close to a NATO nation's coastline. From there, it can project striking power deep into NATO, exploiting recent advancements in modern cruise missile capability (some with ranges in excess of 1500 km) and ballistic missile capability. All of these situations become significantly mitigated by tracking submarines throughout their deployment at a theatre level. NATO excelled at tracking submarines in the Cold War, but the skills have atrophied and the resources have dwindled.

RECOMMENDATIONS

NATO has a history of misreading Russian intent and being ill prepared for Russian military activity. A pervasive feeling amongst many maritime strategists and naval planners is that submarines are a relic of the Cold War. Subsequently, anti-submarine force development has not received the proper prioritization in many national procurement programs.

This study concludes maintaining a credible theatre-wide submarine monitoring capability is a critical enduring peacetime function, but NATO is not currently capable of doing it.

It identifies four critical findings with significant impact on NATO's current and future ability to conduct ASW:

1. NATO should create a theatre-wide ASW Commander, vested with the proper authorities to more efficiently coordinate NATO's limited ASW resources across ships, submarines, and aircraft.
2. NATO should identify a common aircraft replacement for the P-3 Orion series.
3. NATO should identify a common mechanism for MPA and MPH post-mission acoustic analysis and request national aircraft mission support centres adopt this standard.
4. NATO should develop Experimental Tactics and test them for ratification into formal doctrine.

The JAPCC wishes to thank members of the Centre of Excellence for Confined and Shallow Water Operations (COE CSW) and the Centre for Maritime Research and Experimentation (CMRE) for providing insightful comments throughout the development of findings.

In addition to the four critical findings listed above, 21 additional findings and recommendations to mitigate shortfalls identified in the study were identified. Although the Cold War is not returning, the Bear is awakening from hibernation and NATO cannot afford to function with a future capability shortfall against a growing submarine presence.

A P-3C Orion starts engines prior to a night mission.

CHAPTER 1

Introduction

During the decades following the conclusion of the Cold War, non-NATO submarines virtually ceased operations in the European theatre. This resulted in the drastic reduction of Anti-Submarine Warfare (ASW) experience garnered year over year by NATO's Maritime Air ASW forces. Additionally, during this period, alliance nations dramatically reduced their Maritime Patrol Aircraft (MPA) inventories. Furthermore, over the last two decades MPA forces have experienced expansive growth into mission areas beyond Maritime Patrol and ASW.

Unfortunately, NATO's MPA force has gone almost two decades without encountering a significant submarine threat. As a result, some question the current ASW proficiency in NATO's MPA and ASW Helicopter force. ASW was identified as one of the critical capability shortfalls at the 2014 Wales Summit.[1] Conversely, recent trends have emerged showing the potential for an increased number of deep water non-NATO submarine patrols by many nations (most notably Russia, India, and China).

'Once again, an effective, skilled, and technologically advanced Russian submarine force is challenging us. Russian submarines are prowling the Atlantic, testing our defenses, confronting our command of the seas, and preparing the complex underwater battlespace to give them an edge in any future conflict.'

VADM James Foggo, Commander, US SIXTH FLEET[2]

As emerging technologies are developed and replacement aircraft for aged MPA and helicopters are explored, budgets and other factors continue to hamper the development of the future ASW force structure. Unless NATO retains an ASW competency, there is growing risk the Alliance will find itself unprepared to capably respond to a potential increase in future non-NATO submarine operations. In this spirit, this study examines the current status of the

Airborne ASW capability within NATO. It also offers recommendations to ensure the future capability remains aligned with the projected operational environment, ensuring the Alliance remains well postured to protect Naval and Merchant shipping from submarine threats.

'At a time when NATO Air Power has shown itself to politicians and policymakers to be a versatile and essential tool for conflict resolution, those same decision-makers are making reductions that could undermine the capability they have so recently used to such good effect. This has happened before, with armies slashed only to be resurrected in great haste at the onset of the next challenge.'
General Frank Gorenc, Director JAPCC
Commander, Allied Air Command
as stated in the Future Vector Project

The Commander, Joint Force Command, Naples (JFC Naples), Admiral Mark Ferguson, advised in a briefing to the North Atlantic Council on 6 October 2015 that Naval forces should be 'on-call for real-world events to reduce mobilization time, and those forces need to invest in new technologies to keep up with Russian investment'.[3] This study offers solutions to address the challenge presented by the increase in non-NATO submarine operations.

1.1 Aim

This study defines the current challenges experienced by ASW capable air platforms in both today's operational environment and a range of possible future environments to assess whether Alliance Maritime Air ASW platforms have a capability shortfall in the ASW mission area.

This document will:

- Briefly review the role of Maritime Air in the ASW mission during the Cold War.
- Study the ocean as a domain and discuss how the domain has changed from the Cold War to today with an examination of future challenges presented by the ocean environment.
- Review NATO and partner nations' Maritime Patrol Aircraft and ASW helicopter forces, to include inventory, basing, and sensors.
- Review non-NATO nations' submarine capability and discuss current and future challenges presented by emerging submarine classes and national goals related to the use of sea power for projection.
- Discuss the Joint aspect of ASW and how this mission set crosses service boundaries.
- Provide MARCOM with an assessment of current Maritime Air capability against the current threat and offer MARCOM a projection of the future force against the likely future threat.
- Make recommendations to MARCOM for future employment considerations and to shape potential technical developments.

1.2 Assumptions

This study assumes Alliance defence budgets will continue to be constrained, resulting in a sustained political will to support the principles of NATO's Smart Defence (SD) and the European Union's Pooling & Sharing (P&S) initiatives in the long term. Additionally, this study takes into account the currently proposed procurement plan for replacement MPA and ASW-capable helicopters, which is always subject to change based on national priorities.

1.3 Methodology

The study first reviews environmental challenges and oceanography and provides a summary of NATO's Maritime Air history with ASW to provide context for the current and future challenges in the ASW domain. This is followed by an analysis of the current and projected capability of non-NATO submarines, to include a review of national intent and a discussion about the use of submarines as an element of sea power. The study examines current NATO and Partner Nation MPA and ASW helicopter force structure, recommending changes to meet future requirements in some cases, and explores procurement plans to meet future ASW challenges. The study then compares Cold War-era ASW Command and Control that of the new NATO Command Structure. Finally, the study offers a forecast of likely and possible futures as a basis for the examination of potential capability shortfalls.

The data in this study was generated from a variety of sources. The JAPCC participation in numerous maritime forums was key to assessing the current state and direction of NATO's Maritime Air capability. Interviews with Commander, Maritime Air NATO, and Commander, Submarine Forces NATO, were conducted to assess the operational commanders' challenges with command and control of anti-submarine forces. Information from NATO public websites, open source material and relevant unclassified Coalition/Alliance, Joint, and National doctrine was used as a reference. Additionally, publicly available information regarding national procurement strategies for aircraft and submarines was explored. Finally, to create the forecast, the Delphic forecasting model, coupled with comparison to other strategic forecasts (specifically the UK, US and Allied Command for Transformation products) was employed.

1.4 Limitations

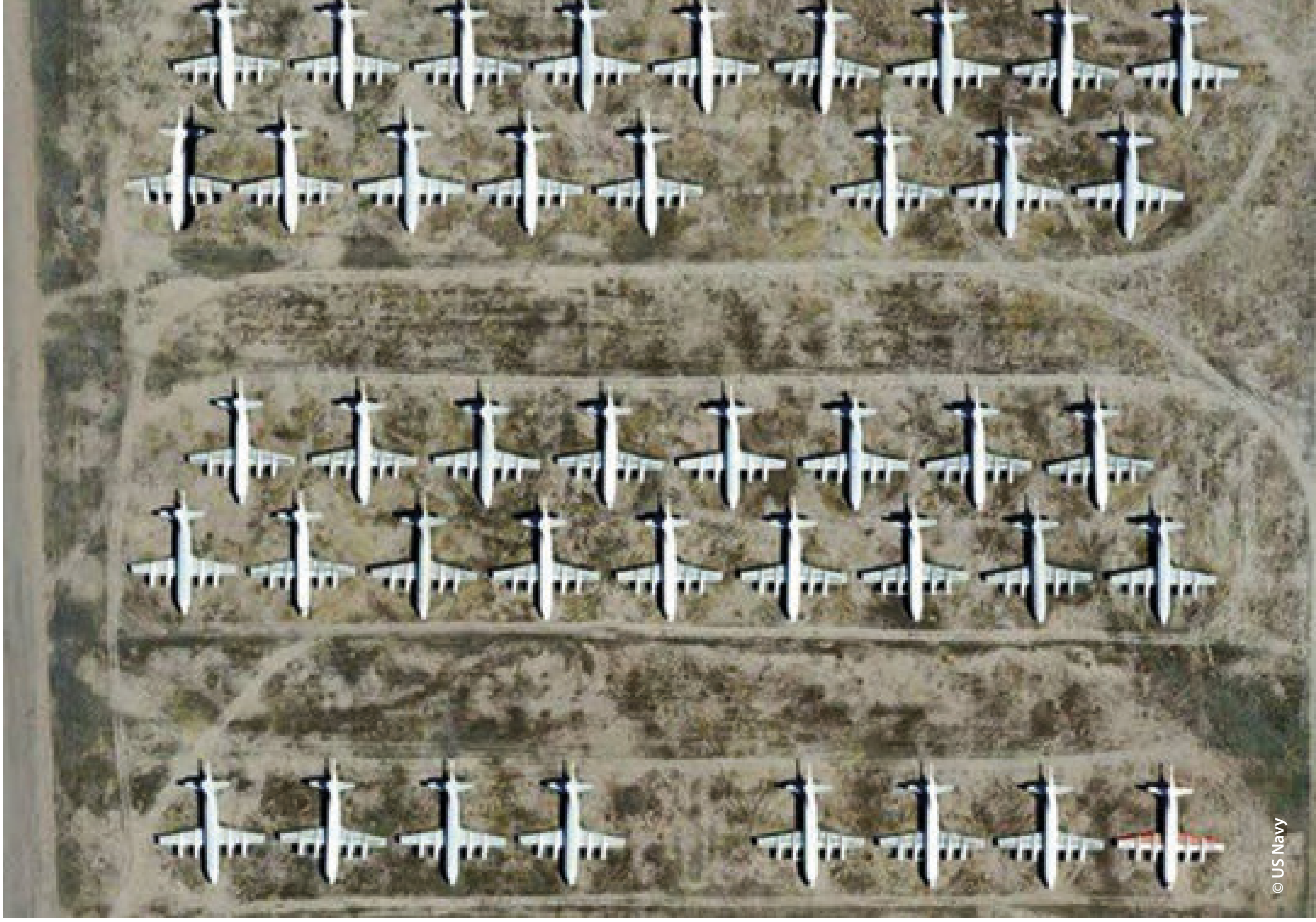
Research and analysis associated with this study included both open and classified sources. To permit the widest dissemination, the published study has been kept at the unclassified level. Additionally, this study was focused on the ASW capability of Maritime Air forces and is not intended to provide a holistic view of all ASW capability across NATO's surface and subsurface forces.

1.5 Evolving Environment

Research for this study began in July 2015, six months before the Russian military demonstrated the integration of their newer generation diesel submarines into their Joint Operations in Syria. Initial conclusions throughout the research phase were exchanged with the primary stakeholder, NATO's Allied Maritime Command (MARCOM). They have been, to some extent, confirmed through the accelerated action of the Russian Navy's involvement in operations in Syria and throughout the Eastern Mediterranean and the Black Sea. This is a rapidly changing environment with potential impacts across the full range of military operations, and many of the driving forces affecting the forecast in Chapters 12 and 13 continue to evolve.

As the conclusions drawn from analysis of Russia's strategy go beyond their use of submarines and as the increased use of submarines has an impact across the joint spectrum of operations, the JAPCC recommends this study not only to strategists in the Maritime service but across NATO's Joint Force.

1. https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20141030NATOWalesSummit.pdf
2. 'The Fourth Battle of the Atlantic'. VADM James Foggo and Alarik Fritz. Proceedings Magazine June 2016. Available online at: http://www.usni.org/node/87164#footnotes
3. Admiral Mark Ferguson, 6 Oct. 2015 Speech to North Atlantic Council. Available online at: http://www.c6f.navy.mil/speech/remarks-delivered-adm-mark-ferguson-atlantic-council



Retired P-3s at the Boneyard on Davis Montham Air Force Base.

CHAPTER II

Terms and Definitions

The purpose of this chapter is to provide sufficient background for terms used in the study so that readers 'off the street' and not fully versed Anti-Submarine Warfare will fully understand the content of the study.

2.1 Submarine Classes and Missions

The two predominant types of submarines employed are characterized by their propulsion systems: nuclear and diesel-electric. These two types are further broken down into generic classes (based on mission) and finally into hull-specific classes (based on hull and propulsion design). This chapter will introduce various submarine types to provide context for a discussion about oceanography, sound propagation, and the challenges both the ocean environment and new submarine classes present to Maritime Air forces.

'Submarines are like steel sharks – quiet, silent, and deadly. They are designed to hunt and kill. Occasionally, it becomes necessary to find and destroy them – to keep open sea-lanes of communication, to sweep an area and make it safe for Allied shipping. Destroying a submarine is the hardest task in naval warfare.'
Admiral James Stavridis
NATO's 16th Supreme Allied Commander[1]

2.2 Nuclear Powered Submarines

Three types of submarines have nuclear-powered propulsion systems. These are the strategic nuclear ballistic missile submarine (SSBN), whose primary mission is to remain undetected in order to deploy ballistic missiles; the Fast-Attack Submarine (SSN), whose primary mission is to locate and engage other submarines; and the Guided Missile Submarine (SSGN). SSGNs are normally one of the previous two hull types that have been modified with a significant anti-ship missile capability and have a primary Anti-Surface

Warfare mission. Although SSBNs generally only have one mission, secondary missions of the SSN and SSGN classes include Intelligence; Surveillance and Reconnaissance (ISR); Special Operations; Mine Warfare and Anti-Surface Warfare (for the SSN).

As a general rule, nuclear submarines of all types operate in a deeper portion of the water column than their diesel-electric counterparts. First, their propulsion plant and propeller combination is more efficient in denser, deeper water. Secondly, the nuclear power plant can operate for extended periods of time without surfacing. For nuclear submarines whose mission is to detect other submarines or ships, the deeper ocean environment offers increased acoustic detection possibilities by exploiting the properties of sound travel in the deep ocean environment.

'A single Nuclear Submarine sinks half the US Carrier Strike Group'

Chinese Submarine Academy's Professor Chi Guocang references an 'After Action Report' from a French and US bilateral ASW exercise in 2015 where the small Rubis class SSN achieved constructive kills against the CVN and its ASW screen by utilizing the acoustic environment to the benefit of the hunter over the prey.[2]

Nuclear submarines are significantly faster, operate significantly deeper and remain submerged for significantly longer than diesel-electric submarines. A nuclear-powered submarine uses speed to its advantage when conducting its mission, as it can travel at high speeds for extended periods of time while remaining relatively undetected by acoustic means. However, the basis of propulsion remains a nuclear power plant. As such, they are significantly more expensive to build and operate safely. Therefore, there are only a few non-NATO nations with an active nuclear submarine fleet.[3]

2.3 Diesel-Electric Powered Submarines

Diesel-electric submarines (referred to for the remainder of this study as 'diesel' submarines) operate a variety of different types of propulsion plants, but all center around a quiet battery to provide power and limited propulsion when submerged and a diesel engine to provide power, propulsion and recharging the battery while surfaced. The length of time a diesel submarine may remain submerged and operate solely on battery power is a function of the hull-specific design.

Diesel submarines are comprised of SS and SSK types, with the primary mission of Anti-Surface Warfare. They also have secondary missions of Mine Warfare and Special Operations. Although both classes have similar propulsion systems, Guided Missile diesel submarines (SSK) are the higher-end, more capable submarines, comprising the majority of modern submarines in this category. In addition to having a significant anti-ship missile capability (varies by nation), many SSKs also have improved sensors to aid the mission. Furthermore, many SSK operate an Air Independent Propulsion (AIP) system, which significantly extends the amount of time the submarine may remain fully submerged before needing to surface to charge the batteries. SS class submarines are those types considered to be of lesser capability but also operate a diesel-electric propulsion system.

For all diesel submarines, travelling at high speed consumes battery power at an excessively high rate. However, operating the diesel engine to generate high speed also generates a significant amount of acoustically detectable engine noise. Therefore, in the conduct of its mission, a diesel submarine will use stealth to its advantage, slinking to its desired operating area at an extremely slow speed to conserve power while it lies in wait for adversary naval or merchant shipping. Accordingly, the diesel submarine will normally remain in a shallower portion of the water column, using other oceanographic features to mask its location (pinnacles, shelves, reefs, and fishing fleets) and loiter while it waits to conduct its mission.

Modern non-nuclear submarines are both more advanced than their predecessors and more widely proliferated, as defence industries that served their home markets during the Cold War now struggle to increase exports to maintain economic viability. Many decades of continual investment by countries like Germany and Sweden have finally paid off in the form of non-nuclear submarines with air-independent systems which dramatically increase the time between surfaced battery re-charging operations. These submarines still do not provide the mobility and endurance of a nuclear submarine, but they greatly reduce the non-acoustic detection vulnerability of a traditional diesel-electric submarine, which must expose a snorkelling mast to recharge its batteries every few days at a minimum and much more frequently if forced to operate at high speed.

Modern diesel-electric submarines are also armed with more advanced weapons and fire control systems than earlier models. One particularly alarming development is the marriage made possible by the end of the Cold War of the Air-Independent Propulsion (AIP) system of some modern non-nuclear submarine with submarine-launched anti-ship missiles. Armed with Harpoons or Exocet missiles available from several western suppliers, these platforms can launch fire-and-forget missiles from over the radar horizon without the need for the noisy, battery-draining approach necessary for a traditional, torpedo-armed diesel-electric boat.

This capability circumvents the traditional ASW approach to dealing with very quiet diesel-electrics, which was to flood the ocean's surface with radar. The submarine is then forced to use speed – and its battery charge – to reposition to a radar-free area and conduct battery recharging operations undetected. In those circumstances, the submarine commander was forced to choose between operations that ran down its battery, potentially causing exposure, or staying quiet and defensive. However, modern AIP equipped SSK are not faced with this dilemma, as they now have the flexibility to operate for extended periods between recharging operations.

2.4 Unmanned Underwater Vehicles (UUV)

As the aviation service is grappling with challenges presented by the proliferation of various sizes of Unmanned Aerial Systems (UAS) sharing common airspace with manned platforms, the maritime domain is starting to see a significant increase in the use of Unmanned Underwater Vehicles (UUV), potentially sharing waterspace with manned submarines. As seen by the explosion in commercial sector's drone use, the aviation sector is far ahead of the maritime sector with respects to the number and capability of unmanned assets.

The development of UUVs is an emerging technology. Many of the existing models still require some level of tethering to a mothership and can be assessed as robotic extensions of that ship. Development is underway in many countries for a truly autonomous capability, which would provide a long dwell time with no man-in-the-loop required. Some systems currently exist, such as the oceanographic drone 'Waveglider.' This system operates autonomously for months on end travelling on the surface of the ocean measuring currents and other oceanographic data. But the development of UUVs in the warfighting spectrum presents two specific challenges to the maritime domain: detection and collision avoidance. Most UUVs are extremely small compared to submarines, but even a collision with a small UUV could cause damage to a manned submarine's propeller which could be catastrophic. COMSUBNATO is developing a procedure to address this issue to avoid Blue on Blue or Blue on White submarine and UUV interaction.

Secondly, and perhaps more critically, is the challenge posed by detection. Currently, there is no system, sensor or method in place to monitor a long duration, battery operated (i.e., silent) UUV. If an adversary were to develop a high-end kinetic capability using a UUV, NATO forces would remain extremely challenged to detect and defeat the UUV from accomplishing its mission.

2.5 Aircraft Carriers

Although many NATO nations refer to their capital ships as aircraft carriers, NATO has not yet embraced a definition which embraces the significant air power capability difference between Catapult Assisted Take-off and Barrier Arrested Recovery (CATOBAR) class nuclear-powered aircraft carriers and conventionally powered Short Take-Off Vertical Landing (STOVL) class of aircraft carrier. This study will use the term aircraft carrier to refer to the CATOBAR type CVNs operated by the US and France. The term Amphibious Assault Ship will refer to the STOL/STOVL carriers (UK Ocean and Queen Elizabeth Classes, ITS Garibaldi class, FR Mistral Class, US Wasp Class, SP Juan Carlos Class).

2.6 Oceanography

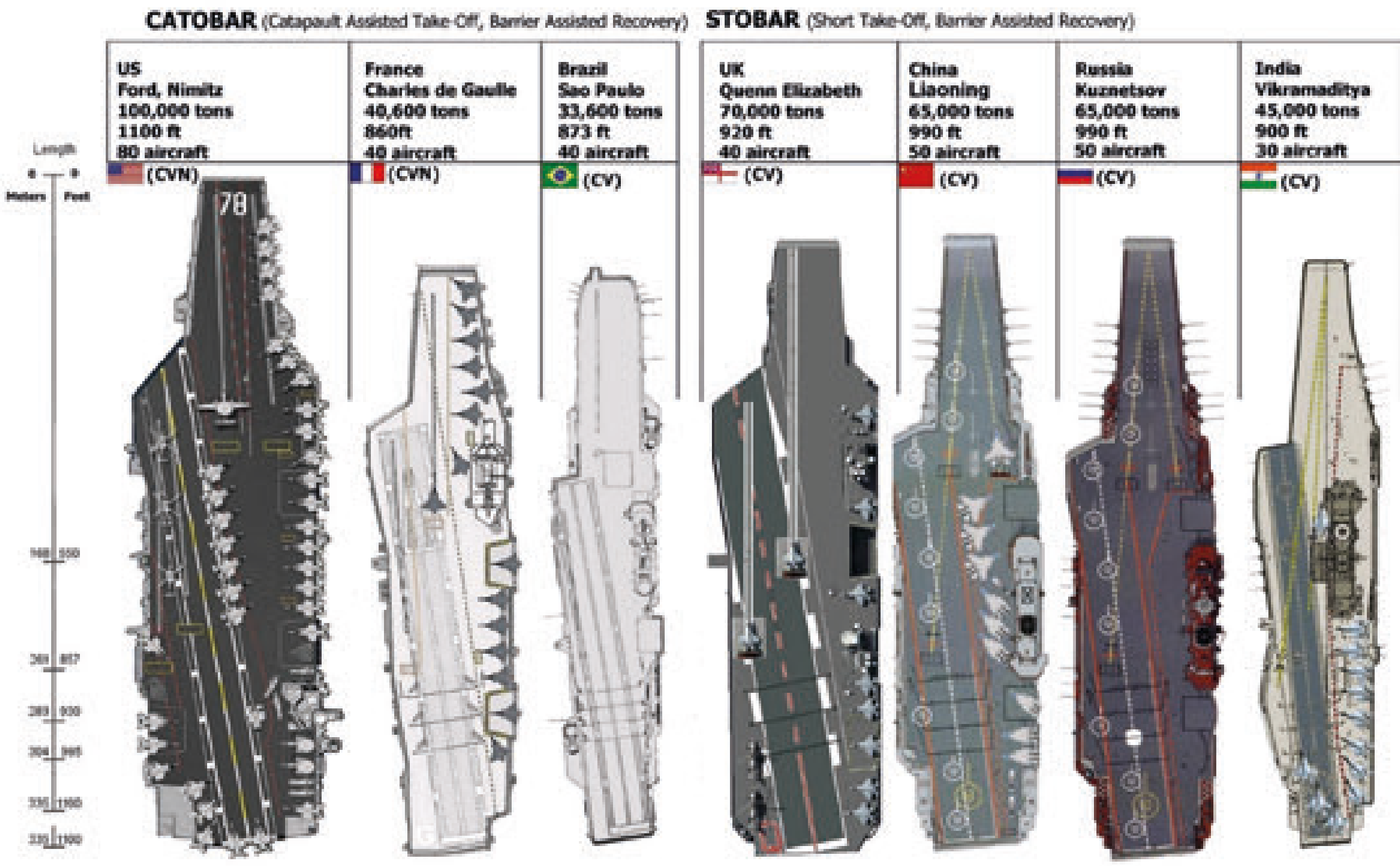
Oceanographic terms and other terminology applicable to understanding sound propagation in the underwater environment will be further defined in applicable sections of Chapter 6 and Appendix B.

2.7 Maritime Surveillance

Recently MPA ISR collection capability has evolved far beyond traditional Cold War ASW. With the advent of relatively cheap and readily available commercial technology, ISR collection capability writ large and maritime ISR specifically have expanded to aircraft of varying types and capability. For the purposes of this study, as they have no ASW capability, purely Maritime Surveillance aircraft will not be considered.

Maritime Surveillance includes all aspects of maritime-related ISR and Maritime Situational Awareness (MSA), most importantly the ability to develop a comprehensive surface picture via visual or electro-optical systems and radar (regardless of whether the radar has an imaging capability) and potentially including an electromagnetic detection capability to aid in correlating radar returns with targets of interest. The functions of Maritime Surveillance can aid the Maritime Component Commander's mission or be aligned with national objectives of counter-narcotics, counter-piracy, and maritime border enforcement. Maritime Surveillance may also incorporate functions such as pollution monitoring and

Figure 1 – A Comparison of Worldwide Aircraft Carriers.



other water measurements for environmental change impact assessment.

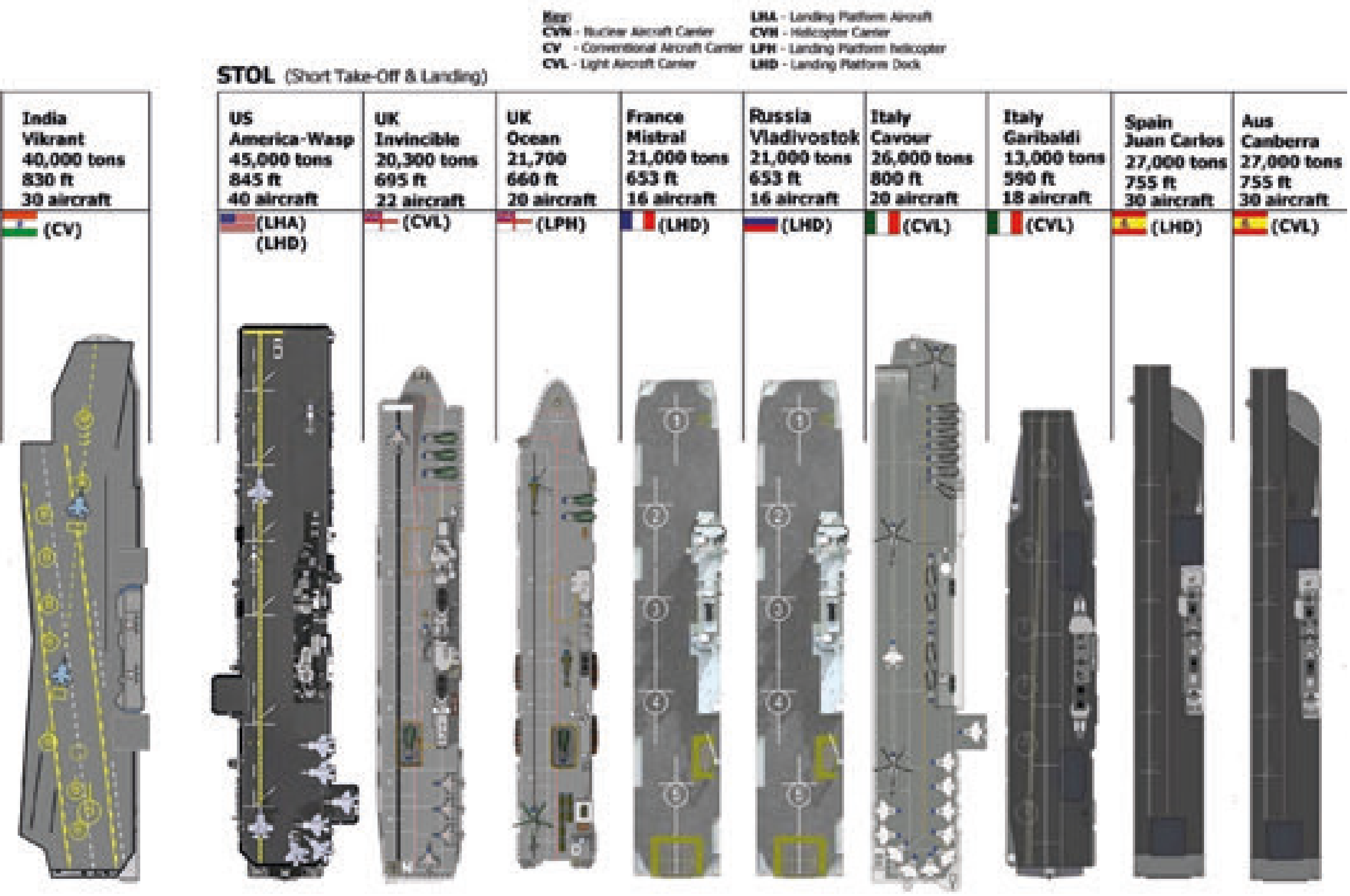
2.8 Maritime Patrol

Maritime Patrol contains all aspects of Maritime Surveillance, with the addition of anti-submarine acoustic tracking capability coupled with the ability to engage and eliminate either surface or subsurface hostile targets (missiles, bombs, mines, and torpedoes). Many nations are referring to new aircraft conducting Maritime Surveillance as MPA. For this study, only aircraft capable of conducting prosecution of a submerged submarine and deploying a torpedo and targeting hostile surface ships with missiles or bombs will be considered Maritime Patrol Aircraft (MPA).

2.9 Summary

Understanding the missions associated with each submarine class, the limitations of each type of submarine based on mission, hull and propulsion system construction, and, finally, how the submarine exploits the sound propagation properties at various parts of the water column are key to assessing the challenge each type of submarine presents for detection as we look forward.

1. 'Destroyer Captain: Lessons of a First Command'. Stavridis, James (ADM, USA N, ret). Naval Institute Press, 1 Apr. 2011, Pg 48.
2. 'How to Sink a US Carrier: China turns to France for Ideas'. Goldstein, Lyle. The National Interest, 13 Dec. 2015. Available online at: http://www.nationalinterest.org/feature/how-sink-us-navy-carrier-china-turns-france-ideas-14605
3. 'Anti-Submarine Warfare after the Cold War'. Cote, Owen and Sapolsky, Harvey. MIT Security Studies. Available online at: http://web.mit.edu/ssp/publications/conf_series/ASW/ASW_Report.html



A P-3C Orion flies over a Soviet Victor-III class Fast Attack submarine in the mediterrean sea circa 1983.

CHAPTER III

The Evolution of Theatre-Wide ASW Operations

3.1 A Multinational MPA Approach to Cold War ASW

Multinational submarine prosecutions were de rigueur throughout the Cold War, as many NATO nations retained an active MPA ASW force and routinely participated in joint submarine prosecutions. Coming on stride in the 1960s and sustained into the mid-1990s, NATO maintained a robust capability of cooperative effort to simultaneously prosecute multiple submarines utilizing MPA from many participating nations.

To counter the near constant presence of Soviet submarines, a robust organization was established for coordinated multinational ASW prosecutions. Having its origins in the aftermath of the World War II struggle to protect convoys from submarines with the explosion of submarine technology and numbers in the 1950s and '60s and the tensions of the Cold War as a backdrop throughout the '70s and into the '80s, this organization was critical to protecting Alliance member nations against the threat imposed by ballistic missile submarines, and to protect naval and merchant shipping against the potential threat of SSN hunter-killer submarines.

US forces in this campaign were led by Commander, Submarine Forces, US Atlantic Fleet (COMSUBLANT) who was responsible for ASW operations in the Atlantic Ocean. He directed these operations from his homeport in Norfolk, Virginia, (US) through Commander, Task Force 84 (CTF-84) in Keflavik, Iceland. CTF-84's resources were assigned by the Atlantic Fleet and included surface ships, Attack Submarines (SSNs), and Maritime Patrol Aircraft (MPA) and the Undersea Surveillance Systems (fixed and towed).[1]

The Soviet Union SSBNs in this campaign were deployed from their Northern Fleet. Their patrol boxes were in the Western Atlantic within striking distance of the North American mainland as well as European capitals.

Attack Submarines (SSs and SSNs) and Guided Missile Submarines (SSGs and SSGNs) also deployed out of the Northern Fleet, but were generally in transit to the Mediterranean theatre or operated in the eastern Atlantic. At this location, they stalked US Naval Units and patrolled sea-lane choke points. The patrol sequence settled into a busy routine for both the hunter (NATO ASW forces) and the prey (Soviet SSBNs). The Soviet SSBNs would depart their Northern Fleet bases into the Barents Sea and, round North Cape in Norway, transit the Norwegian Sea, clear the Greenland-Iceland-United Kingdom (GIUK) gap and emerge into the North Atlantic. South of Iceland, the SSBNs would then cross the Mid-Atlantic ridge and enter the North American basin continuing southwest until arriving at their patrol box east of Bermuda. At this point, the SSBNs would slow to a speed of approximately 4 knots and begin a meandering toward the south end of their patrol box. Normally, there were two SSBNs in the patrol box at any one time, with the arrival of one submarine timed to occur simultaneously with the departure of another. When one SSBN exited the box at the north end to transit home, another SSBN entered the box and began its southerly course; while SSBN at the southern end of the box would turn and start north.[2]

Figure 2 – Representation of a Typical Soviet SSBN Patrol.

The patrol box east of Bermuda was like a barometer forecasting potential trouble. If more than two Soviet SSBNs were in the box at any one time, or were in transit at any given time, it raised apprehension among US intelligence analysts. To counter the SSBN threat, two strategies were used. First, when each Soviet SSBN left port, they were closely trailed by NATO Fast Attack Submarines (SSNs) which remained with their target throughout the entirety of its patrol. They developed intelligence about Soviet SSBN tactics, procedures, and acoustic signatures. Second, NATO Maritime Patrol Aircraft of various nationalities and models (P-3 Orion, CP-140 Aurora, Breguet Atlantic, and MR2 Nimrod) maintained a near-constant 'on-top' presence over the Soviet SSBNs during their entire patrol, both in transit and on station in their patrol box. These MPA, along with the SSNs, allowed commanders two options to neutralize the Soviet SSBNs in the event hostilities began.[3]

The task of maintaining a constant presence on top of all Soviet SSBNs once they left port and returned after their patrol was a daunting responsibility involving crews from eight bases and four countries. When the SSBNs transited the Barents Sea and rounded North Cape, they were kept under close surveillance by the Norwegian Air Force and their P-3s based at Andoya. When the SSBNs were in the Norwegian Sea, P-3 Orions from Naval Air Station (NAS) Keflavik Iceland and UK MR2 Nimrod aircraft from Royal Air Force station (RAF) Kinloss Scotland joined in the tracking. When the SSBNs cleared the GIUK gap and crossed the mid-Atlantic ridge, they continued to be tracked by US P-3s from NAS Keflevik and MR2 Nimrods from RAF Kinloss Scotland and RAF St. Mawgan, Cornwall. Canadian CP-140s from CFB Greenwood, N.S. joined in the surveillance as they passed east of Newfoundland. When the Soviet SSBNs reached the mid latitudes and their patrol box east of Bermuda, they were then tracked by US P-3s from NAS Bermuda and NAF Lajes, Azores. With an operational radius of approximately 1200 nautical miles (and an on-station endurance of at least four hours) the MPA were able to cover the SSBN transit route and patrol box from their North Atlantic bases.[4] Bringing together prosecution capabilities of submarines, MPA, and other highly classified tracking sensors was the epitome of true theatre-wide ASW before there was a concept of 'theatre ASW'.

'For most of the post-Cold War era, there has been no consensus on ASW war-fighting or investment strategies, the various communities (submarines, surface combatants, aircraft, and undersea surveillance) have largely set their own priorities and fended for themselves.'
The Unraveling and Revitalization of US Navy Antisubmarine Warfare, Robert White

3.2 Theatre-wide Command and Control for Cold War ASW

Further enhancing the Command and Control (C2) model in use during the Cold War was the establishment of Task Groups underneath CTF-84. MPA Bases and ASW Operations Centres (later renamed Tactical Support Centres) around the Atlantic were designated under Operational Control of CTF-84 (Keflavik CTG 84.1, Lajes CTG 84.2, Rota CTG 84.3).[5] The true synergy of this effort was realized in the combination of the submarine forces, the highly classified acoustic detection SOSUS system; the ships with long range acoustic detection capability; and the multinational MPA localization, tracking, and if needed, engagement capability all under one commander for peace-time, anti-submarine operations. Concurrently, as shown below, a similar construct was developed for operations in the Mediterranean Sea.[6]

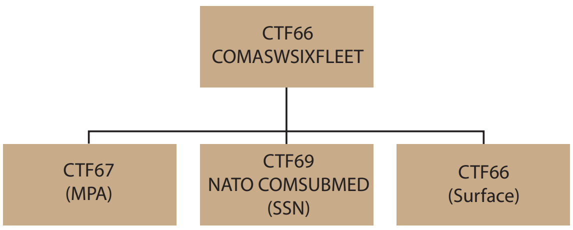


Figure 3 – ASW C2 circa 1980 – 1982. Commander ASW Forces SIXTH Fleet (COMASWSIXTHFLT) was established and in this role, CTF-66 not only coordinated air, surface and subsurface ASW assets, but also Alliance assets as NATO Commander Submarine Forces Mediterranean.

The synergy between the two commands was high, and well-coordinated handover procedures between both the theatre forces, Maritime Air Control Authority (MACAs), and national MPAs were refined to a high level. Procedures such as the 'Keflavik Covert Turnover Pattern' and processes to hand contact over between MPA to MPA, or MPA to NATO submarine and vice versa, during a transit of the Strait of Gibraltar were ingrained in MPA aircrew across both theatres. In fact, CTF-66 became so proficient it could determine, a priori, the path a submarine would take through the straits based on the hand-off of contact information from the Atlantic Command.[7]

3.3 The MACA Construct

In subsequent years, the Mediterranean Maritime Air Control Authority (MACA) network was developed as a multinational method for coordinating and providing mutual support for GBR, SP, IT, FR, US, GR, and TU MPA and MPH operations in the Mediterranean Sea. MACA Gibraltar had dual chains of command, both under CTF-431 (established in the 1990s) and also under CTF-84. MACAs were developed under national OPCON but over the course of their existence have been organized under both NATO and Multinational C2 structures. For example, in 1994, CTF-431 (assigned to the existing Commander Maritime Air Forces South, Naples IT) was formally established to oversee MPA operations in the Balkans and the Adriatic Sea. A formal task organization was created between each of the eight existing MACAs, designated as CTG 431.X.

This resulted in some of the MACAs renaming themselves from Maritime Air Coordination Agency (owing to the origins of MPA mission coordination and safety of flight de-confliction) to Maritime Air Control Authority as they began to exercise C2 authority over assigned MPA forces for the duration of the NATO Operation.

Thus, MACA Sigonella became CTG-431.3 (for example) and had TACOM over the US P-3s (permanently stationed) or Dutch/French/German MPA (when assigned) for the execution of CTF-431 missions. ASWOC Sigonella remained a CTU under the US MPA squadron CTG in the national command structure. When not executing NATO missions, the same ASWOC or MACA facility reverts to a national support system, and the regular national chain of command remains in place.

In 2010, CTF-431 dissolved as part of the consolidation of COMMARAIRNORTH with COMMARAIRSOUTH (Commander NATO Maritime Air North/South). During the creation of NATO's single Maritime Command, the command relationship between COMMARAIRNATO (CMAN) and the MACAs dissolved. Since then, the MACAs have reverted completely to their national mission support line of operation and only operate the MACA function during exercises.

Figure 4 – MACA Sigonella Unit Logo circa 2002.

Ground support, both for pre-flight coordination and mission planning as well as for post-flight acoustic assessment, data-processing, and timely dissemination of collected information about the target submarine, is critical to the success of any MPA ASW mission. Chapter 11 further explores the relationship between MPA and MACAs. It further highlights specific challenges to ASW mission support currently being experienced by today's MPA force and identifies a proposed strategy to mitigate many of these challenges.

3.4 Theatre ASW Commander

Although it has a lengthy history with the concept, NATO has not yet formally embraced Theatre ASW, nor has a Theatre ASW Commander been identified. According to US doctrine, the 'Theatre ASW Commander (TASWC) is a standing organization responsible for ASW C2 in a theatre area of responsibility. The TASWC has operational control (OPCON) of all theatre ASW assets: submarine, surface, and air, as well as information systems.'

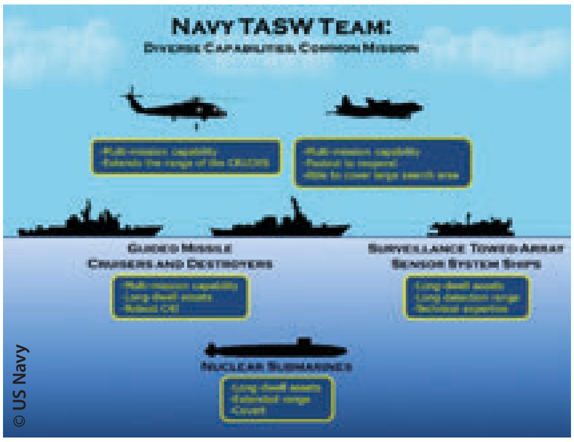


Figure 5 – Resources of a Theatre ASW Commander.

Although existing only within US doctrine today, Paragraphs 3.2 and 3.3 above have outlined NATO's lengthy history in exercising this operational concept in everything but name.

'During both pre-kinetic and kinetic operations, the theatre wide focus enables the TASWC to prepare the water space for the arrival of strike/task groups. Prior to their arrival, the TASWC pre-plans ASW operations and pre-searches the operating area. Upon manoeuvre into the TASWC AOR, the task group ASW commander will take control of the local area from the TASWC while the TASWC retains OPCON for the remainder of its AOR. The TASWC then monitors local execution of the plan, as well as any changes, through reports from the task group. In addition, it provides a reach-back capability for the task group ASW commander to call upon as required. Upon transit out of the area, responsibility returns to the TASWC and the new area transitions to local OPCON.'[8] NATO has not currently adopted this model in doctrine, but nations

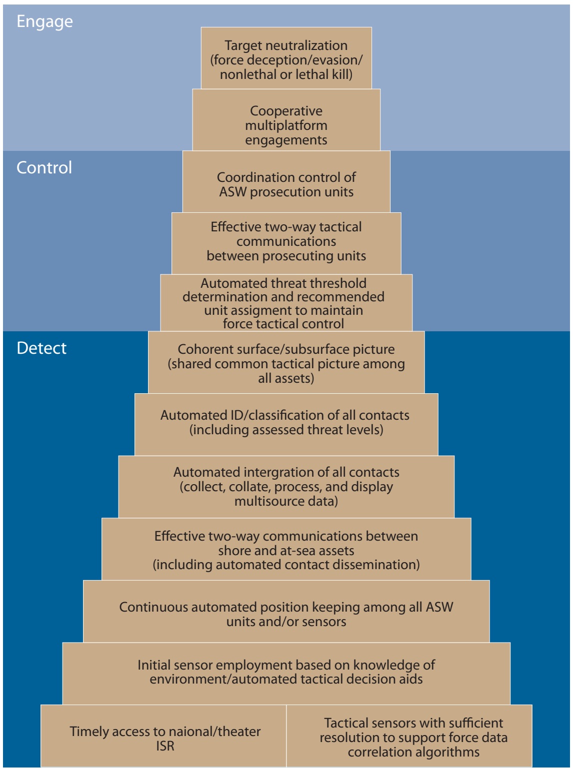


Figure 6 – Network-Centric–Based ASW Force Coordination.

on the more advanced ASW capability scale are discussing its merits.[9]

Many consider this a bridge too far for NATO's current command structure. Some postulate that this step is not warranted because without a standing NATO approved operation, there is no existing maritime component with the authority to conduct ASW. Others, such as SHAPE's Strategic Communications Chief Mark Laity, counter we are already in Phase Zero of a hybrid conflict and certain enduring functions must be conducted continually[10] Although he was responding to a question regarding operations in Syria, his comments are poignant and on target when viewing ASW from a larger scale.

The US and allies in the Pacific region have conducted numerous theatre-wide exercises, to include national (Valiant Shield series), Bilateral (both with Japan and the Republic of Korea), and Multinational (Rim of the Pacific-RIMPAC) where the TASWC construct was exercised, tested, and employed.

Observations from RIMPAC 2014

'Theater ASW requires a team and teamwork, not only among the surface, air, and subsurface warfare communities, but also with our coalition partners.'
Rear Adm. Phil Sawyer, commander of Submarine Force, US Pacific Fleet.

'RIMPAC's theater anti-submarine warfare exercise is all about gaining experience; each different country brings a different set of skills … tying it all in internationally, we can take various bits of information from each country and come up with an international way of doing business.'
Royal Australian Navy LNO Lt. Martin Talbot

Additionally, prosecutions of non-Japanese submarines operating near the Japanese islands have operationally employed the TASWC executed by CTF 74 in a bi-lateral construct with Japan and Multi-lateral arrangement with RoK Navy forces.

Further enhancing interoperability at the Theatre and Tactical level, Japan has occasionally embarked forces on US command ships to more fully integrate Japan Maritime Self-Defense Force's (JMSDF) forces into the Composite Warfare Commander (CWC) structure. In 2015, JMSDF Commander, Escort Flotilla 2, Rear Admiral Hidetoshi Iwasaki, assumed the role of Sea Combat Commander (SCC) onboard the US Navy's forward-deployed aircraft carrier USS RONALD REAGAN (CVN 76) during Annual Exercise 2016 (AE-16). During strike group operations, the SCC is responsible for defending the aircraft carrier from surface and sub-surface opposed units.[11] In previous exercises, the ASW staffs had remained segregated by country with the JMSDF staff remaining aboard JMSDF ships. This model of combining both the tactical level staffs aboard one flagship and the theatre wide ASW planning staffs at the MPA headquarters (for bi-lateral MPA planning) and CTF-HQ (for overall C2 of the theatre-wide prosecution) is a model NATO should assess for utility in the MARCOM command structure.

3.5 Is the NATO Command Structure Sufficient?

Russia has recently increased its submarine presence throughout the NATO AOR. Chapters 4 and 5 will provide further insight into Russia's submarine employment strategy. However, with specific regard to C2 of ASW forces as discussed in this chapter, it is noteworthy that in an effort to generate MPA coverage of a recent non-NATO submarine transiting on the surface, MARCOM requested support from multiple NATO nations. Two issues complicated this prosecution.

Firstly, MARCOM is not assigned any forces to execute an ASW prosecution. The Standing Naval Groups over which MARCOM has OPCON are scheduled by SHAPE, not MARCOM, for maritime engagement activities. This prevents MARCOM from redirecting and employing them for ASW without SHAPE and potentially NAC approval. Furthermore, those Standing Naval Groups are, according to a recent Maritime Strategy Paper briefed to the North Atlantic Council, 'consistently under-resourced and lack the ability to sustain high-level operations over a prolonged period of time.'[12]

Secondly, MARCOM is not vested with the authority to directly allocate or support MPA or submarine forces. It has a 'gentlemen's agreement' with the nations … some choose to support when it aligns with national objectives, others choose not, or are not able to, based on the availability of forces. Additionally, there is no formal information sharing mechanism between the national MACAs (or Maritime Ops Centres). Following a recent submarine transit, weeks passed before some nations provided even basic data such as the submarine position. No acoustic data was shared across the force, and limited data was provided between nations to support refined mission planning. *If this particular submarine had submerged, many believe a coordinated subsurface acoustic prosecution would have been impossible because NATO is missing a command structure to coordinate the necessary resources effectively.* This is not the last non-NATO submarine to challenge NATO's current ability to locate, detect, and track submarines.

Due to the nature of protecting friendly submarine operations, during the early phase of any non-NATO submarine prosecution, details involving the target location and nearby friendly assets conducting operations at this stage of a prosecution will remain extremely guarded. This will impact the available command structure for this portion of the prosecution. It is not feasible to involve the entire Alliance at this early stage, as there are information sharing challenges in this domain which likely would not be overcome. However, as the prosecution of a non-NATO submarine continues out of these remote areas and closer to the European continent, it will require the resources of more nations and should ideally become a NATO-led prosecution.

3.6 TASWC EXTAC

In early 2016, Commander NATO Submarine Forces (COMSUBNATO) drafted an Experimental Tactics publication (EXTAC 181), which was endorsed by the 2016 Maritime Operations Working Group and is expected to be formally published later in 2016. Although this EXTAC outlines the initial concept to stand up an Area ASW Warfare Coordinator, this study determined the proposed C2 structure does not go far enough in solving all of the authority challenges currently experienced in this domain.

The proposed structure does outline a robust coordination network, but falls short in establishing a true chain of command. It relies on the will of nations to share information without a defined command and control relationship. This is the reality with which MARCOM has struggled for the last few years. Although this EXTAC is a step in the right direction and gets nations talking about processes which NATO has recently executed poorly (i.e. sharing location data on submarines), the language in the draft EXTAC is not robust enough to solve the current challenge.

3.7 Recommended TASWC C2 Structure

Therefore, accepting that in the very early stages of submarine detection intelligence on the target may remain within a small group of nations and prosecution

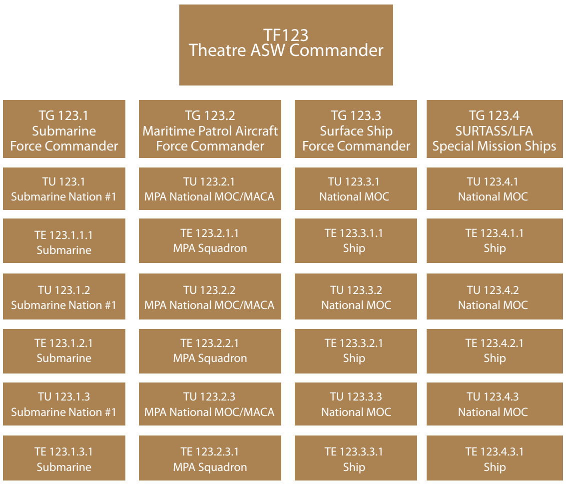


Figure 7 – Notional TASWC Command Structure.

plans will executed only by this core group, this study recommends that when the target submarine crosses some to-be-defined geographic boundary, the handover of the prosecution to NATO's TASWC would occur and involve all NATO Maritime Nations. MARCOM (including COMSUBNATO and CMAN) will need to coordinate with the nations to whom this applies and develop a handover procedure to the NATO TASWC, to include processes for submarines arriving into NATO's AOR from the High North or Baltic Sea. For submarines originating within the NATO AOR (i.e. a submarine which originates from the Black Sea or within the Mediterranean), NATO TASWC would have the lead for all stages of the prosecution. Below follows the recommended command structure for the TASWC.

As the last 15 years have seen some nations expand their MPA capability (i.e. Poland and Turkey) or re-align the internal structure for national control of MPA, MPH and ASW ships into Maritime Operations Centres, any future C2 structure must include a link into each national element capable of conducting C2 of MPA, MPH, Submarine and 'other' special mission ships (for those nations with the capability such as Surveillance Towed array Sonar System-SURTASS and Low Frequency Active ships). One added benefit of this structure is the ability to promulgate the prosecution posture. The prosecution posture includes elements of tracking where some aspects may be more provocative than others and may not align with a strategic goal. These items include whether the use of active sonobuoys or submarine overflight with bomb-bay doors open would be permitted. Providing clear and universally implemented direction for all nations in each specific submarine prosecution is critical to achieving NATO's strategic objectives. This is because not all tracking efforts need to achieve the same effect and the goals for each prosecution may vary. Today, there is no entity capable of setting the standards for each prosecution. It falls to each nation and experience has shown that leads to drastically different results on-station.

To generate the appropriate authorities to execute all phases of Theatre ASW, ranging from peacetime tracking of a transiting non-NATO submarine to coordinating screening efforts for NATO Naval Task Forces to overseeing the handover of prosecution to the local ASW Commander within a Naval Task Force, and if necessary, coordinating and overseeing the attack phase of a submarine prosecution occurring outside the local ASWC's area of responsibility, this study recommends creating a standing Task Force with the following command relationships:

Regions or sectors with a 'lead-nation' role will need to be geographically identified. This implies a particular nation would be responsible for providing national ASW assets, and would provide basing and mission support for other nations' MPA and MPH entering the region to assist in the prosecution. The lead nation's MACA/MOC would be charged with oversight and collection of mission data from MPA and MPH and provide it to the TASWC (MARCOM). MARCOM would then call on other nations to fill gaps in resources. These may run the gamut of ASW resources, including MPA, MPH, ASW ships, submarines, and if necessary, coordinating with AIRCOM for the use of ISR assets overwater.

Finally, and perhaps most critically, handover procedures as the submarine transits from one lead nation's AOR to another must be identified. This would be the overall responsibility of a Theatre ASW Warfare commander but must be agreed to and adopted by the nations executing the tactical phases of prosecution. This is a process that ideally is in place prior to the commencement of operations and in many cases can be a standing arrangement once codified.

None of this is new. In the 1970s and into the late 1990s, the Consolidated Maritime Briefing Book (a CONFIDENTIAL document shared amongst the countries participating in ASW at the time) promulgated the ASW C2 structure in use, MPA and MPH roles in different types of prosecution procedures (overt/covert), Air-to-friendly submarine coordination procedures, prevailing meteorological and oceanographic items of note in each specific region, and specific bottom topography features with notes on specifically how/where to use passive sonobuoys to exploit the unique characteristics of sound propagation around those features. Perhaps most critically, its periodic updates provided the sole resource for retaining salient lessons learned about adversary counter-detection tactics specific to the exploitation of the ocean environment in that region.

Each ASWOC was charged with maintaining currency and profiency regarding their specific region. As the ASW command structure dissolved in the late 1990s, and the subsequent closures of ASWOC Keflavik, Lajes, Rota, and Gibraltar, this critical ASW resource was no longer updated. Following MACA Sigonella's regional update in 2002, this document has vanished into obscurity, and no record could be located for this study. If a copy were to be located in any national archive, it would fill many current information gaps identified in the lead-nation concept. Perhaps it is worth the effort to recreate the data before the last ASW officer or sailor with Cold War ASW experience and first-hand use of this publication were to retire from service.

3.8 Summary

The key strengths of a submarine are stealth, silence, and depending upon the type of submarine, speed. Finding a hostile submarine poses the most significant challenge to ASW forces. As a general rule, once a submarine has been detected and forces assigned to execute the tracking phase of a submarine prosecution, whether MPA, surface ship or another submarine, those forces are usually successful at maintaining contact, or regenerating contact should it be lost for some time. The challenge to ASW planning becomes one of geography and distance: As a submarine passes from a known position to an unknown position (whether leaving the pier, passing through a choke-point or through loss of acoustic tracking data for some reason), the potential location of that submarine expands exponentially as a function of time and transit speed (i.e. nuclear and diesel submarines have drastically different transit speeds due to their propulsion design. Therefore the time-late furthest-on circle expands at a different rate). A coordinated effort at the theatre level has shown to be the most efficient in managing resource shortfalls and maximizing employment of assets to regenerate contact on submerged submarines.

As many nations have reduced their national inventory of MPA and submarines, and while non-NATO submarine patrols in the NATO AOR continue to rise, NATO should explore methods to improve interaction between NATO ASW forces. This should seek to minimize both resource shortfalls and maximize sensor coverage provided by available ASW assets. This analysis must include a holistic review of C2 and a thorough assessment of required capabilities provided by MPA/MPH ground support stations to enhance interoperability. NATO should look to establish a Theatre ASW Commander structure for use in peacetime, modelling the success of this construct both within NATO's history and in other multinational arrangements in use today across the globe.

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Maritime Patrol Aircraft from nine NATO Nations are staged for Anti-Submarine Warfare missions (NAS Keflavik circa 1996).

CHAPTER IV

The Russian Perspective – Strategy for Submarine Employment

'Among the most intangible qualities of a combat force are those cultural factors that influence its basic fighting capabilities. To take what is the most sensational example, consider the Kamikaze pilot. No mere quantitative assessment of the Japanese tactical aviation forces of the Second World War could have accounted for Kamikazes. Only an assessment of cultural characteristics could have keyed analysts to the possibility. In retrospect, we can understand the Japanese belief in the divinity of their empire and the cultural abhorrence of shame that could allow for creating pilots sufficiently motivated to embrace suicidal missions.'
Edward Timperlake[1]

With that in mind, it is critical to consider President Vladimir Putin's maritime strategy, including the role of submarines as a critical component of power projection. Over the decades, NATO has continually failed to understand, predict, and prepare for Russian military actions, which, when viewed through the lens of history, should have been anticipated. Russian maritime strategy has traditionally relied upon the strategic importance of submarines, dating back to the time of the Tsars. Yet there remains today amongst many NATO politicians and military leaders a pervasive and dangerous attitude that today and tomorrow's Russian Federation submarines were defeated in the Cold War and will not provide a significant impact to NATO. Recent examples prove otherwise.

4.1 From Politics to Strategy

Analysis in Appendix A shows a link between Russian influence and the rise of populist, nationalistic, and xenophobic political parties across Europe. Many of these entities receive financial support from Russian-affiliated non-governmental organizations (NGOs).[3] Taking advantage of Europe's economic malaise, these increasingly successful fringe parties have contributed to the weakening of political support for the European Union and governments across Europe.

'The transatlantic community awoke March 18, 2014, to a strategic surprise: the Russian Federation, a 'strategic partner' of the EU, had formally annexed Crimea.'[2]

Their impact is most evident in the former Eastern Bloc, where institutions and civil society remain underdeveloped and susceptible to the revitalization of former Soviet networks. As Heather Conley wrote in 2015, 'Although the 21st-century East-West confrontation does not bear the same ideological vestiges of the Cold War, there is a clear ideological component today … The unqualified success of Central Europe's transformation from Communism to liberal democracies and market economies is not immutable, and we should not trick ourselves into believing it is so.'[4]

Although many government officials and experts perceive Russia as weak, Putin has proven time and time again he is highly adept at successfully 'playing what appears to be a weak hand.'[5] Ukrainian President Peter Poroshenko has described Putin as 'unpredictable, emotional, and dangerous.'[6] Whether President Putin can manage and for how long is an open question, but we not should assume it will end in the near term or whoever comes after Putin will be more open to negotiation.[7]

'NATO's new Eastern Front – consisting of … the Baltic States, Poland, Romania, and Bulgaria – wants physical assurances that NATO will prevent potential Russian aggression, not reassurances that NATO will respond to aggression after it has occurred.'[8] A similar perspective should be applied to ASW: if we as an Alliance are not proactively monitoring submarine activity in peacetime, we cede the initiative to our potential adversaries and allow them to hold the entire Alliance Maritime enterprise (military and civil) at risk. Finding a submarine after it has achieved its mission is too late – Alliance security, in the Maritime domain and beyond, requires continuous presence and overt tracking.

4.2 Putin's Strategic View of the Navy

A Grand Strategy for Maritime Forces

'The renewed interest and investment in sea power is a component of Russia's increasing assertiveness and desire for global influence and power. Contemporary Russian maritime thinking is marked by a significant coherence in its aims, objectives, and synergies with wider Russian grand strategy.'[9]

Russia's formal doctrine for the employment of its naval forces matches much of her Western counterparts. Current Russian Federation doctrine defines 'opposing [Western] naval task groups' as a core operational-strategic task of the Navy, in addition to strategic deterrence. 'It will engage with fires the adversary's naval task forces in the far and near maritime zone, it will aid other Armed Forces services operating in sectors with an outlet to the sea. The forms of the Navy's employment will be as follows: first and subsequent fleet operations (within the framework of a maritime operation); combat operations by the fleets to engage naval task forces and other important targets. This is intended to aid in ensuring 'a favourable operational regime', that is, sea control for maritime operations.'[10]

The operational and tactical employment of all classes of submarines fits well into both the politically stated and doctrinally published strategic goals of the maritime service.

Furthermore, according to Vladislav Inozemtsev of Moscow's Higher School of Economics, a recently stumbling Russian economy does not lead to the Kremlin spending less on its military and internal security forces or to the beginning of widespread political upheaval.[11] Russia's economy has been in a downward spiral for years – not just because of falling oil prices and Western sanctions, but because the government itself is increasingly bloated. It is spending

Figure 8 – 'Whiskey' on the Rocks.

more on weaponry rather than stimulating the country's business sector. The Kremlin has been successful in convincing the public that its economic woes can be blamed on the West – for sanctions causing food prices and unemployment to rise. It also has distracted Russians with interventions in Crimea and eastern Ukraine.[12] Russia's history with showcasing military might in an effort to quell or respond to challenges in the homeland feeds directly into Putin's vision of the role of submarines to achieve his grand maritime strategy.

A Russian View of the Baltics and the High North

Having strategic, geographic importance for any conflict between Russian and other nations' naval forces, the Baltics are of considerable relevance to any maritime scenario. Submarine operations in the Cold War were frequent in this area, as well as other important strategic areas in and around the North Atlantic. It is logical to assess that Russian submarines would conduct operations to familiarize themselves with the operational environment in the Baltics in preparation for any potential maritime conflict. The Baltic Sea could be used as a staging area for the conduct of cruise missile attacks, a haven from which to expand operations into the Atlantic, or an area in which to lie in wait for NATO forces.

However, specific operations conducted around Sweden during the Cold War also outline the Soviet perspective on that nation's neutrality. This perspective is a likely impetus for the current submarine operations in the Baltics. As noted in a 1990 RAND study, '(a)lthough Sweden's stated policy is one of non-alignment [with NATO], Swedish sympathies and security interests lie with the West. Though this is not the public view of the Swedish government, this is certainly the perspective of the Soviet planner … Soviet submarine incursions and related operations can be fully interpreted only within the context of such a scenario.'[13]

Highlighted by the famous 'Whiskey-on-the-Rocks' grounding of a Soviet Whiskey Class submarine in October 1981 in the waters of Gasofjarden, incursions into Swedish territorial waters were aggressively tracked through their high point in 1989 at more than 30 violations.[14] In fact, an investigation into the Whiskey grounding, including logbook entries, revealed intentional, deliberate and systematic incursion.[15]

Although the 'Soviet' government is not the reigning power in Russia today, both the military objectives and the Soviet perspective on Sweden outlined above may colour modern Russian military planners. In fact, it may be a driving influence on some of today's Russian submarine activity. As a case in point, in both 2014 and 2015, Sweden detected Russian submarines operating inside its territory on multiple occasions, a claim which the Kremlin disputes.[16, 17]

Additionally, some Russian military planners view operations against Sweden's ASW forces (surface ships and ASW helicopters, land-based radars and surveillance aircraft), as an opportunity to practice counter-detection against high-end Western capabilities without necessarily engaging NATO forces.[18]

Looking to the High North, Russia's operations in the Arctic cause interaction (and friction) with other nations having claims to the region. This area is also the traditional space for early interaction between western ASW assets and Russian nuclear submarines traveling south into the Atlantic. Based on the location of the Russian North Fleet and the remoteness of this area (providing an excellent training location for Russian submarine crews), the High North should continue to be an area of interest for Alliance and partner ASW forces. Some analysts have noted that Russia has recently prioritized the High North as a focal point for operations through investments in submarine upgrades, evolution in doctrine and a renewed comprehensive maritime strategy.

The Role of Submarines in Putin's Navy

Putin has long held that Russia's ability to project influence is tied to having a strong maritime presence. From the 1960s up to the 1990s, the Soviet Navy conducted distant operations to achieve this level of influence. In 2013, TASS announced that, after a 21-year hiatus, Russia planned to resume nuclear submarine patrols similar to those seen in the Cold War in the southern seas to continue Putin's vision of a strong and agile military.[19] Additionally, the Kremlin has stated in response to NATO expansion, Russia would station a permanent naval presence in the Mediterranean Sea and increase ongoing activity in the Atlantic and Arctic.[20]

'There is more activity from Russian submarines than we've seen since the days of the Cold War. This is very different from the period of quiet submarine activity that perhaps we've seen in the past.' Simultaneously, the technical capabilities displayed by Russian submarines have increased. It is 'a level of Russian capability that we haven't seen before,' the admiral says. The Russian Navy accomplished this 'through an extraordinary investment path not mirrored by the West' and has made 'technology leaps that [are] remarkable, and credit to them.'

Vice Admiral Clive Johnstone
Commander, Allied Maritime Command[21]

In late 2015, two Bulava ballistic missiles were test-fired off of a Borei class submarine,[22] the Russian Federation's newest SSBN. The Bulava ballistic missile is the next generation component of the Russian nuclear triad and although testing throughout the early 2000s saw mixed success, the most recent five tests firings have all been successful.[23] This represents validation of one the stated purposes of the SSBN fleet and is in keeping with Putin's grand maritime strategy of ensuring Russia remains globally relevant and part of any conversation between global powers.

If one accepts a common Western perception 'there remains a deep-seated failure to grasp that aggression against Russia in one form or another is not a key aim of NATO or US policy – which stems from the even deeper failure to perceive that, in the current decade, it is no longer axiomatic that no significant problem can be addressed without Russian involvement,'[24] then Putin's stated goal of a powerful navy and expansive submarine force makes more sense, and should not be quickly discounted.

Submarines as a Strategic Communications Tool

NATO's Chief of Strategic Communications, Mark Laity, remarked that 'the purpose of Strategic Communication is the marriage of communications and messaging delivered specifically to achieve a desired effect.'[25]

Just knowing a submarine is out there causes naval planners to conduct risk assessments and account for the potential action of that submarine. Announcing deployments of ballistic missile submarines, transiting on the surface from the North Fleet to the Black Sea and test firing ballistic missiles (and more recently firing live warheads into Syria from Kilo Class SSKs) all result in NATO's maritime planners accounting for Russia's activity – achieving a strategic effect in line with Russia's grand strategy.

4.3 Recent Russian Submarine Operations

Russian Navy Chief Admiral Chirkov noted from January 2014 to March 2015 the intensity of patrols by submarines has risen by almost 50 percent as compared to 2013.[26] Not only has the deployment number been on the rise, but also the strategic effect of each deployment is starting to be realized.

- In 2009, a pair of Akula class SSNs deployed inside of 200nm from the US East Coast, the first mission of its kind so close to shore in nearly a decade. The White House indicated they did not know specifically what the submarines were doing, while Pentagon officials elaborated the submarine mission appeared to be part of efforts by Moscow to show a greater military presence around the world.[27]

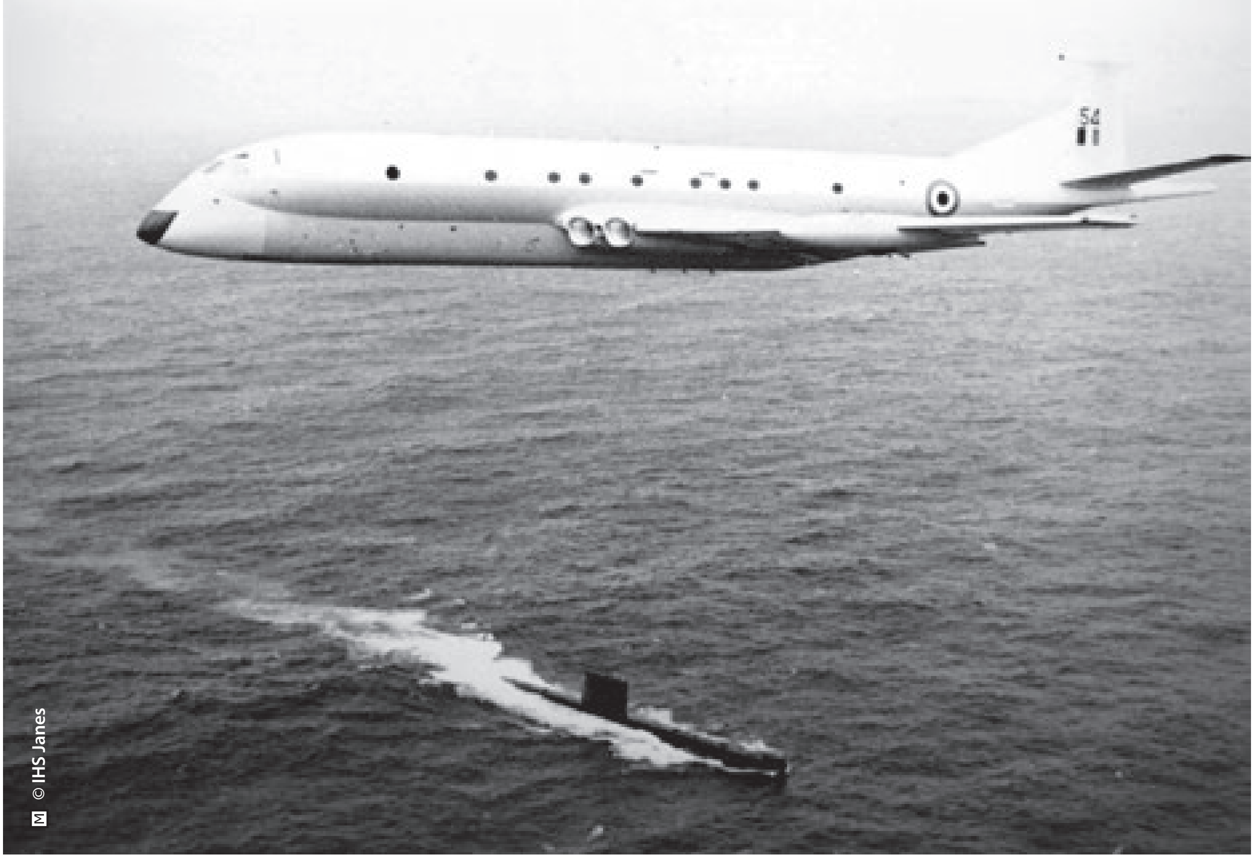

Figure 9 – GBR Retired its NIMROD Fleet and Was Forced to Request NATO Assistance to Track Russian Submarines.

- In Aug 2010, an Akula class SSN was discovered attempting to track a UK Vanguard Class Ballistic Missile Submarine (carrying the National independent nuclear deterrent) off the Clyde Approaches (off the coast of Liverpool, UK).[28]
- In late 2012, an Akula SSN allegedly remained undetected for several weeks while conducting operations in the Gulf of Mexico.[29]
- Later in 2012, a Sierra-2-class guided-missile submarine crept within a mere 200 miles of the Eastern Seaboard of the United States and observed operations of a US Carrier Strike Group.[30]
- In the Mediterranean, Russian submarines have similarly increased operations, including participation in a large scale naval exercise off the coast of Syria in January 2013.[31]
- In December 2014 and early 2015, Britain asked on multiple occasions for NATO MPA assistance to search for a submarine reportedly operating in Scottish waters, as the UK no longer has MPA capability.[32]
- In September 2015, a Kilo SSK conducted an intra-fleet surfaced transit from the North Fleet to its new home in the Black Sea. More Kilos are expected to make this transfer in the upcoming years, re-establishing Russia's ability to deploy submarines into the Mediterranean Sea with little notice and bringing the Kilo's 'Kalibr' cruise missiles within range of targets in Eastern Europe.[33]
- In perhaps the most notable and most visible example of the modernization of Russia's submarine force, in December 2015 the second Kilo en route to the Black Sea conducted Kalibr cruise missile strikes into Syria.[34]
- In January 2016, as research for this project was coming to a close, the French Navy detected a Russian Nuclear ballistic missile submarine, likely a Delta-IV class SSBN, operating just outside the Bay of Biscay.[35]

This list serves to highlight recent noteworthy deployments. There have been more. In fact, some reports indicate that the UK may have asked for NATO MPA assistance as many as 20 times in 2015 to prosecute submarines near British waters.[36]

As a result of the Russian Federation's recent surge in military activity in what has recently been referred to as the 'arc of steel' (from the Arctic to the eastern Mediterranean), the US finds itself, in the short term, forced to review its global posture in terms of air and naval assets. The reinforcement of Russia's military strongholds in the Far North, – bases, surface-to-air batteries, troops, etc. – has resulted in an unprecedented 'anti-access/area denial' challenge, which neither the resources nor the current strategy of the US (and NATO) are capable of countering.[37]

As established in Tom Spahn's recent 'Proceedings' article, US Navy planners are growing increasingly concerned with the link between stated Russian intentions and the reality of the significant increase in actual submarine patrols. 'Although Moscow has made no attempt to conceal the fact that it plans to accelerate submarine operations, the audacity of some recent patrols exemplifies a troubling trend.'[38]

'The language coming from the Russian military reflects the mindset and actions characteristic of direct challenge and confrontation with NATO. What makes this approach troubling is hybrid warfare coupled with the ever-present threat of the full application of robust conventional and nuclear forces.'
Admiral Mark Ferguson, Commander, Joint Forces Command Naples in a briefing to North Atlantic Council 6 October 2015

4.4 The Link Between the Russian Populace and the Kremlin's Use of Military Force

In reviewing Russia's past to assess Putin's likely future intentions, it is important to remember Putin frequently broadcasts his intentions. Unfortunately, those signals are often either overlooked, ignored or not believed, frequently due to western behavioural mirroring. As of the writing of this study, the global price of oil has hovered for weeks at a decade-low $30 per barrel. The Russian economy is mired in turmoil and nearing stagnation; however, many assess a proportional increase in defence spending (as seen by the strategic goals of shipbuilding and naval deployments) will not only continue, but increase in the coming decades as Russia attempts to keep pace with global powers.

Ordinary Russians are suffering because of the devastating impact of low oil prices and Western sanctions. Kottasova and Chance reported in January 2016 that real wages fell 9.5 percent in 2015, and official data show an average Russian earning just over 30,300 Rubles ($385) a month last year. At the same time, prices are rising fast. Inflation hit 12.5 percent in 2015 and could take a long time to slow down if the Ruble continues to fall. The currency has plunged since the start of the year, hitting an all-time low of 85 Rubles per dollar on (21 January 2016). Official statistics show over 20 million Russians, roughly 14 percent of the population, are now living in poverty. That compares with 16 million in 2014.

While Putin still enjoys approval ratings of up to 89 percent, small cracks are starting to appear in Russian resilience. Russian long-haul truck drivers have protested outside Moscow against a new road tax they say could destroy their business. Pensioners in the Olympic town of Sochi blocked traffic demanding free transportation to be reinstated in the city after it was cut as part of the country's austerity measures. Businesses in Russia's crucial oil and gas industry are also complaining about punishing conditions. The price of oil has collapsed in the last 18 months, sending their revenues plunging.[39]

All of this has resulted in a growing sense of unrest within the populace, which history suggests may result in a military show of force from the Kremlin. This is likely to be directed not at the populace, but at the world to demonstrate capability, resolve, and strength with the secondary effect of building national pride within the Rodina.

'They want to be a major global power but with a limited ability to do it-that makes them more unpredictable … It puts an enormous pressure on the Russian leadership to deliver something to the Russian public.'
Lieutenant General Kjell Grandhagen
Director of the Norwegian Intelligence Service

In the latter half of 2015, this type of demonstration took the form of an arms show over Syria, showing to the world the might and reach of Russian Federation military capabilities, including submarines. In 2016 and beyond, as President Putin has already expressed, it is likely NATO will see the increase in submarine deployments continue for many of the same reasons.

In fact, in conjunction with the re-establishment of a permanent submarine presence in the Black Sea with the reassignment of a portion of the North Fleet's Kilo

SSK inventory to a new homeport, in Novorossiysk, Russia, (just east of the former Russian naval base in Crimea) the Russian Federation Navy has also 'revived the Soviet-era practice of permanently stationing warships in the Mediterranean, with large destroyers and cruisers beginning to patrol in January 2016.'[40]

'The new maritime doctrine tells us that Russia will counter our existing ASW technologies; challenge US and NATO's maritime presence in the Atlantic as well as the Baltic, Black, and Mediterranean seas; and expand Russian permanent presence in the Arctic and Mediterranean.'

Vice Admiral James Foggo, Commander, US SIXTH FLEET[41]

4.5 Summary

This chapter reviewed the political backdrop of the evolution of the current Russian Military stemming from the economic challenges following the Cold War. A historical background and insight into Putin's motivation for the current use of military force to achieve his grand strategic plan was further explored, with further details outlined in Appendix A. There is a clearly defined link between the economic status and the challenges faced by the national population with an expansion in military spending and operations. Additionally, there is a clearly defined global ambition for Putin to ensure the Russian Federation remains relevant and interacting with Western powers as a peer in any global issue.

As a backdrop to understanding the development of Russian maritime strategy, Appendix A provides further insight into the cultural issues at work within the Soviet Union and the current Russian Federation which influence the behaviour of its political leadership and the operations of its military forces. Additionally, the Appendix includes an assessment of the impact of economic sanctions on the Russian Federation and how sanctions may have resulted in President Putin's viewpoint on the use of submarines as a portion of his grand maritime strategy.

As it pertains to this study, this chapter and the associated appendix provide a detailed counter-argument to the prevailing theory that the Russian military is not operating at significant levels, nor is comprised of significant submarine capability, to warrant prioritization of effort. It is this prevailing attitude which has resulted in the ASW resource and MPA inventory shortfall which will be elaborated in Chapter 8.

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A Russian Akula SSN was leased to india in 2012.

CHAPTER V

Submarine Development

5.1 The Russian Federation's Submarine Development

In the past decade, Russian shipbuilding has made great strides in returning to a dominant role in the world. Submarine construction is a key aspect of this. Not only does ship and submarine export continue to be one of the major sources of Russia's income, but, as many of the Cold War era submarine classes are at the end of their service life, Russia is expending significant effort to upgrade its entire submarine fleet with modern replacements. These upgraded systems still retain ballistic missile strike capability coupled with the full gamut of nuclear and diesel-electric mission submarine portfolios.

Although the new submarine classes are extremely capable and are slowly narrowing the capability gap with NATO submarines, the decades of neglect of the Russian maritime service and significant delays in construction of new classes have resulted in a significant inventory reduction of the Russian strategic and attack submarine fleets. However, Russia has recently invested significant resources and effort to address this, and it is likely to see increased numbers of these new classes in the near future. This chapter provides a brief overview of the capability of the new classes either currently at sea or in development.

SSBN

The Yuri Dolgoruky, Russia's newest ballistic missile submarine and first of the Borei Class SSBNs, officially entered service in the Northern Fleet in early 2013.[1] Upgrades over previous models include advances in quieting technology, including to the propulsion system. As an SSBN's primary mission is strategic strike, the deterrent capability of the submarine is linked with the capability of its embarked missiles. Although the Yuri Dolgoruky was completed in 2008, significant delays in the development and testing of the Bulava

Figure 10 – A Borei Class SSBN Sets Sail for Sea Trials.

ballistic missile delayed fielding of the submarine. Recent Bulava test firings have proved successful enough for Russia to formally field the platform. The Borei class SSBNs (ten projected) are replacing the aging Typhoon and Delta III/IV series (14 total SSBN as of 2015, nine of which are stationed in the Northern Fleet with the remainder in the Pacific Fleet) which entered service in 1981 and 1976/1981 respectively.

SSN

Russia's hunter-killer Fast Attack submarine is the Akula SSN. Stealthy and fast, the improved Akulas significantly closed the capability gap with their Western SSN counterparts in the mid-1990s. The Akula entered service in 1986 with an improved model fielded in 1995. As of 2015, 19 Akula remain in service with 14 in the Northern Fleet. Much of the fleet, including all three of the improved Akulas, are expected to remain in service until 2025. Russia also has two Sierra and five Victor-III SSNs. Both have similar capability to the Akula class, remaining in the Northern Fleet inventory and projected to remain in service through 2017. Of note, the Akula is one of the few nuclear submarines in the world available for export. The newest hull was constructed in 2012 and leased to India, for which it is currently in service.[2]

SSGN

The Guided Missile submarine in the Russian inventory is the Oscar-II class SSGN. A large submarine, yet also

Figure 11 – The Emblem of the Russian Federation Navy.

Figure 12 – A Kilo Class SSK Type 636 Variant.

Class	Baltic Fleet	Black Sea Fleet	Northern Fleet	Pacific Fleet
Nuclear Powered Balisstic Missile Submarines (SSBN) – **Delta III/IV, Typhoon, Borei**			8	5
Nuclear Powered Guided Missile Submarines (SSGN) – **Oscar II, Yasen**			4	5
Nuclear Powered Attack Submarines (SSN) – **Akula, Sierra, Victor-III**			13	5
Attack Submarines (SS/SSK) – **Kilo, Lada**	2	6	7	8

Figure 13 – Disposition of the Russian Federations Submarine Fleet 2016.

stealthy and fast, the Oscar-II is equipped with 24 SSN-19 Shipwreck missiles, sometimes referred to as carrier-killers. As of 2015, nine Oscar-II SSGNs (four in North Fleet) remain active. The Oscar II first sailed in 1985 and is expected to remain active past 2020, although some have already been decommissioned.[3] Russia is also upgrading 12 of the remaining Oscar-II's and Akula's combat systems, countermeasures, and weapons systems. [4]

To replace the SSN and SSGN fleet, Russia elected to construct a hybrid to upgrade its current capability. Being built with low magnetic signature steel, the Yasen will displace less than the Akulas with improvements in weapons capability, delivering increased firepower.[5] Based on a common hull design, two variants of the Yasen will be constructed, one to meet the SSN role of protecting the SSBN fleet against other SSNs and the other designed to hunt carrier strike groups in the SSGN role. The Severodvinsk, first of the new Yasen class SSGN (eight projected), completed Sea Trials and is expected to be fielded by 2016. The Yasen class SSGN will serve its multipurpose role as the older Akulas and Oscar-IIs begin to leave service.

SS/SSK

The Kilo-class submarine has become globally recognized, as Russia has exported variants to China, Brazil, Vietnam, India, and Iran. Other Southeast Asia countries have expressed interest in acquiring a low-cost, highly capable diesel-electric platform.[6] Although the Kilo first entered service in the early 1980s, upgrades to electronics and propulsion in later models have significantly raised the capability of this very stealthy submarine, especially when operating on batteries (enhanced by AIP technology).

Not only are Russian Kilos equipped with a highly capable anti-shipping missile (the SS-N27 Sizzler), but also they are equipped with 'Kalibr' land-attack cruise missiles. These were used in December 2015 for strikes from the Mediterranean Sea into Syria. Currently nine Kilo Type 877 and four 'improved' Kilo Type 636 remain in the inventory in addition to the Kilo submarines based in the Pacific. A small number of Kilo Type 636 have been designated for transfer from the Northern Fleet to the Black Sea Fleet for future operations in the Mediterranean and Black Seas.

The planned replacement submarine to the Kilo, the Lada, experienced significant design challenges with the initial hull (St Petersburg). The initial hull of the Lada class design failed to live up to design goals, specifically in the propulsion system. The class remained stalled for years. In 2014, construction of the second and third Lada resumed. The Lada is designed with an AIP fuel cell with a projected submerged time of 45 days at 3 knots.[7] An export variant of the Lada, the Amur, is also under development. Multiple nations, including India and China, have expressed interest in acquiring an upgraded AIP-capable SSK.[8]

5.2 Overall Detectability

Advances in equipment quieting, hull construction and propulsion plant design have resulted in modern submarines producing less and less noise detectable via passive acoustic means. The Office of Naval Intelli-

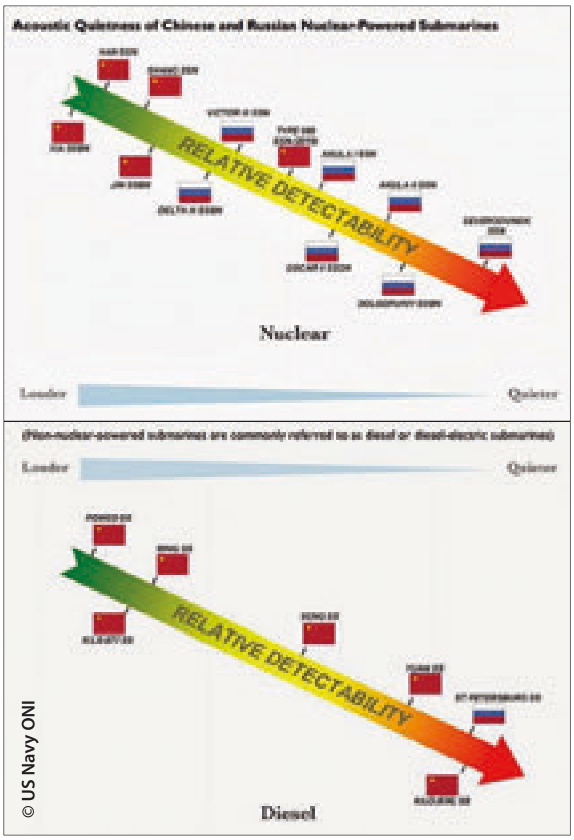

Figure 14 – Relative Detectability of Submarines.

gence created two unclassified charts (Fig. 14) showing the relationship between modern submarines and their predecessors.

One of the significant challenges Russia will face with the fielding of these three new submarine classes is each of them was designed and partially constructed more than a decade ago before the financial crisis hit the shipyard and shipbuilding industry extremely hard. Therefore, these submarines should not necessarily be viewed as the most modern, as the design and propulsion models are 10–15 years old even though the boats are just now coming down the sluiceways. However, there will be some level of improvement to propulsion and stealth over what is currently at sea. Major improvements will be realized in electronics, weapons systems, and system integration capability (C4I advances), which can be overlaid on top of existing hull designs.

5.3 The Export Challenge

'The diesel submarine may become the perfect asymmetric weapon for countries, which can afford to purchase them, and which wish to disrupt US power projection operations off their shores at some future date.'[9]

The export of diesel-electric submarines is a continued growth area for Russia's shipbuilding industry. Throughout the Cold War, Russia found willing customers for an export industry. This included Khadaffi's regime in Libya, which purchased a Foxtrot class SS (1970s era diesel submarine). This submarine remains in the Libyan active inventory today, although many NATO analysts have doubts about its serviceability. Additionally, it has been assessed not to pose a serious threat to NATO forces due to its significant age and reduced capability. In the waning years of the 20th century, Russia sold twelve export variant Kilo SSs to China, three to Iran, four to Algeria and ten to India. Current buyers on the Kilo market include Vietnam and Venezuela. China, Morocco, Malaysia, and India have expressed serious interest in the Amur (Lada export) AIP-capable SSK.[10] The challenge to NATO remains the proliferation of highly capable, relatively

Figure 15 – A Kilo SSK is Transported for Delivery to its Foreign Buyer.

low-cost submarines that can tip the balance of power in a region.

Learning how to both safely and tactically operate a submarine is no small feat. When Russia sold submarines to Iran, they deployed crews for significant lengths of time as advisors to train and operate with the customer. They would likely follow the same model for future buyers of Russian export submarines, regardless of the nationality of the buyer. Therefore, one cannot assume a low capability for a nation with limited submarine experience upon purchase of a Russian export, as it is very likely Russian advisors with significant experience will train them.

5.4 The Russian Federation's Use of Unmanned Underwater Vehicles (UUV)

Russia has explored the use of UUV for non-warfighting roles, such as submarine-launched drones to travel to the ocean floor and monitor fiber-optic cables (internet, voice, etc …).[11, 12] UUVs used in this manner could either tap or disable (cut) communication lines. Two accidents in 2008 show the vulnerability in these systems. Cables to the Middle East were simultaneously severed from both directions (Europe and Asia), one due to a ship dragging anchor and one due to an undersea landslide, which in essence isolated the Middle

East from the rest of the world. All internet, including classified systems, and communications networks were significantly reduced when satellite connectivity and cables with considerably less bandwidth capability became the predominant communications method.[13]

On the kinetic end, in November 2015, a Russian news station 'inadvertently' showed classified documents allegedly containing a description and diagrams of a kinetic submarine launched 'drone' equipped with a nuclear warhead that was capable of travelling autonomously deep into an adversary's port before detonating.[14, 15] No credible evidence supports the existence of this capability; however, it offers insight into Russia's technical aspirations for the maritime employment of UUVs.

5.5 Submarine Development in the Rest of the World

This section will discuss the views of other nations with a robust submarine force likely to be encountered by NATO, either within the European theatre or during a potential out-of-area deployment. Inside the Mediterranean, four non-NATO nations operate submarines. Libya's sole Foxtrot has been discussed already, leaving Israel, Egypt, and Algeria. Outside the Mediterranean, NATO ASW forces have the potential to interact with submarines from Iran, India, and the PRC.

Figure 16 – Israeli Dolphin SSK (INS Tanin) at Kiel Dry Docks.

The State of Israel

Israel's five Dolphin class SSK submarines contain a relatively modern electronics suite. The Dolphins are also equipped with US-built Harpoon anti-shipping missiles and Tomahawk cruise missiles (it is suspected but not confirmed that these may be nuclear capable). Perhaps unique when discussing 'RoW diesels' (Rest of the World), Israel has both a power projection and deterrence role (sea-based second strike capability) explicitly assigned to its diesel submarine fleet. The Dolphin SSK are comparable to the German Type 212, with three of the five being AIP modified.

The People's Democratic Republic of Algeria

The People's Democratic Republic of Algeria has purchased four Kilo SS (two Type I and two Type II improved Kilos), and in late 2014 it ordered two additional Kilo SSKs. 'Algeria is in the process of expanding its navy, as it faces problems such as smuggling, illegal migration, and indigenous terrorism. In April 2012 it emerged that Algeria had signed a contract with the China Shipbuilding Trading Company for three light frigates, after ordering two Meko A200N frigates from Germany's ThyssenKrupp Marine Systems in March 2012. Algeria has also ordered two new Tiger class corvettes from Russia.'[17]

The Republic of Egypt

The Egyptian Navy boasts four German-built new-construction Type 209 SSKs, a high-end diesel submarine, to complement its four much older Romeo class SS. In spite of Type 209 not being the newest German SSK export (Type 214), it remains a submarine with modern electronics, acoustics, and weapons systems. The first of the four Type 209s first sailed in December 2015, and when the full complement is realized, Egypt will have one of the more capable submarine forces in the Mediterranean.[18]

Figure 17 – An Egyptian Type 209 SSK.

The Republic of Iran

Although possessing only three export-class Kilo SSs of an older model (the third delivered in 1997), which are arguably in poorer condition than any other countries' submarine force due in no small part to the challenging operational environment posed by high water temperatures, Iran offers perhaps the highest likelihood of encounter with NATO forces executing the current maritime operation Ocean Shield in the Red Sea and Gulf of Aden. Iran has, on multiple occasions, sent a Kilo into the Red Sea for operations. An Iranian Kilo is commonly operated on the surface rather than fully submerged, and usually in proximity with one or more escort ships. However, Iran has shown the capability for short duration submerged operations. Iran's principle use for the Kilos would be in an anti-shipping or mining role in an attempt to close off a critical chokepoint.

In addition to the Kilos, Iran also has a fleet of mini-submarines (Ghadir and Nahang classes) for covert/special operations missions. These mini-subs will likely not proceed out of the Arabian Gulf region. Therefore, the likelihood of interaction with NATO forces is minimal with the exception of those countries with national interests and permanent presence in the Middle East AOR.

The Republic of India

India boasts both nuclear and conventional submarines. Possessing a single Akula SSN (leased from Russia from 2012 through 2022), India does field a robust diesel SSK fleet of 13 operational submarines, nine remaining Sindhughosh class (Russian built, one lost in 2013 due to explosion) and four Shishumar class (German built). India is also indigenously producing two Arihant SSBNs and six Kalvari SSKs. In fact, the INS Arihant class sailed for Acceptance Sea Trials in April 2016 as this study was coming to a close.[19] India has also expressed interest in leasing either a second Aklua or a Yasen class SSN with the goal of integrating Indian Engineers in the construction phase. They would then bring the experience back to India to facilitate an indigenous shipbuilding project with a goal of fielding six additional SSN.[20]

Figure 18 – PRC Song Class SSKs.

India's maritime strategic goals include power projection from the Arabian Gulf to the exits of the Strait of Malacca, and it has recently pushed back against what it considers Chinese incursion into the region.

The Peoples Republic of China (PRC)

Perhaps the most capable non-NATO submarine navy besides Russia, China has been focused on expanding both its submarine inventory and capability for much of the past three decades to re-assert its naval projection past the first island chain. China has a large fleet of nuclear and conventional classes of submarine covering SSBN, SSN, SSGN, SS and SSK classes. In the last decade, China has made particular efforts to increase the length and distance of out-of-area submarine deployments. *China has already conducted bilateral exercises with the Russian surface navy off the coast of Syria, so it is not unlikely NATO would see a Chinese submarine in the Mediterranean Sea in the not too distant future.*

China has aggressively monitored US, Japanese, and Korean naval exercises to include attempts at Cold War-esque covert intercepts of aircraft carriers. Although the acoustic design of the indigenous Chinese submarines lags both Russian and Western high-end submarines, the skill of the Chinese submariners is increasing annually, including improved exploitation of the ocean environment. By 2020, it is expected the Chinese submarine inventory will grow to somewhere between 69 and 78 submarines[21], depending on the retirement timeline of the older elements of the fleet.

The rapid growth of the Chinese submarine inventory, coupled with increased patrols both seaward of the first island chain and southward throughout the South China Sea has caused many nations to re-assess their naval capability to respond in kind. The maritime environment in Southeast Asia is extremely dynamic. There are many hot-spots surrounding national claims to fishing and mineral rights. The dramatic uptick in submarine inventory throughout the theatre is representative of each country's desire to protect its national interests in the region.

From a strategic perspective, China will most likely retain her ballistic missile fleet in waters close to the homeland. However, China has shown intent to use advanced SSN and SSKs far from the Pacific in a testament to her global power projection aims. The most likely classes of submarine for NATO forces to encounter will be the Shang SSN and the Song and Yuan class SSKs.

As a significant upgrade to the aging Han class SSN, 'the Shang's range and weaponry give the PLA its first non-nuclear global strike capability. Incorporating advanced quieting technology with a hydro-dynamically efficient hull form, a single shaft, and a highly skewed 7-bladed propeller, the Shang is equipped with torpedoes, antisubmarine warfare missiles, and a submarine-launched anti-ship cruise missile, possibly a follow-on to the C801, as well as the projected Land Attack Cruise Missile.'[22]

The Shang is estimated to be 6,000-7,000 ton displacement when dived. This is about 50 percent larger than the displacement of the earlier Type 091 Han class. The Shang features a water-drop shape hull, with a pair of fin-mounted hydroplanes and four diving planes. It is fitted with sophisticated sonar systems, including bow-mounted sonar and H/SQC-207 flank-mounted sonar. The Shang has six 533mm bow torpedo tubes (four above, two below), and is presumed to be equipped with a range of anti-submarine and anti-surface vessel torpedoes of wire-guided, acoustic- and wake-homing, based on both Chinese and Russian designs. The torpedo tubes can also be used to launch Chinese indigenous YJ-82 anti-ship missiles.[23] The Shang has recently conducted operations with Chinese naval units as far West as the Bab-al Mandeb Strait, the approach to the Red Sea.[24]

Although having less range than the Shang, other potential candidates for interaction with NATO forces include their advanced diesel submarine fleet, comprised of the Song and Yuan class SSK (13 hulls of each type are in the active inventory).

The Song class is one of the most advanced diesel-electric attack submarine types designed and built by indigenous Chinese effort. It is planned to replace the aging Ming SS fleet. The Song is equipped to fire the YJ-82 (a submarine-launched version of the ship-launched C-801) missile, as well the YU 1/YU4 Torpedoes and various types of mines. In broad terms, many assess the Song SSK to be at a technological standard generally similar to that of Western submarines built during the 1980s.[25]

A more advanced Chinese diesel submarine is the newer Yuan class, which, in addition to the technology found in the Song, is assessed to be equipped with an Air Independent Propulsion (AIP) system enabling significantly longer submerged operations over other diesel-electric submarines.[26]

5.6 Summary

This chapter reviewed the submarine development underway by the Russian Federation as well as other nations within the NATO AOR. Additionally, a brief discussion of submarines with which NATO forces may interact while deployed to the Middle East (for example supporting Operation ATALANTA) was also conducted.

The trend for submarine operations in both the Atlantic and the Mediterranean Sea is rising. Almost every nation which boasts a submarine capability is expanding their current inventory. Further chapters will discuss the reality that NATO is behind in countering this growth trend.

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Sonobuoy load is tailored to exploit the characteristics of the ocean environment.

CHAPTER VI

The ASW Environment

6.1 Overview

Recognizing the Allied Maritime Tactical Instructions and Procedures (ATP-1) provides details for tactical exploitation of the ocean environment, some knowledge of oceanography is necessary to understand the evolving challenges in this domain. This chapter will provide a foundation in tactical oceanography for those readers unfamiliar with the concepts. A more detailed review of specific technical aspects of tactical oceanography is provided in Appendix 2.

6.2 Acoustic Properties of Submarines

Submarines generate noise in the water mainly from three different sources: Propulsion plant noise, propeller noise, and noise generated as water moves over the hull. Chapter 2 outlined the differences in submarine classes and propulsion systems, while Chapter 3 discussed submarine operations during the Cold War. This section will explore those oceanographic characteristics most prone to exploitation by aircraft in ASW prosecution and those that affect tools used for detection.

Blade Rate/Max Quiet Speed

For both diesel- and nuclear- powered submarines, there is a speed (unique to each submarine class) below which the propeller generates minimal cavitation, and the rotation of the shaft and movement of the blades through the water is essentially undetectable. Submarines travelling faster than this blade rate threshold speed generate significant acoustic signal from the propeller which is easily detected by ASW forces. Therefore below this 'blade rate threshold' or 'maximum quiet speed', the primary noise generator is the propulsion system itself.

Propulsion Plant Noise
The nuclear propulsion system generates approximately the same amount of noise regardless of the submarine's speed. When operating below the detectable 'blade rate threshold', the submarine will have, for each frequency generated, a standard amount of noise produced by the propulsion system at various frequencies.

The intensity of this sound will vary by frequency, based on the mechanics of the propulsion system of that class. Reactor coolant pumps, auxiliary equipment, and steam turbines are some of the sources generating noise within a nuclear submarine's propulsion plant. Although the nuclear reactor and many of its associated components produce the same amount of noise regardless of the speed, some components are only utilized in certain speed regimes. For example, some pumps may only operate above a certain speed; therefore, if the frequency associated with that pump is detected, it is an indicator the submarine is travelling above that known threshold. Detection of these 'speed related components' is a useful tool in determining the approximate speed of the submarine.

'Picking up the quiet hum of a battery-powered, diesel-electric submarine in busy coastal waters is like trying to identify the sound of a single car engine in the din of a major city.'
Rear Adm. Frank Drennan USA (N), March 2015

Diesel submarines have two methods to generate propulsion. This results in drastically different amounts of detectable noise. When submerged and using the battery (electric mode), very little detectable noise is generated. However, the amount of noise generated when using their diesel engines during periods of battery recharging is significant. Therefore, it is a critical vulnerability of the diesel submarines that they are more detectable during battery recharging periods, both acoustically and with radar/electro-optic detection systems because their air intake is exposed and their diesel engines are operating.

It is for this reason that Air Independent Propulsion (AIP) systems are being developed by many nations, so the exposure time for full recharging of the battery system is minimized. Modern AIP-equipped diesel submarines can remain submerged for close to 45 days between full recharge cycles.

Hull-Generated Noise
Water travelling over a smooth, laminar surface encounters little friction and, as such, generates little turbulence. The ideal form for a submarine would be something that generates as little friction and turbulence as possible as it travels. However, mission requirements and installed systems often result in protrusions from the hull (towed array sonar, propeller guards, control surfaces, modules attached to the hull to support Special Operations forces, etc.). These protrusions generate turbulence, therefore noise, which is detectable by ASW forces.

Each class of submarine generates different amounts of water flow noise. Many of these 'swaths' are class specific and may be utilized when determining what type of submarine has been detected (classification). Additionally, unlike propulsion noise, which will remain relatively constant, hull-generated noises are not only unique to each submarine class but are also unique to a specific speed regime for each class.

Frequency and Source Level
Each of these 'noise sources' discussed above is generated at a specific frequency and sound intensity based on the design of that specific submarine. Therefore, each type of submarine will generate different frequencies at different sound source levels. The goal of submarine builders is to construct a submarine that generates as little detectable noise as possible, and recent models prove they are succeeding. Subsequent sections will demonstrate the challenge of traditional ASW passive tactics when viewed through the lens of an ocean which is growing louder and submarines which are becoming quieter.

6.3 Acoustic Raypaths

Although many different raypaths (the direction of travel sound takes from the source to the receiver as influenced by the variables outlined in Appendix B) exist and are well discussed in NATO ASW publications, two are worth highlighting in this study: Direct Path and Convergence Zone. Appendix B provides further insight into tactical oceanography and the variables in the active and passive sonar equations as each raypath is exploited.

The Direct Path Raypath

On the Direct Path raypath, as the name indicates, sound travels directly from the source (submarine) to the receiver (sonobuoy) without undergoing a refraction (change in direction due to pressure etc …) or reflection (bottom or surface). This is the most common raypath exploited in the tracking and targeting phase of prosecutions. It provides the most accurate locating data on the submarine. However, due to attenuation, spreading, and other factors which degrade noise as it travels through the water, the frequencies used in Direct Path exploitation have relatively short detection ranges. As a general rule, loud submarines may provide direct path ranges in excess of 2nm. For very quiet modern submarines, the range is measured in scant hundreds of yards.

The Convergence Zone Raypath

Previously submarines had generated sufficient sound to be detected at significant distances. In most cases, the sound generated from a submarine will initially bend downward as temperature has the largest near surface impact to sound velocity. As temperature cools and the water depth increases, pressure begins to take over and will eventually bend that sound wave back toward the surface. This takes place over the course of many miles. It requires both significant water depth and initial signal strength/source level (submarine loudness) for there to be sufficient detectable sound signal remaining when it returns to the near surface environment.

Due to variances in the waveform and the effects of pressure, temperature, salinity, and other influences, this sound won't re-converge in a single spot, rather over an annulus of a few miles of gradually decreasing sound intensity. This annulus is referred to as the convergence zone. Tactics for exploiting this sound have evolved in both the submarine and maritime air communities.

Figure 19 – An Acoustic Operator Onboard a 201 Squadron Nimrod Feb. 1975.

As a general rule, modern submarines do not generate a high enough source level to provide sound in the convergence zone detectable by today's air-launched sonobuoys. Nonetheless, the raypath may still be exploitable by ship/submarine passive towed array sonars or by air launched mono/multi-static active sonobuoys.

6.4 Today's Challenge with Traditional Passive Detection

In the 1970s–80s, it was not uncommon to measure submarine passive detection ranges in miles, as depicted in the CZ grey arc in Figure 20. Tactics were employed to convert this CZ detection to direct path contact and leveraged the fact submarines generated sufficient sound levels (noise) to support these detection tactics. Submarines could be detected on the second or even third CZ annulus. As the ocean grows louder and warmer while submarines become quieter, Cold War methods of submarine detection have begun to falter in today's ocean environment. The following changes are impacting current and future passive acoustic detection techniques.

- Modern Submarines are quieter and designed to produce less noise
- Raypaths which were exploited in the past for initial submarine detection are no longer viable due to the decrease in submarine noise
- There is insufficient depth to exploit some raypaths due to diesel submarines operating closer to shore
- The ocean itself is louder than in the past further masking submarine generated noise

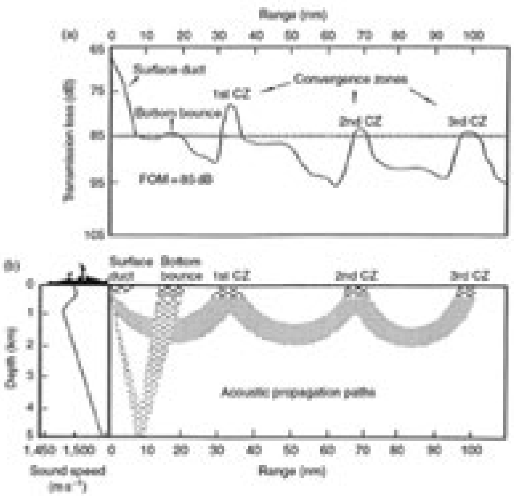

Figure 20 – Notional Depiction of Propagation Loss Curves and the Convergence Zone Raypath.

It is unrealistic for today's modern submarines to yield CZ contact. More realistically, modern submarines, both nuclear and diesel, provide passive detection ranges better characterized as hundreds of yards instead of multiple miles. Non-NATO submarines have grown increasingly quiet with each subsequent class fielded. Technology to reduce propulsion plant and propeller generated noises have been implemented and anechoic hull coatings to both reduce noise and mitigate active sonar detection have been fielded.

Additionally, with the increase of submarine operations in the littorals, there is insufficient water column depth to support the regeneration of sound energy into a convergence zone, as sufficient depth to reach the point where pressure forces the sound ray to return to the surface, and thus, the raypath, simply doesn't exist in shallow water.

Furthermore, the ambient, or background, noise in the ocean has been notably increasing over the last few decades. Over the last half century, as cargo shipping and deep sea oil exploration has increased, background noise in the ocean has doubled roughly every decade.[1] This has a dramatic impact on the ability to discriminate submarine generated noise against the background noise. As quieting technology improves, eventually a point of diminishing return will be reached.

Figure 21 – This section discusses the mathematical relationship between SPL, MDR and sonobuoy utilization rate. Readers are cautioned to ensure availability of a soft landing place in the event of inadvertent narcolepsy.

Sound Pressure Level (SPL)

Submarine source levels are measured in decibels which exert sound pressure upon the passive receiver. As discussed earlier, the submarine generates noise (sound pressure) at a given frequency dependent upon each piece of machinery. A decibel is a unit used to measure the intensity of the sound level of a signal by comparing it with a given level on a logarithmic (non-linear) scale. A 3db change is a doubling of sound intensity whereas a change of 10db is a change in sound intensity by a factor of ten.[2] Therefore, the 636 Kilo class (SSK) with an acoustic signature of 105 decibels is ten times as loud as the 95 decibel acoustic signature of a more advanced NATO SSN.[3]

The key takeaway is that as improvements in submarine design are achieved, reducing the SPL generated at each frequency, for a given 10db drop due to improvements in design, there is a corresponding 'significant' decrease in the passive detection ranges using the propagation loss curves discussed in Appendix B. This is the crux of the issue and the actual challenge with passive detection today.

6.5 Sonobuoy Utilization Rate: Then and Now

Nuclear submarines typically operate submerged, therefore MPA traditionally used passive search patterns for initial detection. Sonobuoy fields, normally consisting of between 24–32 buoys, were deployed in as wide an area as possible, nominally five times the Median Detection Range (MDR). This was done to maximize the chances of a submarine passing within

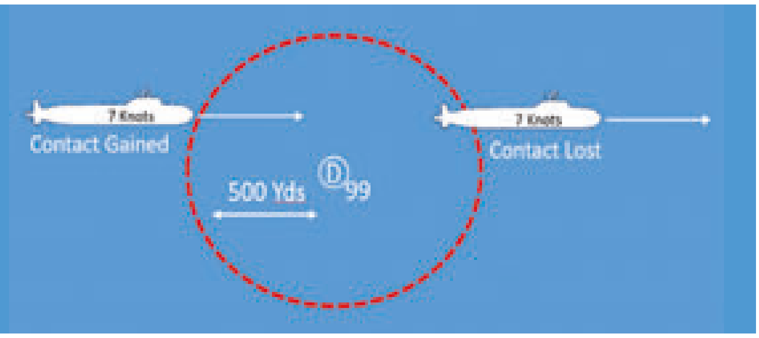

Figure 22 – Notional Depiction of a Passive Sonobuoy Detection Range.

the passive detection range of one sonobuoy during the notation time, at which point the MPA would convert from the 'search' into the 'localization' and 'tracking' phases of prosecution.

During the Cold War, MDR was measured in multiple thousands of yards versus the small hundreds of yards presented by modern submarines. Assuming an MDR of 3000 yds and a 32 buoy search pattern deployed at 5 MDR spacing, this would cover an area close to 1690 square miles. This meant that the tactics of the Cold War were effective: SOSUS or some other sensor could provide an MPA with a large search area (due to time latency) and still be assured one of the first few flights of a multi-day prosecution would locate the submarine.

However, assuming an MDR of 500 yards of a more modern submarine, that same 32-buoy search pattern deployed at 5 MDR spacing could only cover 47 square miles with the same probability of submarine detection. Therefore, to generate the same amount of coverage as in previous years, significantly more sonobuoys would need to be deployed. A point of diminishing returns is reached as many MPA are only capable of monitoring a limited number of sonobuoys simultaneously. In short, passive detection against today's submarines relies on precisely knowing where to look and when to look there, or the chances of detection are drastically reduced.

Furthermore, in the tracking phase, a submarine travelling at 7 knots (a notional figure below the detectable blade threshold rate of most submarines) with a passive detection range of that same notional 500 yards used in the buoy spacing example above will provide fewer than 5 minutes of contact time on each sonobuoy. (i.e. at 7 knots, the submarine will travel approximately 1000 yards in about 4 and a half minutes, 500 yards detectable into the buoy and 500 yards down Doppler outbound from DIFAR 99 as shown in the figure below).

Therefore, in the tracking phase of the prosecution, instead of the buoy utilization rate of 7–9 buoys per hour which was the goal in the 1990s, crews today are experiencing double or treble the hourly utilization rate due to decreased passive ranges on modern submarines. This stresses both aircraft on-station time (planned for 4–5 hours based on a typical sonobuoy load and aircraft turnaround time) and total force sonobuoy inventory. Assuming passive detection and tracking was the sole method employed, today's passive buoy utilization rate would rapidly deplete NATO's passive sonobuoy inventory.

Further exacerbating this challenge is the national sonobuoy inventory. As the cost to build each sonobuoy has increased, and the stockpiles are no longer kept at Cold War levels, the inventory of sonobuoys has dramatically fallen across NATO. It is not uncommon for national restrictions to impose carriage limitations on aircrew, limiting the number of buoys brought for training missions to well below the carrying capacity of the airframe. This has a measurable impact on the decision making of less experienced aircrew, who are often hesitant and overly conservative when employing sonobuoys. This hesitancy has, in many cases, led to lost contact during dynamic phases of the prosecution such as the initial period following a submarine submerging or during aircraft on station prosecution turnover.

6.6 Multi-statics

Mono-statics, developed in the early 1990s, were an improvement on traditional active sonar employment and are discussed in greater detail in Appendix B. Mono-statics were briefly employed in the 1990s and were originally designed to exploit an incoherent signal utilizing the Convergence Zone raypath. The use of Mono-Statics is briefly discussed for historical context in Appendix B. During that time period, it was assumed (likely open-ocean, deep-travelling, nuclear-powered) submarines would be operating in water deep enough to support CZ transmissions. However, with the current shift away from nuclear submarines and the proliferation of diesel submarines operating in or near the littorals, new detection technology is required. Many navies have turned to multi-statics for use in the littorals.

Multi-statics employ a coherent signal, similar to an active buoy but at a much larger signal strength. Little signal drops off from an off-beam aspect return. Additionally, the receiver buoys are not collated with the source buoys, which means the submarine, should it determine a multi-static source is being employed, cannot know which direction to turn to avoid the pattern. Multi-statics are still an emerging technology, but, based on analysis of classified briefs made available for this study, may address many of the challenges presented by quiet submarines operating in acoustically challenging operational environments.

NATO's Centre for Maritime Research and Experimentation (CMRE) is developing a Multi-static Tool Planning Aid (MSTPA) for use in refining generated area of probability and recommendation for initial sensor deployment to aid in submarine detection with multi-statics.

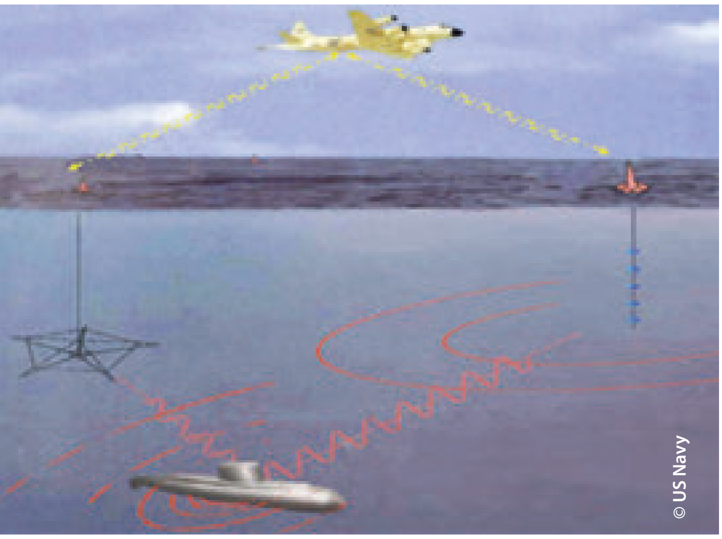

Figure 23 – Multi-static Sonobuoys, Receiver and Transmitter.

Because the traditional passive detection and tracking sensors and tactics are rapidly approaching a point of obsolescence, active sonar systems, including hull mounted sonar, active sonobuoys, and multi-static systems provide the most viable future submarine detection methods.

6.7 Classification via Active Sonar

A limit to the use of active sonar has always been the lack of ability to 'classify' the return. Passive signals can be used to determine submarine type/class and in some cases even the specific hull if a unique sound is generated. Although an extremely experienced acoustic operator might be able to estimate submarine size from the active return, active returns have not yet evolved in discrimination to determine submarine class or even friend from foe. Future development not only in the use of multi-statics for initial submarine detection but also for target classification via active sonar will become a necessity.

6.8 Environmental Considerations and Impacts to Training

With the advent of active sonar, including mono- and multi-statics, came an awareness of the impact of active sonar use on marine mammals. All western navies take this into account, and stringent rules are observed during the planning and execution of ASW training exercises. This will continue to be a planning factor, but to date both COMMARAIRNATO and COMSUBNATO indicate that abiding by the construct of the current mammal mitigation procedures has not, and is not assessed to, impact either operations or exercises/preparation for operations. Additionally, improvements made in acoustic modelling may also help in this area. 'High-fidelity, multi-static sonar performance models can also be used to gauge compliance with environmental noise regulations concerning marine mammal protection.'[4] Chapter 9 provides an overview of governing NATO doctrine regarding mammal mitigation.

6.9 Radio Frequency Interference

Another challenge to littoral ASW is Radio Frequency Interference (RFI). Currently, sonobuoys pass acoustic data to aircraft via a VHF uplink. In operations close to land, or with the aircraft at higher altitude, signal inference from and based systems operating in the same frequency spectrum can be severe. This will only get worse in the future, and in some of today's ASW hot-spots, RFI can be excessive (Mediterranean Sea, Arabian Gulf, South China Sea). Some research has been conducted into either encrypting the signal to prevent RFI or migrating the communication medium to an entirely different spectrum. Until this is complete, RFI will continue to challenge littoral ASW.

6.10 Space Support to ASW

Space provides support to ASW operations in two main areas: meteorological prediction and ISR. In the future, space support to meteorological prediction tools will continue to provide invaluable mission planning for aircrew conducting submarine detection missions. Prediction of radar refraction ranges and oceanographic modelling of the water column for acoustic range prediction will continue to be a critical component of ASW planning.

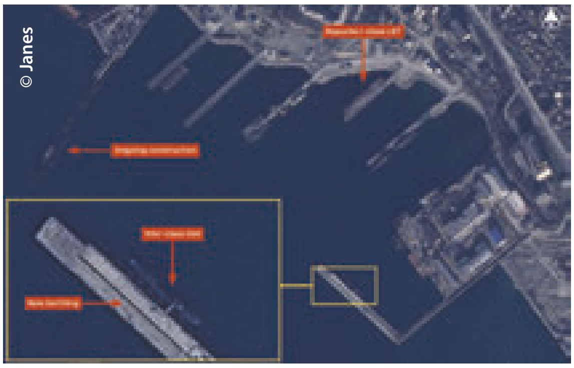

Figure 24 – Satelites maybe used to Detect the Presence or Absence of Submarines in Port.

Additionally, ISR roles in both the submarine pre-sailing phase (imagery of thermal heat blooms in engine rooms, pier-side supplies onload, etc …) as well as electro-optic or signals collection of surfaced submarines underway provide cueing for which other detection systems might yield more precise data. Finally, research into other aspects of space support (such as the ability to detect the minute changes in ocean surface level due to the deep passing of a submarine) are ongoing and may offer other avenues of non-traditional space support to ASW.

6.11 Summary

As this study is focused on Maritime Air's capability in the ASW domain, it is important to recognize a variety of methods exist for cueing an MPA or helicopter onto a potential submarine. Surface ship-mounted towed-array sonar systems and hull-mounted active sonar exist in almost every NATO nation's navy. Other methods including satellite detection of emissions and Surveillance Towed Array Sonar System (SURTASS) Low-Frequency Active Sonar exist to generate potential submarine locations. To exploit this, MPA and helicopters routinely practice prosecution of submarine datums generated by surface ships.

The tried and true passive detection tactics of the Cold War are no longer viable against modern submarines. Submarines are significantly quieter, the ocean is significantly louder, and the challenge of those two facts would yield an unsustainable sonobuoy utilization rate. Sonobuoy inventory has also affected both the training and proficiency of many NATO MPA and MPH aircrew. It is not uncommon for an inexperienced or less-proficient crew to lose contact on a submarine due to being overly conservative deploying sonobuoys due to national inventory limitations.

Leveraging the discussion in Chapter 2 of submarine propulsion design and mission sets, this chapter analysed Cold War ASW tactics against the modern nuclear and diesel submarine threat through the lens of acoustic oceanography. Acoustic detection and passive tracking are not as effective in today's environment as they were in previous decades. As active sonar and active sonobuoy (of various types) use became the preferred method to generate targeting quality locating data on submarines, a brief discussion of mammal mitigation concerns with the use of active sonar was conducted. Finally, challenges to littoral ASW close to populated areas with respect to sonobuoy RF signal interference was highlighted.

Looking to the future, the ASW problem presented by current and emerging non-NATO submarines is best addressed with non-acoustic detection methods. Multi-statics seem to be the predominant way ahead in many navies. The theoretical science behind the concept is mature, although the software and computer processing for exploiting this type of propagation is still under development. Additionally, Chapter 10 outlines other non-acoustic submarine detection methods as well as new technology under development which may mitigate the challenge presented by today's quiet submarines in today's louder ocean environment.

Perhaps the most critical takeaway from a review of current and projected environmental challenges is that as submarines grow quieter (not necessarily in the current Russian models, but perhaps in future designs), a point of sound parity will be reached, at which submarines will be quieter than the other noise in the ocean. This will completely remove the ability for passive detection, tracking and use in engagement.

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CHAPTER VII

ASW and Joint Operations

'Just as the Navy is an enabling force for the other services, ASW is the enabling mission for the Navy.'[1]

7.1 Introduction

Beginning with the advent of the modern battleship and continuing with the evolution of the aircraft carrier force and submarine-launched cruise missile, the maritime component has had the capability to project power deep inland in addition to its other historical roles. However, a single submarine can wreak havoc on an entire campaign plan by impeding maritime force operations. The maritime component's ability to ensure maritime superiority has a significant impact on the execution of the joint operation.

Recent NATO operations have been conducted in areas where maritime superiority, almost supremacy, was the position at the commencement of the operation. A competently crewed submarine would have the goal of evading an ASW screen to strike at the highest value naval target. NATO has never experienced the loss of a capital warship and, consequently, NATO's psyche might not be prepared for the loss. The presence of adversary submarines will occupy significant attention of the maritime force and, in many cases, might require requesting support from other services to locate and defeat the threat. Failure to do so will have significant consequences.

7.2 Role of ASW in NATO's Joint Operations 1990–2015

During the Cold War, aggressive encounters at sea bordering on simulated battles between Western and Russian Naval Task Forces occurred with regularity and NATO's exercises were scripted with this role in mind.

As the Cold War ended, NATO's military forces began seeing predominant use in a land role in Iraq and Afghanistan. Although this has been identified in numerous fora, not the least of which was the 2014 Wales Summit, NATO must re-learn the importance of certain aspects of Maritime warfare to be fully prepared for the future.

Whether a future operation will employ the Maritime component as a joint enabler, integrating the deep strike capability into the Joint Air campaign, or the maritime component's role will be to provide transportation for the amphibious Landing Force and then control the Sea Lines of Communication for the duration of the joint campaign, a single submarine could wreak havoc to the maritime component and potentially impact the entire time-phased joint campaign.

While executing its last three major Joint Operations, NATO's Maritime Component entered Phase 1 of each campaign having already achieved Maritime Supremacy – there was little to zero threat to maritime forces at sea. Largely because of maritime supremacy, maritime components were seen as joint enablers, integrating deep-strike capability into the Air Campaign or as transport and support for amphibious units. Additionally, Maritime Supremacy permitted full freedom of manoeuvre to execute the full spectrum of maritime operations in support of the joint campaign.

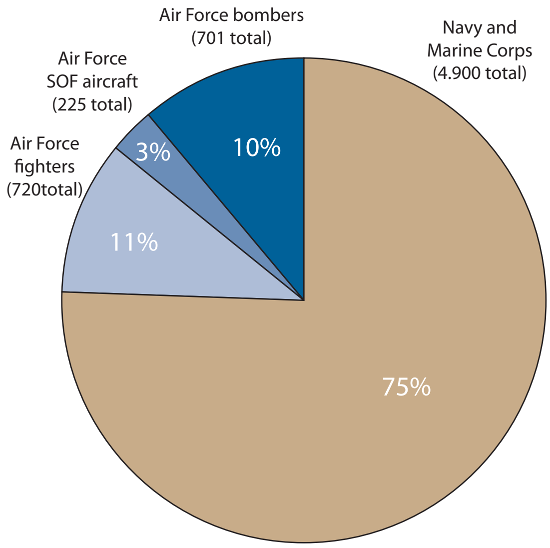
As other nations invest in their submarine fleets, NATO must re-learn the importance of certain aspects of Maritime warfare, particularly ASW and full-scale naval combat, in order to be fully prepared for the future.

Operation ALLIED FORCE

The Yugoslavian Navy possessed a small handful of low-capability diesel submarines during the conflict. MPA were employed during this campaign in a manner representing their true multirole capabilities. MPA were employed overwater with a specific ASW mission: if the adversary submarines were detected outside Tivat harbour, find and sink them. At the same time, some NATO nations had begun installing ISR upgrades to their MPA fleet. The US, Dutch, and French MPA were used in both an ASW and overland ISR (and even strike in the case of the US) role. During this operation, at no time was a submarine detected underway. Some intelligence analysts believe the submarines were hidden in a tunnel or intentionally bottomed in the harbour to prevent them from being sunk. The lack of a threat to naval forces permitted the aircraft carriers to operate freely inside the confined waters of the Adriatic Sea. A submarine threat would have likely changed this geometry, pushing the carrier south into the Ionian Sea, shortening on-station times for carrier-based strikers and straining the tanker plan.

Operations in Afghanistan and Iraq

Although Air Force heavy bombers flying from outside the theatre delivered the vast preponderance of munitions, US carrier-based air power, flew 75 percent of all strike missions. The Navy jets substituted almost entirely for land-based theatre air forces because of an absence of suitable forward operating locations for the latter. Barely more than a year later, in 2003, the Navy's carrier force again played a pivotal role when American forces



SOURCE: Sea Power, March 2002.
NOTE: SOF = Special Operaions Forces.

Figure 25 – Operation ENDURING FREEDOM (OEF) Strike Sorties by Service Through December 2001.

conducted around-the-clock operations against Saddam Hussein's forces in Iraq. Six of 12 carriers and their air wings were surged to contribute to the campaign, with a seventh carrier battle group held in ready reserve in the Western Pacific and an eighth also deployed at sea and available for tasking. The air wings from the committed carriers flew approximately half the total number of fighter sorties generated by US Central Command.[2]

The lack of established basing for land-based aircraft forced commanders to rely heavily on the US and Allied aircraft carriers. Even then, the tyranny of distance was a challenge to the naval force and significantly strained the air refuelling tanking plan. Although Afghanistan had zero naval capability, three local nations of varying levels of participation in the coalition possessed a submarine capability. This proved to be a factor in the daily execution of the air plan: the Agosta SSKs operated by Pakistan, the Kilo SSK and Akula SSN operated by India and most notably the three Kilo SSKs operated by Iran were closely monitored for potential impact to operations.

Looking back at the initial stages of the operation, the potential impact of submarines to the projection of naval power was less than feared. The Iranian submarines, the most likely potential adversary, did not present a significant risk because they would have been rapidly identified leaving port. If the political or military situation had devolved to the point where a true threat to coalition forces was anticipated, based on the capability mismatch between coalition forces and the Iranian submarine force, it is likely that threat would have been rapidly neutralised, resulting in limited impact to air operations. As NATO assumed the follow-on Operation INHERENT RESOLVE, the carrier support reduced as land-based air power capacity increased.

Operation ODYSSEY DAWN/UNIFIED PROTECTOR

Similar to operations in Afghanistan, operations over Libya began with a multinational operation which expanded into a NATO operation. However, unlike Afghanistan, the JOA in Libya could be reached from existing air bases within NATO territory. Therefore, the lack of an aircraft carrier did not impact the ability to conduct deep strike missions from the early days of air operations. Although the lack of AWACS/AEW assets in the early days did impact the early phases of operations, it was mitigated through use of the sea-based Tactical Air Control Center (Navy TACC) embarked on the Amphibious Assault ship USS KEARSEARGE. Additionally, some limited strike capability did exist with the sea-based AV-8B Harrier fleet on USS KEARSEARGE and ITS GARIBALDI. Furthermore, those and other ships in the region provided the sea-based Combat SAR forces. This proved to be instrumental in the Tactical Recovery of Aircraft and Personnel (TRAP) operation of BOLAR 34,[3] an F-15 shot down early in the campaign.

Additionally, there was again limited-to-no threat to naval forces presented by the Libyan navy. Although Libya does indeed possess a submarine force, it is aged and extremely limited in capability and did not sail during the conduct of this operation. The only threat to naval forces from the sea was in the form of the potential threat posed by guns from smaller coastal patrol craft, shore-based cruise missile threat, and potential of strike aircraft originating from ashore. This permitted MPA to focus on coastal surveillance and ISR instead of ASW. A US P-3C Orion did fire two Maverick missiles into a Libyan Corvette engaging in gunfire on nearby merchant ships,[4] but the majority of the MPA role was devoted to the ISR collection plan.

Summary of ASW in NATO Joint Operations

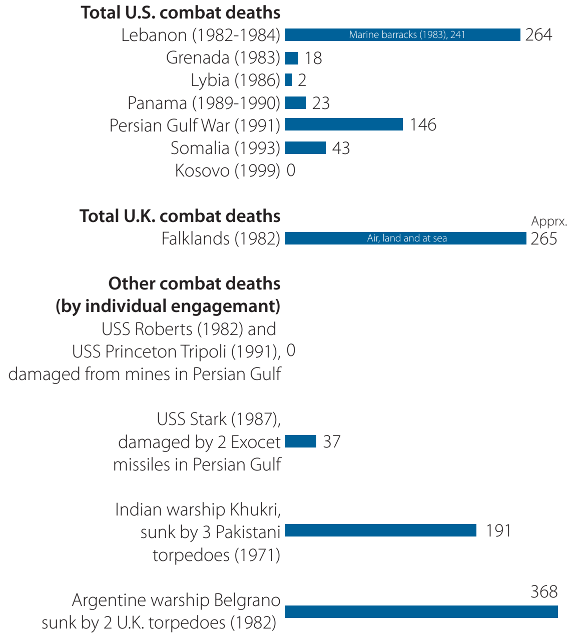
Since the end of the Cold War and the reduction of a significant threat posed by the Soviet Navy, NATO has been fortunate in that recent Major Joint Operations have been conducted with Maritime Supremacy from the onset of combat operations. However, many non-NATO nations have dramatically increased their defence spending, many notably into acquisition of newer diesel submarines, and the likelihood that all future NATO operations will occur with Maritime Supremacy in hand and little to no submarine threat will reduce accordingly. Should a future Maritime Component Commander

(MCC) have to fight their way to the beach, the defence of the naval force requirements would impact Joint Operations in many ways. Assets would have to be allocated for defensive purposes to counter a threat posed by adversary surface ships and submarines. Some strike aircraft from carriers would have to be re-allocated from a strike role to defensive anti-Surface Combat Air Patrol (SUCAP) stations. This would have a two-pronged result of reducing the support to the land-based target striking plan and potentially raising the requirement for land-based aircraft from the JFACC to be apportioned overwater to fill naval defence roles (Anti-Air and potentially Anti-Surface) in the event the aircraft carrier and her embarked carrier air wing could not meet the requirement. Additionally, MPA would fulfil their primary role of ASW and Anti-Surface Warfare (ASUW). MPA, which normally supports the ISR Collection Plan, might, therefore, not be available, further impacting the target strike plan and campaign phase timing.

'The only thing that really frightened me during the war … was the U-boat peril.'
Sir Winston Churchill

Finally, the Joint Task Force Commander will have to determine how much support from outside the maritime component is be required to protect the maritime force to a sufficient level. The impact of getting this decision wrong could be devastating to the entire joint campaign plan.

Although Figure 26 pre-dates operations in Iraq, Afghanistan, and Libya, it shows the manpower loss comparison from some of the most notorious sinkings in the 20th century against other land campaigns. Anecdotal evidence indicates each of those maritime losses are burned into the psyche of the respective countries' naval forces, remembered for the suddenness of the incident as well as for bringing to light the disparity between low-cost munitions (mines, torpedoes) against the cost in blood of a warship and what damage a single submarine strike can inflict on the entire maritime campaign.



Source: Future Undersea Warfare Perspectives
John's Hopkins APL Technical Digest (2000).

Figure 26 – Comparison of Deaths from Anti-Ship Torpedoes with Combat Deaths due to other Weaponry in Regional Conflicts.

Furthermore, the impact of the sinking of an aircraft carrier (instantaneous loss of 5500 personnel and up to 75 aircraft) or amphibious assault ship (loss of 2500 personnel, including the majority of the landing force infantry and equipment as well as up to 36 embarked aircraft) would be significant, not only to the operational plan but also by striking directly at NATO's critical vulnerability, the will of the nations. While a single submarine could achieve this, it is noteworthy that Russia currently has approximately 60 and China currently have approximately 84 submarines at their disposal.

In future conflicts, NATO JTF commanders will have to re-learn the Sea-basing concept and how to operate from contested seas, rather than assuming the luxury of maritime supremacy at the onset. The best way to solve the submarine problem is to do it at a distance, prior to the submarines' entry into the JOA, if possible. From this stems the relationship of the Theatre ASW Commander with the local ASW Commander.

'Military capabilities that have asymmetric effects are very attractive. In maritime terms, systems that can provide anti-access or area denial capabilities will continue to proliferate. Submarines fit perfectly into concepts for anti-access and area denial (A2/AD). Analyses of past maritime conflicts, combined with the knowledge of the challenges faced by Western militaries against asymmetric threats in Afghanistan and Iraq, have led some nations to focus on various asymmetric assets.
In the maritime domain, submarines and mines make up a central part of such strategies. Submarines are considered to be an excellent sea denial weapon of choice. They are proven, cost efficient, robust, stealthy, and lethal. Submarines are sought both by great powers, such as China and India, as well as smaller states, so called "maritime underdogs." Conventional submarines are "the weapon of the weak against the strong" and will continue to be attractive.'
Decision time for ASW:
Increased Cooperation to Prevent Irrelevance
Commander Oliver Berdal Royal Norwegian Navy

7.3 The Role of Theatre ASW Prior to Major Joint Operations

Chapter 3 outlined the history of NATO's Theatre ASW Commander and proposed a C2 construct to enhance the Alliance ability to locate, track, and monitor submarine activity throughout NATO's AOR in periods prior to the commencement of Crisis Response operations. The goal of this construct is to hand over peacetime continuous tracking of a non-NATO submarine to the Naval Task Force assigned ASW commander whenever the submarine transits within the task force AOR based on its resources and ability to conduct a submarine prosecution. In wartime, the TASWC would oversee engagement of submarines outside the local ASWC's AOR with the goal of preventing the submarine from ever becoming a threat to the force. If submarines originate from within the JOA, or transit between the waterspace overseen by the TASWC into the Task Force's ASW AOR, prosecution, and engagement of that submarine would fall to the local ASWC.

Even in peacetime, accepting gaps in submarine tracking at the theatre level induces challenges to the protection of the task force at the local level. Having a robust theatre-wide capability becomes requisite as an operation transitions from peacetime to crisis response. If no coordinated NATO-wide effort is put into tracking submarines prior to the onset of a crisis response operation, it will overly burden the maritime component with a problem that could have already been managed.

7.4 The Impact of an Un-located Submarine on NATO's Land and Air Components

In addition to the challenges un-located adversary submarines pose to the Maritime component, the modern cruise missile systems on many modern SSK class submarines have a significant range and precision capability. When layered into the larger Anti-Access/Area-Denial problem, these missiles will potentially challenge both the Air and Land components.

Figure 27 – A Submarine Periscope is Sighted next to a NATO Aircraft Carrier.

Figure 28 – Notional Range Rings for a Kilo SSK Launched Kalibr Cruise Missile.

The SS-N-30A Kalibr cruise missiles launched from a Russian Kilo SSK submarine into Syria have an approximate range of between 1000km and 1500km.[5] Those cruise missiles could target critical NATO C2 nodes, standing airbases and other critical military targets. Furthermore, the shore- and sea-strike capability of these submarines could potentially be used to counter NATO's burgeoning Integrated Air and Missile Defence system by targeting critical elements of the system either afloat or ashore. Kalibr missiles are domestically produced in both an anti-shipping and land strike model, and many assess them to be capable of either conventional or nuclear warheads. Although he was likely talking about the combination of ground-based and submarine-launched cruise missiles, Russian Defence Minister *Sergei Shoigu* announced in July 2015 that Russia 'will *boost the number of cruise missiles fivefold* in the next three years and by *30 times* by 2020'.[6] His plans put the submarine-launched cruise missile strike capability demonstrated by Russia in the Syrian conflict in stark perspective.

Although traditionally a ballistic-missile submarine mission, the advent of the missile technology available on the SSKs allows them to potentially target numerous densely populated urban areas. By exploiting the strengths of diesel submarines as described in Chapter 3, modern SSKs have the ability to close critical maritime chokepoints while simultaneously holding at risk critical infrastructure ashore.

7.5 Summary

ASW has a critical link to Major Joint Operations. If the maritime component has to expend resources to gain maritime supremacy, fewer resources are available to support land operations. Furthermore, a single submarine can have devastating effects on an entire campaign plan by sinking a critical asset such as an Aircraft Carrier, Landing Ship, or Oiler/Re-supply ship. Every component of the campaign should be aware of submarine threats.

1. 'Anti-Submarine Warfare after the Cold War'. Cote, Owen and Sapolsky, Harvey. MIT Security Studies. Avaialble online at: http://web.mit.edu/ssp/publications/conf_series/ASW/ASW_Report.html
2. 'The New Face of Naval Strike Warfare'. 2005 RAND Corporation Study. Available online at: http://www.rand.org/content/dam/rand/pubs/research_briefs/2005/RAND_RB9137.pdf
3. 'The Rescue of Bolar 34'. Phillips, Josh. Naval Aviation News, 15 Dec 2011. Available online at: http://navalaviationnews.navylive.dodlive.mil/2011/12/15/bolar-34/
4. 'VP-5 Takes out a Libyan Combatant'. JaxAirNews. 6 Nov 2011. Available online at: http://jaxairnews.jacksonville.com/military/jax-air-news/2011-04-06/story/vp-5-takes-out-libyan-combatant
5. 'Russian Submarine hits Targets in Syria'. Cavas, Christopher. Defense News. 09 Dec 2015. Available online at: http://www.defensenews.com/story/breaking-news/2015/12/08/submarine-russia-kalibr-caliber-cruise-missile-syria-kilo/76995346/
6. 'US Concerned about Russian Submarines with Nuclear Armed Cruise Missiles near Washington'. The Atlantic Council Guardian and Foreign Policy branch. 6 Jan 2015. Available online at: http://www.atlanticcouncil.org/blogs/natosource/us-concerned-about-russian-submarines-with-nuclear-armed-cruise-missiles-near-washington

A French Atlantic-II launches a MU90 torpedo.

CHAPTER VIII

Should NATO Explore a Common MPA Replacement?

'Mass (quantity) has a quality all its own'
Unidentified Russian Naval strategist

As air defence planners in Taiwan have come to realize in a rather public forum, capacity is a requirement in addition to capability.[1] In the same vein, NATO's MPA force will have a significant capacity challenge in the near term. Unless a solution is formulated, the Alliance runs the risk of being unable to maintain the required levels of Maritime Situational Awareness (MSA) of submarine activity.

8.1 The ASW Roadmap

The Defence Investments Division of the International Military Staff, working in conjunction with ACO and ACT, is developing a roadmap to identify areas that may be addressed by each nation to mitigate capability shortfall challenges identified at the 2014 Wales Summit. Although not yet fully mature across each of the capability areas, a significant amount of work has been put into developing the ASW roadmap. The current version of the roadmap further divides ASW into three mission areas: MPA, Submarine, and Surface Ships. Although the details of the ASW Roadmap remain classified, it does bring to light the MPA community is experiencing challenges resulting from a reduced inventory. Expanding upon a NATO Industrial Advisory Group (NIAG) study (NIAG SG. 166) completed in June 2012[2], the roadmap highlights many NATO nations' current MPA will reach the end of service life at around the same time (near 2025) which will exacerbate the challenge if left unresolved.

Stemming from this, the International Military Staff (IMS) established Specialist Team 5 as an element of the Under Water Warfare Coordination Group to

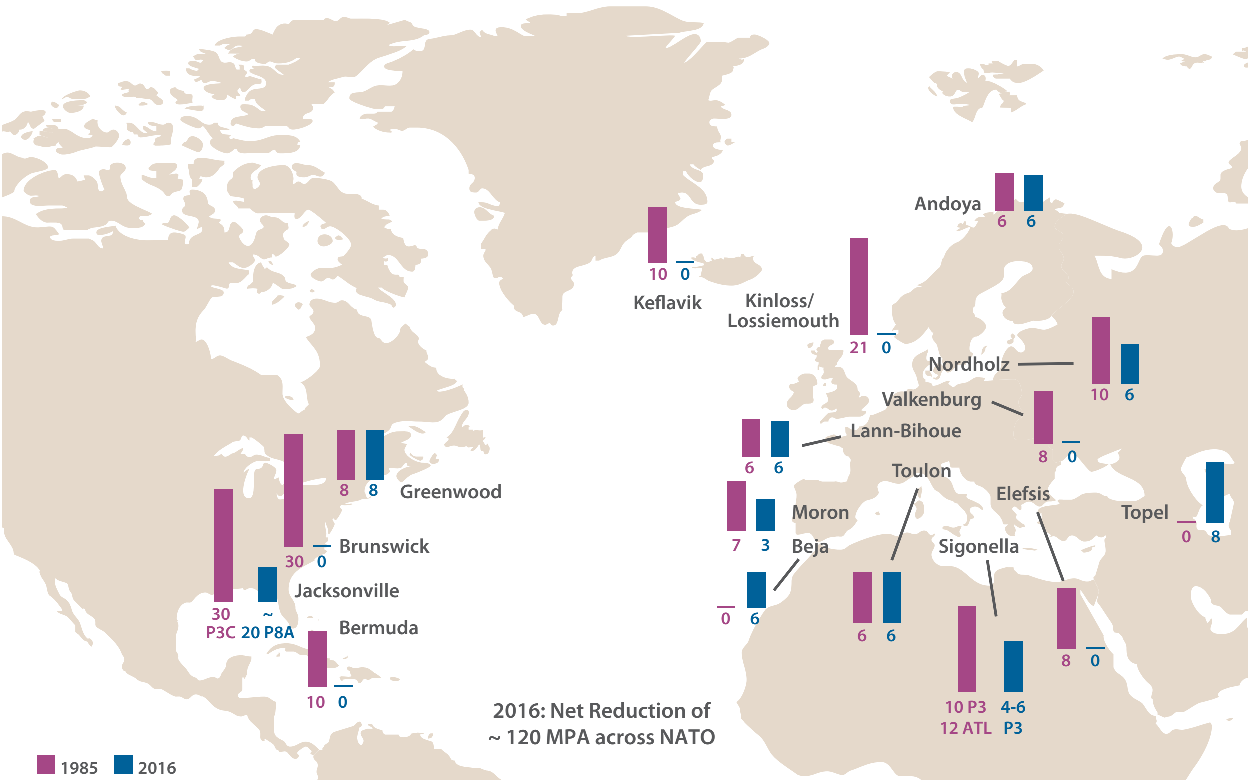


Figure 29[3] – MPA Inventory 1985–2016.

explore a possible MPA replacement airframe for effected nations. Unfortunately, in the last two years, little progress has been made on this issue. As of the Fall 2015 meeting, nations participating in this team have not even provided the UWWCG ST-5 with a national position on the MPA capabilities requirement matrix, which was agreed upon at the 2012 workshop, although some headway was made toward this end in early 2016. Further effort is needed to define the requirement before any true conversations regarding a common airframe can proceed beyond the theoretical. This is a key focal point of the ASW Roadmap, which is being folded into the NDPP and national Country Target Books.

The IMS is developing a Letter of Intent (LOI) for key nations of which MPA are most in need of replacement to explore the potential of a common airframe solution to this challenge. Although many of the nations on ST-5 (re-designated as M3A – Multi-Mission Maritime Aircraft) have expressed initial support for this LOI, it remains a source of concern that many of the proposed signatory nations and who find themselves in the most need of a replacement airframe do not actively participate in this M3A development team.

8.2 How National Interests Impact the Alliance Composite ASW Capability

The NIAG SG.166 study provides a comprehensive and holistic review not only of the current MPA inventory shortfall but also of the challenges of the current procurement process. Observing the US experience in fielding the P-8 Poseidon and matching conclusions drawn in the NIAG, this study concurs with previous assessments that approximately ten years will pass from definition of the requirement to operational deployment of a new airframe. The challenge for NATO today is the current MPA of many nations are already at the ten-year window of their expected end-of-

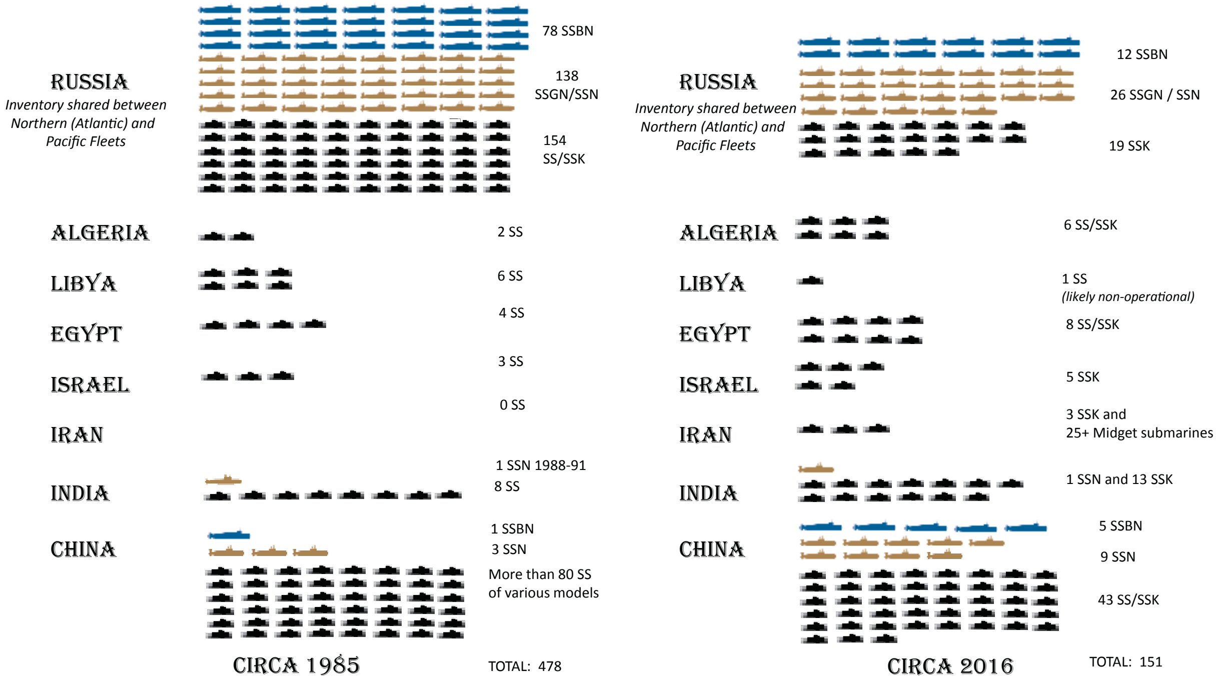


Figure 30[4] – Submarine Inventory Comparison 1985–2016.

service life. Yet neither a national nor NATO-common way ahead has been developed.

Each nation is faced with internal budgetary challenges to be balanced against the perceived threat to the nation and their ability to provide collective security to the Alliance. As an example of how a national decision has broader impacts across NATO's maritime capability, in the first decade of the 2000s, both GBR and NLD dissolved their MPA capability. NLD sold their P-3C fleet to Portugal (to establish an MPA capability) and to Germany (to replace their aging Atlantics) and has elected not to pursue a replacement capability.

Figure 31 – The UK Scrapped its Complete Inventory of the MR2 Nimrod and its Planned Replacement, the MRA-4, in 2011.

The UK elected to retire the Nimrod citing airframe airworthiness concerns and also elected not to replace the capability with a new airframe. The three MR-2 Nimrod squadrons were decommissioned, and GBR hoped to subsume the MPA portfolio of ASW and Long Range Search and Rescue into its ship and helicopter force. This decision turned out to be flawed. In November 2015, GBR announced the intention to purchase a fleet of nine P-8 Poseidons from the US, but it will be some number of years before that capability is realized in Britain. The Netherlands, GBR, and Greece also either decommissioned entire MPA squadrons or transitioned those squadrons entirely out of the ASW mission into maritime surveillance. The US decommissioned half of its fleet of 24 P-3C Orion Squadrons between 1992 and 1995. Other nations have permitted their MPA fleet inventory to dwindle while only maintaining a small number of mission capable aircraft.

The result of these decisions was an overall reduction in NATO's MPA inventory of over 120 MPA airframes. This number may appear skewed as the US numbers account for a large percentage of the reduction with the elimination of 12 entire squadrons in the early

1990s. Six of those squadrons and their aircraft were based on the US East Coast. This study includes them as resources readily available to NATO.

The submarine inventory chart above (Figure 30)[5] comparing non-NATO submarines in a similar timeframe as the MPA inventory on the preceding page highlights a reduction from approximately 478 to 151 submarines. Not all of these currently operate in the NATO theatre, but all of them could if their nation demanded. Analysis of the MPA-to-submarine ratio with the assumption that in 1985 China had no capability to deploy to NATO's AOR and assuming the Russian North and Pacific Fleets were equally balanced indicates that NATO had over 180 MPA available to prosecute what was likely around 100 submarines yielding a near 1.8 : 1 (MPA to submarine) ratio. In 2016, with the drastic reduction in MPA contrasted against the current submarine inventory (assuming China now has the capability to deploy to NATO's AOR and maintaining the same assumption about Russia's fleet balance), that ratio is now nearly the opposite- 1 : 2 (MPA to submarine).

This is further exacerbated by the fact that many nations are increasing their submarine shipbuilding while few nations are increasing their MPA inventory.

8.3 Aging Fleets Across NATO's MPA Force

The NLD and GBR decisions to eliminate their MPA fleet are amplified by end-of-service life challenges experienced by Spain, Canada, Italy, Greece, France, and Germany.

Although the acquisition of the former Dutch P-3s offset the retirement of the German Atlantic I to some extent, **Germany** has had significant material readiness challenges with all of its P-3C Orion airframes. As a result, mission availability is a constant challenge. Additionally, eight P-3Cs were acquired to offset the two squadrons of Atlantics. Although both squadrons remain in existence today, each operates fewer aircraft and has fewer aircrew than with the Atlantics. Although the endurance and range capability differences of the two airframes are somewhat offset, there still was a net reduction in inventory and maximum on-station coverage realized through this exchange. In addition, the German P-3Cs are in the midst of a life extension program (2016-2017) to bring the expected end of service life to near 2035.[6] Previous experience with P-3C life extensions have shown mission availability to decline toward the end of projected service life as airframe fatigue and parts support issues become exacerbated.

Spain's P3 fleet has dwindled to three aircraft upgraded from P-3B model to P-3M. This model provides an ASW capability nearing that of the P-3C and will extend the airframe service life to around 2025. Spain has not yet identified an ASW-capable replacement to follow the P-3. The Spanish maritime mission portfolio has become predominantly maritime surveillance rather than maritime patrol. The surveillance portfolio has been offloaded to other airframes such as the CASA 235 which is neither ASW capable nor equipped to deliver ordnance.[7]

Greece found itself in a similar position. As the end of life approached on its fleet of P-3Bs, service life extension was explored. Unfortunately, national budgetary restrictions derailed many of those efforts, and the fleet was sidelined in 2007.[8] Greece is currently without MPA capability, although some plans to restore a portion of the Hellenic P-3 fleet are being explored. In fact, in 2014 Greece contracted for a life extension to five P-3B airframes, which would bring another 15,000 flying hours[9] (until approximately 2025). Doubts about Greece's ability to fund the contract amidst its current fiscal challenges remain.

Italy has experienced nearly the same challenge with the retirement of its fleet of Atlantic IIs projected for later in 2016. Although Italy can boast the capability to project ASW capability from its robust shore based helicopter fleet in addition to those embarked on ASW ships, the MPA replacement, the Italian variant of the ATR-72 is not expected to be configured for ASW. However, Italy is actively participating in the UWWCG M3A replacement aircraft development team and is researching options to restore a long-range ASW capability by 2030.

Canada operates the CP-140 Aurora, an MPA model based on the P-3 airframe. Canada has upgraded its mission systems aboard its Aurora fleet in the last few years. It is believed to be on par with that of the US P-3C model[10] (prior to the US ASW C4I upgrade in 2015). This was a factor in the decision to perform a subsequent airframe life extension versus aircraft replacement. Canada had expressed interest in a variant of the P-8 Poseidon but, in late 2015, elected to conduct a life-extension to the CP-140. This service life extension includes upgrading 14 airframes with Block IV ASW/C4I upgrades to maintain an ASW capability to 2030, although the total invetory will be reduced to 14 airframes.[11]

France was interested in building the Atlantic III but in 2015 elected to conduct an ASW sensor upgrade and life extension on 15 of the 27 Atlantic IIs. This is expected to take the airframe to 2030.[12] With the pending retirement of the Italian Atlantic fleet, France will be the only remaining NATO nation operating the Atlantic model of MPA.

Norway currently operates two models of P-3 Orions, two P-3N, and four P3C UIP. Norway has elected to conduct service life extensions to its Orion fleet with expected service life between 2025-2030.[13] The additional challenge Norway will face involves aircrew training and simulator use, as Norway uses the US P-3 training pipeline at VP-30 in Jacksonville, FL. The US is scheduled to migrate complete away from P-3 support in upcoming years.

The Norwegian Chief of Defense released his Defense White Paper in October 2015, in which he proposes to retire the P-3 Orion fleet by 2020 due to budgetary prioritization. In its place, it is proposed to execute the long-range maritime surveillance function through the use of Medium Altitude Long Endurance (MALE) Unmanned Aerial Systems (UAS). Recognizing the severe impact this will have on both national and NATO ASW capabilities, NOR is in the process of prioritizing new and renewed capabilities. Potential items on this list include eventually replacing the current 4 P-3C UIP MPA with a new airframe, such as the P-8 Poseidon. The White Paper will lead into the politically approved long-term plan for the Norwegian Armed Forces, scheduled to be reviewed in mid-2016, which will have bearing on the future of the Norwegian MPA fleet.

8.4 New Participants in MPA

Turkey has begun operating the CN 235 Persuader as a Maritime Patrol Aircraft, which in mid 2016 was re-designated the P-235. The P-235 (inventory of 6 ASW variants) has an integrated sensor suite of FLIR, ESM, radar and acoustic and can carry up to 2 MK-46/54 lightweight ASW torpedoes.[14] Turkey also intends to operate a small fleet of ASW modified ATR-72 aircraft (P-72) with a target of 6 airframes by 2018.[15] Turkey is also exploring a long range Multi-Mission Aircraft capability to address capability shortfalls by the P-235 and P-72 aircraft.

Poland operates a fleet of five M-28B Bryza 1R Maritime Surveillance aircraft[16], one of which is configured for ASW. The Bryza ASW variant integrates Star Sapphire optics with an imaging radar and acoustic suite and is equipped with Link 11 capability. Regarding the bridge between Maritime Surveillance and Maritime Patrol, the Bryza is not capable of carrying or deploying torpedoes, but can hand-deliver light bombs by opening the cabin door.[17]

Portugal has been operating a small fleet of six P-3P Orions since the mid-2000s[18]. It has been an active participant in the limited prosecution of submarines recently conducting surfaced transits near Portugal. All of these models are expected to maintain service life until the late 2020s.

These new MPAs stem from a variety of airframe backgrounds. Technology has to some extent levelled the playing field for surveillance sensors (imagery systems, datalinks, radars provide the maritime component commander a similar capability regardless of which airframe is employed), but these other MPA have a lower level of acoustic onboard processing capability than traditional MPA (P-3, ATL, P-8). Subsequently, their utilization in a multinational ASW prosecution would have to be factored accordingly. NATO should specifically focus on integrating these ASW-capable aircraft into ASW exercises to enhance joint interoperability, grow experience, and explore integration and capability seams brought on by differing levels of acoustic capability. In the future, operations may efficiently use the capability brought by these nations who are new to the submarine prosecution domain.

Further details about each variant of MPA operated by a NATO nation may be found in the Appendix C.

8.5 Assessing the Validity of a NATO MPA Squadron

The challenge for the UWWCG's MPA Specialist Team as they attempt to move forward in researching a NATO common MPA airframe is nations do not share a common perspective on maritime patrol. Those with a lengthy history of MPA operations in the Cold War, who have adapted their current MPA fleets into true multi-mission aircraft (MMA) while maintaining a robust sensor and training program to retain an ASW capability, have one perspective on what the portfolio of a future MPA should be. Those nations less involved with traditional ASW and more focused on coastal surveillance and other aspects of maritime security have a different perspective. A true multi-mission aircraft capable of performing at high levels across the spectrum of Maritime Patrol and ISR will be a significant financial expenditure that not all nations will be willing to afford.

To advance the discussion on this issue, as time is fleeting to have a replacement aircraft fielded before the existing MPA are no longer serviceable, NATO must first determine the requirement then elect whether to approach a solution from national procurement channels or via the NATO procurement process.

Selecting a common airframe across the Alliance will lead to efficiencies in interoperability (air to air and air to ship). It will also permit common logistics processes and smooth out some of the ground support challenges identified in Chapter 3. Furthermore, a single

Figure 32 – View from the Cockpit of a Portuguese P-3 Orion.

airframe with scalable models from high-end Maritime Patrol (with embedded surface and subsurface engagement capability) to low end maritime surveillance might be more financially acceptable to many nations.

A detailed review of the options and differences between national procurement of MPA compared to a NATO procured and owned MPA squadron was outside the scope of this study. However, the following sections, which are an adaptation of the conclusions from the JAPCC research into the creation of a NATO/Multinational Joint ISR Unit (Oct 2015), offer some insight into the issue. The complete MNJISRU study is available at www.japcc.org/portfolio/nato-mnjisru/.

Common Will. The sustained political will to support the principles of NATO's Smart Defence is essential for the initial creation of a NATO MPA squadron and its long term success. The declared objectives of the 2014 Wales Summit, such as reversing declining defence budgets, emphasizing multinational cooperation, as well as enhancing and reinforcing NATO's ASW capabilities, mesh well with the creation of a NATO owned MPA squadron.

Common Funding. Initial acquisition and funding will require a multinational or joint funding approach.

Figure 33 – Unit Patches from MPA Squadrons, ASWOCS and ASW Bases which have Decommissioned since 1995.

Based on the analysis of the study, once the unit is established, costs for operations and maintenance as well as general unit support should come from NATO common funding. This funding model would align with the principles of the NATO Smart Defence Initiative by sharing the financial burden amongst all 28 NATO nations. This would not only leverage the political will to create an MPA squadron but also strongly support the long term sustainability of the unit.

Common Ownership. As a direct result of using the NATO common funding model, the MPA squadron's equipment and materiel will be owned by NATO itself. Therefore, it would not be subject to any national caveats. This will significantly contribute to ensuring the unit's full operational capability.

Common Platform. All MPA missions involving ASW require personnel specifically trained and qualified for that specific platform. As more nations share a common MPA platform, the more likely it is that personnel for an MPA squadron and associated ground support stations could be provided without requiring additional training.

Common Training. Not all nations interested in participating in ASW may be capable of appointing fully trained and qualified personnel for a NATO-specific MPA platform. The unit could be initially augmented with a dedicated training element from those nations with lengthy ASW histories both in the air and at ground mission support stations. This could also serve as a central NATO 'ASW Training Centre' for the benefit of all participating nations.

Common Post Sharing. Similar to NATO's AWACS squadron, a NATO MPA squadron could be based in a single location and operate with small detachments to current MPA bases for routine, enduring operations (surveillance, exercises) and surge operations. Depending on the location of the base selected, the majority of submarine prosecution missions could be operated from the home base. This should be a consideration for the squadron's home location.

Common Architecture. The MPA squadron should be structured to provide seamless integration into both NATO peacetime and wartime ASW and ISR architectures. This requires consideration of C2 arrangements regarding ASW prosecution management (Theatre ASW Commander), ISR Collection Management, and practical employment of the assets. Concurrently, the question of retaining national OPCOM over the assets also requires careful consideration.

Magnus Nordenman, in his recent study 'NATO's Next Consortium: Maritime Patrol Aircraft', has further proposed that a Consortium might be a viable way ahead to address current shortfalls. His proposed consortium would be able to 'coordinate their efforts, acquire a range of capabilities and share platforms, maintenance, basing, training and the intelligence derived from MPA missions.'[19] Although this is an exceptional model which leverages the best of the Smart Defense and Pooling & Sharing initiatives from the 2014 Wales Summit, our study concludes that this model would not fully address one of the most critical MPA shortfalls: Inventory.

In fact, it is likely that should this model be pursued, that, although the new aircraft would be equipped with latest sensors and technology, there would likely be even fewer airframes available for tasking in the future using this model than there are today.

8.6 Is an MPA Needed for ASW?

ASW has been proven to be best conducted using a layered, and when possible federated, system of sensors.[20] From space systems to bottom mounted sensors and leveraging the capabilities of platforms above, on and below the sea, NATO has best succeeded in locating and tracking non-NATO submarines when exploiting the full spectrum of available resources employed in a layered approach. The ocean is a diverse and challenging environment, and there are many reasons why a single sensor could lose contact on a submarine from one moment to the next, not the least of which could be the experience of the submarine commander in exploiting weaknesses in detection and tracking technology. Although few would argue that one of the best systems for tracking a submarine is another submarine, due in no small part to its inherent speed, stealth and duration similarities, MPA, MPH and space systems provide an irreplaceable part of the ASW continuum.

Some have postulated that the MPA capability could be 'outsourced' to ships and their embarked ASW capable helicopters. This study concludes that at the tactical, or naval task force level, embarked helicopters are capable of screening friendly ships against an ASW threat, although continual, persistent 24-hour coverage would be limited by the number of aircraft and crews within the task force. Although coordinated operations in a hi-boy/low-boy role are common between MPA and helicopters, an MPA in this instance is also suited to address the need to search, detect and potentially engage at distance, prior to the arrival of the task force into an operations area. Furthermore, MPA provides the ability to deliver ordnance on a potentially hostile submarine and then returning to land to re-load and re-arm, giving the task force commander the flexibility to employ ASW weapons without depleting the at-sea task force inventory.

The helicopter fleet is not only range limited compared to an MPA, but also limited to the relocation capability of the ship on which it is embarked. Therefore, due to the slow manoeuvre speed of ships compared to aircraft, at-sea based helicopters alone are insufficient to address ASW on a wider, theatre wide perspective. Finally, land-based ASW helicopters would have similar range and speed limitation issues compared to an MPA and would be unable to prosecute submarines operating in the deep ocean far from land.

Low MPA inventory will eventually strain NATO's response capability with MPA. Although the NDPP used a more detailed level of analysis to determine its recommended MPA inventory, a simple review of the number of airframes needed to prosecute a single datum is insightful. Assuming a baseline a 1.5 hour transit, 4 hours on task then 1.5 hours return transit (nominally 400nm at 250kts) with a 30 min overlap for a relieving aircraft, it requires 7–8 aircraft to maintain a 24 hour MPA coverage. Factoring in traditional aircraft readiness rates and accounting for multiple datums across NATO's AOR, it becomes apparent that a large number of MPA inventory is required just to meet the operational demand of theatre wide ASW in an environment with multiple submarines underway. The inventory issue becomes further exacerbated when acknowledging the numerous ISR and overland roles which MPA have filled in the last 20 years and are now part if the Joint ISR process, a critical enabler to any joint campaign.

Therefore, there are certain aspects of the ASW domain which are best filled with employment of an MPA. It is imperative, as NATO moves forward to address shortfalls within the ASW domain, that MPA works in concert with other systems, platforms and technologies.

8.7 Rebuilding NATO's ASW Experience

Following nearly two decades where ASW was not conducted at high levels, it may take a full generation to rebuild the experience of airborne ASW. This is viewed not just from an airframe perspective, but also to grow the experience level and build the expertise of acoustic operators and mission commanders in various MPA and MPH platforms. Rebuilding experience is not something which can be readily solved by a political statement or by increasing funding for technology; it takes time operating on top of non-cooperative submarines which are actively trying to evade detection. It will take a period of years to grow the core competency for a nation which stopped its airborne ASW program. This is an important lesson for the nations with new ASW platforms to understand.

8.8 Summary

Looking to the future, mitigation strategies for many of the shortfalls within the ASW domain are currently being pursued. However, the inventory of NATO's MPA is one of the shortfall areas for which a clear, cohesive mitigation strategy has not been identified.

The challenge is less about the capability of each airframe, but rather more about the lack of theatre-wide capability NATO loses as inventory shortages increase. It is commonly agreed NATO's MPA fleet could conduct a prosecution of a patrolling submarine. In fact, they have done so in recent months. But if, in five years' time, a significant surge in submarine deployments were to be realized, as trends are indicating, then NATO will be challenged to prosecute more than one submarine in geographically diverse areas with its current low numbers of MPA. This problem will be exacerbated by the projected further reduction as both the P-3 Orion and Atlantic models reach end of service life in the next 10–15 years.

This is not a new issue. It has been identified as far back as 2012. However, not all nations have assigned the procurement of a replacement airframe with the same level of urgency as others. This is evidenced by the fact that, as of January 2016, no nation had provided its national priorities and required capabilities to the team exploring a common NATO airframe even though the spreadsheet matrix was agreed to four years earlier. It appears some nations were waiting on GBR's decision. It is unlikely the remaining NATO nations who operate MPA will have the funds to pursue GBR's solution to procure nine P-8 Poseidon aircraft. Therefore, reaching consensus on this issue has even more urgency.

The commonality of airframe has many benefits, including the opportunity to exercise NATO's Joint Logistics process as well as ease basing support challenges as MPA deploy in and around the entirety of NATO's AOR. Furthermore, should the concept of a NATO-operated MPA squadron be desired, this study offers some very initial conclusions in this matter, although a detailed review of that aspect of a replacement MPA was not part of the scope of this study. This study concurs with the process and planning factors with which the NDPP used to identify the appropriate number of NATO MPA. It is this target number, coupled with the looming decrease in inventory expected next decade, which is driving the urgency of the work underway toward identifying a potential replacement airframe.

This study recommends the Military Committee reinforce to the UWWCG and its subordinate MPA Specialist team the urgency of reaching a decision and direct them to strive toward identifying a common MPA airframe. This airframe must have the ability to perform not only extended ASW (to include attack if needed) but also all aspects of both Maritime Patrol and ISR. The period for resolving this is short: History informs us it takes approximately ten years from identification of requirements to airframe delivery. Many NATO nations are fast approaching ten years before the end of their current MPAs' service life.

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An MH-60R deploys an exercise torpedo.

CHAPTER IX

ASW Doctrine

9.1 Current ASW Doctrine

NATO's Maritime Community has developed and published a significant amount of doctrine in the ASW domain. Much of it remains relevant; however, continued development of emerging technology and conversion into standardized TTPs and approved NATO doctrine is necessary. Several major publications cover the employment of Maritime Air assets in ASW and are in great need of doctrine review and updates to advance Maritime Air's support to ASW.

ATP-1 – Allied Maritime Tactical Instructions and Procedures (NC)

This document provides general guidance for mission planning aspects of ASW. It is a relatively comprehensive document that provides a solid foundation for the fundamental concepts involved in locating, tracking, and when necessary, attacking and defeating adversary submarines.

Additionally, this document provides the process and procedures for ship, helicopter, and MPA Coordinated ASW operations. It includes recommended tactics for efficient integration of the various sensors provided by each. This allows the maritime task force ASW commander to assign available resources to prosecute the submarine based on what assets are available at any given time, to include ship's passive sonar tail (TACTASS, MFTA etc..), ship's active sonar capability, and the sonobuoy loadout/acoustic capability presented by each type of ASW-capable helicopter or MPA which may be on station at any given time.

Although much of this publication is founded on Cold War tactics and has to some extent integrated Experimental Tactics (EXTACSs), which have been tested and validated in the subsequent years, the current doctrine falls short in addressing the expanded capability of today's ASW helicopters.

Many of NATO's ASW helicopters have significantly improved active (dipping) sonar capability over previous models. This fact has not been fully explored nor codified into doctrine. The same dimensions for search areas between MPA and MPH (with helicopters nominally being assigned Sector Zero in most ASW Airplans) from 30 years ago are still in use and have not been adjusted to account for the improvements in dipping sonar, which is now a component of much of today's ASW helicopter force. As an example, in the US inventory, 15 years ago the only dipping sonar capability existed on the helicopters embarked on an aircraft carrier. With the development of the MH-60R, that capability is now resident on the helicopters embarked on the DDG/CG. This has significantly altered the ASW capability available to the commander at any given time.

Other NATO nations have included a low-frequency active dipping sonar capability on recent models of ASW helicopters. This includes the EH-101/Merlin (ITA/GBR), and the NH-90 (BEL, DEU, FRA, ITA, NLD and NOR). Additionally, improvements in the dipping sonar capability have been realized in the last 10–15 years to the point where the current dimensions of ASW AIRPLAN sectors have not kept pace. Further information on the specific sensors installed on ASW helicopters may be found in the appendices of this study.

ATP-1 should be reviewed to insure the tactics employed align with the capabilities of today's aircraft.

ATP 17 – Naval Arctic Manual (NU)
This publication discusses water mass, oceanography, bottom topography and sound propagation in the Arctic. It is important for ASW aircrews to understand the differences between polar water masses and non-polar oceans and is recommended reading prior to any Arctic operation. Additionally, the chapter on Arctic air navigation outlines different procedures when flying in the extreme high latitudes. Finally, the discussion about ice generated ambient noise and Arctic propagation loss curves due to sea ice are valuable. This study concludes no significant shortcomings exist in this document specifically related to Maritime Air. However, there remain some sections regarding other aspects of Arctic operations which have been identified (at the Maritime Operations WG) for review.

ATP-28 – Allied Anti-Submarine Warfare Manual (NC)
ATP-28 provides an excellent foundation for detailed ASW mission planning. It includes a thorough review of types of submarines and their capabilities, and types of friendly force ASW resources and their capabilities, although at times this document tends toward over-classification. ATP-28 is the source document for further details beyond the information provided in Chapters 5 and 6 of this study.

ATP-28 does fall short in addressing different types of NATO MPA and MPH (specifically newer models), which will provide significantly different capabilities in coordinated ASW operations with surface ships. ATP-28 discusses passive acoustic tactics and techniques over the course of 49 pages, whilst only four are devoted to active sonar/sonobuoy procedures. Although passive sonar tactics are still in use today, by comparison, the level of detail provided in the publications does not reflect the current use of active sonar, both ship mounted, via airborne deployed active sonobuoys or MPH dipping sonar. This is an area in need of improvement in the next revision.

As previously stated, ATP-28 provides a solid foundation and thorough review of the fundamentals of ASW; however, the specific tactics for coordinated operations between MPA, MPH and surface ships do not reflect current MPA and MPH sensor capabilities. The next review of this publication should address this shortcoming.

AJP 3.3 – Joint Air Operations (NU) and ATP 3.3.3 – Allied Joint Doctrine for Air-Maritime Coordination (NU)
AJP 3.3 recently underwent a review and is expected to be ratified in the spring of 2016. Moving forward for the next version, AJP 3.3 will be reviewed for applicability of additional guidance to the integration of Joint Air assets into the Integrated Air and Missile Defence domain so subordinate doctrinal publications may

provide guidance for how the Land, Air, and Maritime components will deal with that joint problem set.

In the same vein, this document should be modified to include guidance on all services' air contribution to the Anti-Submarine Warfare problem set. It should include a brief overview of the domain and contributions other services may provide to the Maritime component in this area. Subordinate documents are attempting to codify the process by which non-maritime assets may integrate overwater to provide support to the Maritime component. In order to align with higher governing doctrine, this concept should be identified in the next revision of AJP 3.3 and ATP 3.3.3.

ATP 3.3.3.1 – Air-Maritime Coordination Procedures (NU)

In its early stages, this publication began as a method by which the Air Defence procedures for the Maritime component could be identified for use by other services. But the document has not been updated in almost a decade. In late 2015, the custodian hosted a drafting conference. At that time, JAPCC proposed and all participants agreed to expand the scope of the document to include all aspects of integration of joint and non-organic maritime aircraft into the airspace controlled by various maritime components. The new concept for this document would be to provide information for land-based fighters to join the maritime air defence network. Examples include codifying procedures to check in and work an over-water CAP station integrated into the maritime Air Defence Plan and to clarify the linkage between land-based AOCs (CAOC, JAOC) with Maritime AOCs. Additionally, it will define the process for land-based MPA and helicopters to join and integrate into the surface and subsurface warfare domain. The custodian expects to have a study draft with all of these concepts included routed for national review in the fall of 2016.

MC-0547 – Code of Conduct for the Use of Active Sonar to Ensure the Protection of Marine Mammals Within the Framework of Alliance Maritime Activities

Protection of marine mammals from harm due to sound intensity provided by active sonars has been an ongoing challenge for naval forces for the last two decades. Restrictions to operations to manage this have resulted in some reductions in ASW exercise operations areas around the globe, threshold settings on active sonars, and even speed restrictions on ASW ships sailing in areas populated by certain species of marine mammals. After consultation with MARAIR and COMSUBNATO and based on the author's personal experiences in ASW operations both within NATO's waters and also throughout the Pacific, this study concludes that the current restrictions on active sonar do not overly burden aircrew or significantly impact NATO's ability to train and exercise tracking and engagement of submarines.

9.2 Experimental Tactics

Unique to the Maritime doctrinal portfolio are Experimental Tactics (EXTACS) publications. EXTACS are used to propose doctrine codifying the procedures for a new technology, new capability, or even new command structure. The concept behind an EXTAC is that once approved, it is folded into the Maritime exercise portfolio to be tested and evaluated. If the procedure identified in the EXTAC is validated through experimentation and exercises with live naval forces, it is then folded into an existing Allied Tactical Publication (ATP) or, if needed, a new ATP is written to codify the procedure into formal maritime doctrine. The EXTAC library is maintained in AXP-5 (NC). The following list highlights EXTACs pertinent to this study:

EXTAC 181 – LFAS in Support of an HVU

This document provides guidance on the use of Low-Frequency Active Sonar (LFAS) in support of defending a High Value Unit (HVU) such as an aircraft carrier or logistics re-supply ship. The applicability to Maritime Air involves the generation of a moving barrier to screen and protect the High Value Unit from adversary submarines. Although the science behind the EXTAC is sound, it falls short of addressing tactics to convert an LFAS detection ahead of the HVU's movement. This EXTAC proposes one method of using LFAS to generate a sonobuoy barrier to screen an HVU's movement, but it seems to blur the line between 'detect' and 'deter' and per ATP-1, fails to clearly articulate the purpose of the ASW prosecution.

One additional challenge in this EXTAC is the potential for national differences in terminology involving Low-Frequency Active Sonar. This EXTAC refers to ASW Naval Combatant ships with hull-mounted active sonar with realistic detection ranges out to the first CZ. There are other Special Mission ASW ships with a Low-Frequency Active in some national inventory capable of detection at significantly longer ranges, prosecuting raypaths in multiple CZ convergences.

This study recommends this EXTAC be reviewed for prosecution tactics beyond just the generation of a moving barrier. Additionally, further coordination with the Terminology Working Group to ensure there is a clear definition of Low-Frequency Active Sonar to separate the different types and significant differences in LFA capability across disparate types of LFA systems is needed.

EXTAC 193 – ASW Protection of a Carrier

This EXTAC derived from France's experiences during Charles De Gaulle's recent deployments to the Indian Ocean leveraging actual ASW interaction with IR, IN and CH submarines operating near the carrier strike unit. The EXTAC specifically highlights methods to adapt NATO doctrine to increase flexibility in conducting ASW operations in and around CVN air operations. It includes procedures for which the level or air activity of the CVN at any given time is taken into account by the ASW Warfare Commander and ASW-related air operations in close proximity to the carrier.

This study finds subtle but important differences in the operation of the French CVN and the operation of US CVNs, specifically regarding the launch and recovery aspects of flight operations. It is also important to remember frequently there will be a subsurface, surface and air threat to the CVN which require a three dimensional protective screen be employed. Therefore positioning of ASW 'goaltenders' as outlined in this EXTAC must take into account the potential for concurrent Anti-Surface Warfare (ASuW) and Anti-Air Warfare (AAW) missions and the impact the geographic and relative stationing of an AAW 'goaltender' will have on CVN flight operations.

Finally, as discussed in Chapter 2, many NATO nations refer to their amphibious assault ships as aircraft carriers. With the arrival of the F-35B to Alliance STOVL carriers in the next few years, there will likely be a significant change in both capability and amount of fixed-wing flight operations conducted from the STOVL Carriers/Amphibious Assault Ships. Flight operations on these types of ships differ dramatically from CVNs and should be addressed in this EXTAC.

EXTAC 193 should be reviewed by STRKFORNATO for concurrence and to ensure that all types of CVN and Amphibious Assault Ship flight operations are reflected with appropriate ASW tactics derived accordingly.

EXTAC 194 – ASW Operations in Situations Other Than War

This EXTAC addresses what is commonly referred to as Peacetime ASW but viewed from the Task Force ASW Commander perspective. This EXTAC provides a solid foundation for developing coordination handover procedures from a Theatre ASW Commander to a TF or Local ASW Commander. At the 2016 MAROPS WG, COMSUBNATO was requested to synthesize salient elements of this EXTAC for inclusion in their proposed Area ASW EXTAC 197.

EXTAC 195 – Multi-Static Sonar Operations

The field of bi- and multi-statics is a developmental area that is progressing only as fast as R&D / S&T efforts are driven by a few nations. This EXTAC is not fully developed and, per agreement at the 2016 Maritime Operations Working Group, will be retained in its current status until Nations are able to field Multi-Static Sonar capabilities into their fleets for experimentation.

EXTAC 197 – Area ASW Operations (DRAFT as of Feb 2016)

This EXTAC defines a proposed command structure. COMSUBNATO would serve as focal point for ASW operations occurring outside a naval task force's local ASW commander's AOR. This is a step towards formalizing a Theatre ASW commander, moving forward in parallel with and as a result of research and conclusions in this study. In the opinion of this study, as drafted the EXTAC falls short of defining the authorities truly needed to execute theatre-wide peacetime ASW. There remains a reliance on the willingness of the nations to participate and share information. There is no forcing function to ensure CMAN/CSN receives either the information needed to shape theatre-wide ASW prosecutions nor the formalized arrangement for temporarily assigning maritime forces to MARCOM for the purposes of conducting peacetime ASW.

This study endorses the steps taken by the current draft of this EXTAC and recommends immediate approval and validation at the next opportunity as a step toward a future TASWC structure. Furthermore, conclusions on TASWC and recommendations for command structure to solve the current C2 challenges are further identified in Chapter 3.

9.3 Summary

This chapter reviewed current NATO doctrine and provided recommendations for updating certain ATP and for exercising then ratifying certain EXTACs. Although many of the higher level documents align with current strategy and provide a solid foundation for the execution of ASW operations, some work is needed to align the tactical documents, specifically those involving coordinated ASW operations and use of ASW helicopters, to account for modernization of sensors. Additionally, the study reviewed salient ASW EXTACS with a recommended priority for immediate evaluation of the experimental tactics in upcoming exercises.

Finally, and perhaps most critically for NATO's ability to conduct peacetime ASW, is a recommendation for immediate endorsement of EXTAC 197 (Area ASW Operations). Although this study concludes the proposed C2 plan in EXTAC 197 does not go far enough, it is moving in the right direction and should be implemented immediately.

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Artist's conception of MPA and an air-deployable UAV jointly conducting ASW.

CHAPTER X

Coordinated ASW Operations and Emerging Technology

10.1 Multi-layered Approach to ASW

Detecting, tracking, and engaging adversary submarines has never been a one-asset show. From the history of submarine tracking in the 1960s to today, a layered approach to ASW has been utilized. Maritime Patrol Aircraft have traditionally played a key role, working with submarines and other assets, as undersea surveillance systems became fully operational in the early 1960s.

MPA offered speed that submarines lacked, making them particularly useful in the initial localization of a contact, which could be handed off to a platform with more endurance, like a nuclear submarine, and coordinated tactics between MPA and submarines for joint prosecution evolved with advances in adversary submarine technology over the decades. The surface warfare community was slowest to change its traditional ASW methods, remaining dependent on active sonar and short range ASW weapons until the late 1970s. Then, in response to the deployment of more capable Soviet submarine-launched anti-ship missiles, surface combatants also embraced passive acoustics and long-range, shipborne ASW helicopters.[1]

Today, at the Naval Task Force level, coordinated ASW operations remain a focus of effort. Shifting from detecting and holding a submarine at arm's length, ASW operations inside the Task Force AOR are migrating toward detecting and engaging hostile submarines to protect a High Value Unit within the Task Force. Exercises practice a myriad of detection methods, including surface ships' passive sonar tails or active bow-mounted sonar, radar, or ESM detection from a ship, MPA or MPH or acoustic detection from a sonobuoy field. Furthermore, once contact has been generated, procedures for passing contact back and forth between tracking assets (ships, MPA, MPH) are practised to avoid losing contact in the turnover process. Finally, coordinated attack procedures are also exercised, not only from the aircrew perspective but also involving decisions made by the LASWC involving the presence of friendly submarines to avoid fratricide.

10.2 SOSUS

Historically, multiple types of sensors have been used in a layered approach for initial submarine detection. In the Cold War, a bottom-mounted acoustic detection system (SOSUS: Sound Surveillance System) would gain initial submarine detection and pass that information to ships and aircraft for further prosecution. This was an extremely closely guarded secret. It is still representative of intelligence sharing challenges between various NATO nations. Of note, the entire SOSUS/Integrated Undersea Surveillance System (IUSS) underwent a drawdown as significant as that experienced by MPA, albeit for a different reason.

'As increasing numbers of Soviet submarines began entering the North Atlantic from bases in the Barents and White Seas, additional acoustic monitoring facilities (referred to as NAVFACs) were established in Iceland and Wales. By the mid-1970s, the SOSUS system consisted of 20 NAVFACs, two Ocean Systems commands (COMOCEANSYSLANT and PAC), and about 3,500 personnel. In the 1980s, improved cable technology, closely related to the technology used in transoceanic telephone cables, allowed the arrays to be located farther from the NAVFACs. All of the coastal Atlantic and Caribbean sites were replaced by Naval Ocean Processing Facility (NOPF) Dam Neck, for example. In addition, the network of fixed arrays was augmented by acoustic surveillance ships deploying the Surveillance Towed Array Sensor System (SURTASS). This consisted of a towed line array over 8,000 feet long. The overall system, including both the fixed and towed arrays, was called the Integrated Undersea Surveillance System (IUSS).'[2]

The system reached its Cold War peak with 11 NAVFACs/NOPFs, 14 SURTASS ships, two Ocean Systems commands, and manned by approximately 4,000 personnel in the late 1980s. Eventually, Soviet intelligence learned of the existence of SOSUS and its remarkable success in tracking Soviet submarines at long ranges with the help of information supplied by the Walker-Whitworth spy ring. John Walker was a US Navy warrant officer and submarine communications expert who sold countless naval messages to the Soviets from 1968 to his arrest in 1985.[3] Jerry Whitworth was another Navy communications specialist recruited by Walker to assist with his espionage activities.[4] The Russian Navy responded by working to quiet their submarines. By the end of the Cold War in the late 1980s, the ability of IUSS to detect and track Soviet nuclear submarines at long ranges had decreased significantly. Modern diesel-electric submarines are even quieter and more difficult to detect by passive listening.

The combination of the end of the Cold War and improved technology resulted in a much smaller system. By 2010, only two NOPFs, five SURTASS ships (all in the Pacific Ocean), a single system command, and about 1,000 personnel remained.[5] Bottom sensors today, including their location and capability, remain highly classified but are still a part of the holistic ASW prosecution.

10.3 MQ-4 Triton

The advent of UAS into the ASW mission will be realized with the US Navy's MQ-4 Triton. As the EP-3 Aries retires, the SIGINT capabilities of that asset will be shared between the P-8 Poseidon and the MQ-4 Triton. The Triton is a maritime derivative of the Global Hawk. Equipped with a Maritime GMTI radar, an EO/IR sensor, and SIGINT/ELINT detection systems, the Triton will bring long-duration mission capability to this portfolio.

Specific to ASW, Triton may offer initial cueing based on radar periscope detection or ELINT for further prosecution by other ASW assets. Along with the P-8A Poseidon, the MQ-4C Triton is integral to the Navy's Maritime Patrol and Reconnaissance Force (MPRF) Family of Systems and airborne ISR recapitalization strategy. Triton is expected to reach IOC in 2018.[6]

10.4 Other UAS to Augment ASW

The ability of other types of UAS to augment the Maritime component in the execution of ASW is currently limited to the Search/Initial Detection phase of prosecution. Long-duration ISR assets, such as the maritime MQ-4 Triton, the Air component's Alliance Ground Surveillance System (AGS), the MQ-9B Reaper, with its Maritime Wide Area Search (MWAS) using radar and EO, or other manned ISR platforms (including Maritime Surveillance planes not normally capable of ASW) can all play a role in the initial detection of a submarine. Diesel submarines present non-acoustic detection opportunities when exposing their snorkel while recharging their batteries. Although this happens less frequently with the advent of AIP-equipped SSK, the opportunity is still present. ISR assets can cross-cue radar with AIS (Automated Information System – similar in concept to IFF for merchant ships), convert to electro-optics, and make an initial identification, which can be then passed on to a prosecution platform.

Although less likely in the Search/Detection phase, Tactical UAS embarked on naval ships may also be used to validate radar returns. The EXTAC on Maritime Tactical UAS should be expanded to include this tactical possibility. The key takeaway in the Detection Phase is for the maritime component to remember the air component can offer assistance in the form of ISR assets to this phase and to not hesitate to request the Maritime Component Commander to request support formally.

Acoustic tracking of a submerged submarine is not in any current UAS' portfolio. However, one of the more promising emerging technologies is a small, lightweight quad-copter, which may be deployed in an ASW role. One of the prototypes of this technology, the Aqua-Quad, is a four-propeller design that has been tested in sea states up to ten feet. This model is equipped with both a solar power system enabling long-duration operations up to three months as well as an acoustic sensor which could be used to detect submarines. This drone is essentially autonomous and can take flight from the water to reposition, or remain in place for significant periods of time.[7]

10.5 Self-Synchronization of Drones for Anti-Submarine Warfare

One of the significant challenges to passive sonar detection, as discussed in Chapter 6 and Appendix 2, is the passive detection range of submarines decreases as submarine quieting technology improves. Therefore, once a submarine has passed beyond the passive detection range a sonobuoy, that buoy is effectively of no further use.

The Aqua-Quad technology could replace a passive sonobuoy field with a swarm of these drones. Then, by either self-synchronizing to reposition ahead of an evasive submarine or being controlled to do so by a manned MPA or through a link from an unmanned high-altitude UAS, these drones could effectively maintain a moving 'net' around a transiting or patrolling submarine.

Once the network technology is developed, these systems could work in concert with other long duration tracking assets, such as the Sea Hunter unmanned surface vehicle, MQ-4 Triton, manned MPA, or even a surface ship. This would mitigate many of the long duration tracking challenges currently experienced by NATO. If a situation evolved where escalation from tracking to engagement occurred, these drones could provide cueing data to an attack platform, likely an MPA or MPH.

10.6 Unmanned Underwater Vehicles (UUV)

The development of NATO standards for Unmanned Underwater Vehicles has the potential to address the ASW shortfall. Although UUVs have made tremendous strides in their role in Naval Mine Warfare (mostly in mine detection) during the last decade, the technology is not yet mature enough to initiate experimental tactics development for inclusion of UUV into the ASW role. The key enabler for advancing UUV integration to the ASW tracking and detection aspects of submarine prosecution stems from the development of a robust communications data network capable of linking the UUV to other assets in the ASW prosecution. The ocean as a medium for this network provides many challenges for bandwidth which are not resident in airborne link architectures. The Centre for Maritime Research and Experimentation (CMRE) is researching potential solutions to this challenge in coordination with those nations putting effort towards the development of UUVs.

One interesting development in the field of UUVs is the long-duration sub tracking capability proposed by DARPA's Sea Hunter (a derivative of research into Anti-Submarine Warfare Continuous Trail Unmanned Vessel – ACTUV). Although not a detection system, this UUV would be designed to maintain continuous track overtop of an adversary submarine with a long-duration capability of between 60-90 days.

'*Sea Hunter* will be a trimaran design (artist's conception in Fig. 34), with the vast majority of its hull and superstructure built of lightweight and radar-translucent carbon-composite materials. It will have a length of around 130 feet, and its centre hull will be long and streamlined. The trimaran design lends itself to endurance, sea keeping, and speed, which will be necessary for keeping up with sprinting diesel submarines as well as those that are running slow and quiet for long periods of time. The first ACTUV prototype, named *Sea Hunter*, is currently under construction at the Oregon Iron Works and will be tested on the Columbia River in 2016. Aside from its on-board tracking sensors, the most important electronics suite aboard *Sea Hunter* will be its satellite and line-of-sight datalinks that provide situational awareness to controllers thousands of miles away, as well as connectivity with other sub hunting assets. These include *Sea Hunter's* high and long flying semi-autonomous cousin, the Navy's new MQ-4C Triton, as well as sonobuoy dropping

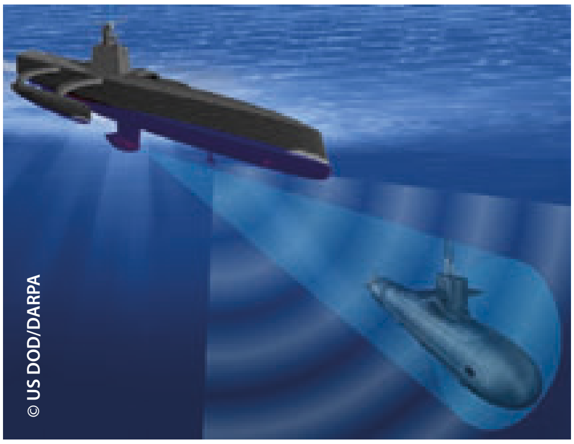

Figure 34 – Artists Conception of the Sea Hunter USV Tracking a Submarine.

P-8A Poseidon maritime patrol aircraft and MH-60R Seahawk helicopters.'[8]

This technology is intriguing and may offer a potential solution for long-duration submarine tracking. However, in heavy weather, the submarine can dive deep and avoid the worst of the environmental impacts. Surface assets, like Sea Hunter, may not be able to remain in the area as waves grow to excessive heights. A handover to another ASW asset in the family of systems will be required at that point.

Additionally, a surface-based ASW asset, whether manned or unmanned, is not necessarily granted special status by the International Rules of the Road (COLREGS-72: Regulations for the Prevention of Collison at Sea). It will therefore need to interact with other ships likely in the Power-Driven Vessel status rather than Restricted in Ability to Manoeuvre. This may further complicate the submarine tracking capability in a high-traffic environment, such as the littorals. Nevertheless, the technology is promising and opens up a range of possibilities for interaction with Maritime Air ASW assets.

10.7 The Surface Fleet's ASW Advancement

To meet expanded foreign submarine operations and UUV technological advancements, the surface naval force employs state-of-the-art ASW technology aboard numerous destroyers. The SQQ-89A(V)15 Combat System, which will be aboard 64 US destroyers by 2020, and the new Multi-Functional Towed Array (MFTA) are game changers in ASW operations. Their combined capabilities alter the methods by which the surface navy searches and tracks submarines. With enhanced sensor capability and data processing, the surface naval forces have an increased role in integrated ASW operations. ASW surface ships can remain on station longer than aircraft and also provide real-time command and control capability beyond that of a submarine.

As an integrated component of many ASW ships, their embarked ASW helicopters have also undergone numerous sensor upgrades, including an enhanced active dipping sonar. This new sonar is advertised to increase detection ranges from three to seven times that of legacy systems.[9]

The upgrades to both the surface ship sonar suites and their embarked helicopters' dipping sonar have resulted in an increased capability not yet reflected in NATO's ASW doctrine for tracking and attacking adversary submarines. Chapter 9 highlighted specific examples where coordinated ASW operations tactics should be reviewed and updated to reflect current technology.

10.8 The Advent of Persistent Sound Technologies

Research is also ongoing into the integration of multi-statics into traditional passive systems (fixed sensors, passive sonobuoys, and ship-deployed passive tails). Chapter 6 outlined the challenges presented by a sound medium which is becoming louder with increased traffic coupled with a target which is becoming quieter through sound suppression technology. Pervasive Sound refers to integration and data fusing of input from multiple types of ASW sensors to generate a holistic view of the waterspace, accounting for differences in sound propagation raypaths.[10] Although the term Pervasive Sound has been coined by one particular defence contractor developing a system for installation on ASW capable ships, the concept is being explored by more than one corporation.

10.9 Other Emerging Technology

National research programs are also offering new technology that may be integrated into an ASW prosecution.

- **UASs Deployed from MPA:** The future concept of operations for the P-8 Poseidon involves a shift to high-altitude stand-off tracking and attacking of submarines. This is due to the increased potential of submarine-launched surface-to-air missiles and the subsequent risk to the aircraft. The adaptation of torpedoes for high altitude deployment (fins and guidance system upgrades) and the potential of a UAS deployed from the P-8 with a magnetic detection capability for tracking submarines are under exploration.
- **Improved Ocean Measuring Sonobuoys as Potential Detection Devices:** Research is ongoing into using extended-life sonobuoys to better characterize and predict the behaviour of sound in the littoral environment. Some designs contain a thermistor string to measure ocean temperatures and hydrophones to measure ambient noise. This type of complex sonobuoy would be far more expensive than a traditional single-measurement device, but it could provide a more thorough environmental assessment.[11] Additionally, research into using these sonobuoys (or a UUV) as long-duration acoustic monitoring device has begun. A long-duration asset could signal when it has been 'triggered' by a submarine, which would then be prosecuted by another ASW asset.
- **Bottom-Mounted Environmental Sensors:** Similar to the previous item, scientific research including both environmental measurements and tracking of cetaceans and dolphins using an Autonomous Multi-channel Acoustic Recorder (either bottom mounted or moored) has already been completed.[12] Many of these are remotely monitored through the internet rather than processing data on station with ships, UUVs or aircraft. A challenge is the inadvertent detection of friendly

submarines by these systems. A process for coordination is already underway. Conversely, existing systems or potential future derivatives might be exploited in chokepoints or other areas of likely non-NATO submarine operations to serve as initial detection devices.

- **An Evolution In Sonobuoy Transmission Medium:** Sonobuoys may be migrating away from today's typical radio frequency interface toward a digital or even web-based interface. NATO is developing a STANAG for sonobuoy standardization to assign each an individual IP address.[13] In this instance, the standardization precedes the technological capability, but it will only serve to improve the process as that capability comes online.
- **Adding MSA to Helos and UAS:** Some nations are exploring the potential of multi-static processing aboard their ASW helicopters. In 2014, the UK elected to outfit their EH-101 Merlin fleet with MSA capability[14] to enhance interoperability with NATO's MPA fleet as Multi-Static Active technology continues to develop.
- **UAS to Deploy Sonobuoys:** One final advance in sonobuoy technology involves the miniaturization of future buoys for adaptation and carriage by UAS. Although not currently fielded by any nation, an exploration into the feasibility of internal carriage by UAS (requires airframe adaptation) or external pod carriage is ongoing. The engineering behind carriage and deployment of sonobuoys is sound. However, the technical limitation (bandwidth being the most critical limiting factor) of remote acoustic processing of a UAS deployed sonobuoy field must still be overcome.
- **Pervasive Sound Technology:** Investigation into detection of pervasive sound is underway in some NATO nations. Focusing on the principle of Distributed ASW (networking the sonar systems of multiple platforms [ships, buoys, friendly submarines] so that they perform as a linked set of sensors rather than an independent, discrete sonar system), Pervasive Sound technology refers to exploiting 'sonar energy which is diverse with respect to frequency, time and space (depth/positon) which can be detected and processed multi-statically across a wide geographic area with the emphasis on utilization of multiple lower power energy sources rather than few high power sources.[15]

10.10 New Adversary Technology

As NATO is researching advanced technology for improving ASW operations, other non-NATO nations are doing the same. In addition to the nuclear-tipped hypersonic UUV discussed in Chapter 5, other research areas of interest are noted below:

- Based on some challenges with the first-in-class deployment of the St Petersburg, Russia has pushed back deployment of its AIP capability until 2020. Research into quieting technology and overcoming engineering setbacks will be its focus in the next few years.[16]
- China is researching a supersonic submarine design based on *supercavitation,* which was originally developed by the Soviets in the '60s. In theory, supercavitation could allow for speeds up to the speed of sound – which, underwater, is approximately 3,300 mph. This technology could further be applied to weaponized torpedoes. Of note, hyper-cavitating torpedoes[17] are operated by Russia, Germany, and Iran (which likely reversed engineered the Russian 'Shkval').[18]

10.11 Summary

Coordinated, multi-layered prosecution of submarines is the logical answer to both a dynamic problem within a Naval Task Force and for detection and tracking in a large, potentially theatre-wide area where distances will challenge the availability of all resources. As technology has advanced the capability of surface ships and their embarked helicopters, NATO should review applicable ASW tactics to ensure it is aligned with current sensor capabilities.

The development of emerging technology will continue to bring new challenges for the ASW domain. Potential adversaries are researching capabilities to which NATO does not have a current response, while NATO research into expanding the integration of UUV into ASW is dependent upon the development of an appropriately capable underwater data exchange network.

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A deployable mobile Tactical Operations Centre is capable of supporting the entire mission portfolio of MPA.

CHAPTER XI

MPA Mission Support Centres/ Maritime Air Control Authority

NATO's MPA come with their own unique set of ground mission support requirements and, of course, interoperability challenges. Several possible solutions could mitigate those challenges as aircraft evolve.

11.1 Cold War ASWOCs

Not only was the C2 relationship discussed in Chapter 3 critical to multinational support, but the success of the MACA construct and the MPA-based ASWOCs/TSCs (ASW Operations Centres/Tactical Support Centres) outside the Mediterranean were able to support MPA from any nation. In the past, a Norwegian P-3 conducting the ASW high-boy role overtop a US Orion and recording acoustic data from the US sonobuoys could land at Keflavik and have that acoustic data analysed, processed, and disseminated across the MPA and the entire ASW force intelligence system. The same was true for all varieties of MPA at each of the TSCs or MACAs. French, German, and Italian Atlantics could be supported alongside Dutch and US P-3s by the MACA at Sigonella. At that time, Alliance MPA systems were mutually supportable by each other's ground stations.

As the digital age has unfolded and national procurement processes have overtaken aircraft upgrades without an eye toward NATO interoperability, this mutual support by a common ground station is no longer the standard today.

11.2 The Evolution of Mission Support Centres

As many MPA were modified for ISR mission capability and ISR collection grew to consume a larger portion of the MPA mission portfolio, many ASWOCs and national

MACAs were concurrently modified. Additionally, the advent of the digital age and availability of commercial technology resulted in both MPA and their associated mission support centres evolving without consideration of interoperability with other NATO nations' assets, which previously was a hallmark of the ASW mission in the 80s and 90s. For example, the US MACA in Sigonella, IT, is currently only capable of processing and reviewing acoustic data collected from the US P-3C Orion. It will be augmented by the Mobile Tactical Operations Centre (MTOC, which deploys with each P-8 squadron) upon the arrival of the P-8 Poseidon into theatre. MACA Sigonella cannot process acoustic data from either Italian or French Atlantics, or Spanish, Greek, German or Norwegian P-3s. These countries' national systems have evolved to unique data recording mechanisms which can no longer be processed across the NATO MACA architecture. Rather, this data can only be processed at their national MACAs.

This problem persists across each of the national MACAs in the Mediterranean. Post-mission analysis of acoustic data to confirm the aircrew was actually tracking the submarine they thought they were tracking, or to detect post-mission actual submarine contact, which a crew may have overlooked in the air, are both critical functions of any MPA or MPH ground support station.

In the search phase of a submarine prosecution, this post-mission 'missed detection' capability provides an irreplaceable link in the management of ASW resources for future events. Post-mission analysis, to confirm whether contact was missed, of patterns deployed at critical locations, such as choke points, may mean the difference between future missions searching inside or outside the Strait of Gibraltar. With the loss of mutually supporting post-mission analysis capability, a multinational prosecution is severely inhibited.

11.3 MACA Support to NATO's ASW Exercises

In many instances, MACAs truly only exist/operate when supporting NATO exercises. Even during operational missions (such as in support of Operation Active Endeavour), aircrew obtain mission briefings from the national support structure. Post-mission data is processed through national channels. It is then given to MARCOM in a pre-determined post-mission report format. This is a fundamental shift from the operational construct in place 15 years ago.

For ASW exercises, most MACAs provide a NATO-level portion of the facility (separate and distinct from the national systems and spaces). In this area, the basic mission planning, safety of flight briefing, and post-mission interviews to determine exercise objectives may be conducted. In flight, real-time support is no longer possible through most of the MACAs. That has now reverted to national channels. This limits the high-end capability (cipher communications, datalinks, inflight ISR data exchange, etc …) to only those aircraft from the nation which operates that particular MACA.

For exercises, MARCOM traditionally generates an ASW exercise support cell. This is because much of the MACA's 'national manpower' has been reduced to the point where they cannot operate both a MACA conducting NATO ASW missions and maintain their national mission support centre simultaneously.

During exercises, there exists a rudimentary level of post-mission reconstruction. Each nation has developed software to convert the MPA and MPH 'mission computer' data (aircraft track, positions of deployed sonobuoys, specific items recorded by the computer – ESM, MAD detections, etc.) to a common format for integration into a debriefing tool. This capability is not resident in every MPA and MPH nation. Some rely on hand-written logs, which are provided post mission to the ASW cell for integration into the exercise reconstruction.

Most importantly, mission reconstruction capability does NOT include acoustic data processing. It is only the basic information recorded by the mission computer. All MPA and MPH acoustic data is recorded on a different system than their onboard computer. As NATO has diverged from any semblance of a common standard, the hardware and software for the MACA's to process other nations acoustic data does not exist.

Acoustic processing, as discussed, is a key element in the post-mission analysis.

Additionally, information exchange with MARCOM has significantly degraded since its move from Naples to Northwood. In the course of upgrading their national MPA to ISR and overland strike missions (as is the case for the US and France), the building which houses many national MACAs underwent infrastructure alignment to more closely align with national information systems and is now less aligned with NATO information exchange systems.

In fact, MACA Sigonella has undergone internal building upgrades and modifications necessary to accommodate the national mission support realized with the combination CTF-67 (formerly located in Naples) with the MACA in Sigonella. This resulted in restricting the aircrew briefing rooms, which were used in the past for NATO aircrew performing missions over Kosovo, or multinational ASW missions in the Mediterranean, to only US aircrew. This includes access to the acoustic processing equipment for MPA and MPH aircrew to do things such as post-flight analysis of passive acoustic contact and other ASW -mission support functions. Currently, there are a small number of bare-bones rooms available in NATO spaces, but those spaces do not have the IT infrastructure support and are nowhere near the equivalent of the spaces to which NATO used to have access when visiting this MACA.

Furthermore, MACA Sigonella is unable to meet the manpower requirements for simultaneous national mission support and NATO ASW mission support. During exercises, even with a moderate number of ASW missions such as the Dynamic Manta/Mongoose series, MACA Sigonella is only able to provide a small number of personnel to an ASW aircrew briefing/debriefing cell. It must rely upon augmentation from other nations to perform this function.

The original MACA construct was arranged such that nations would be able to perform both a national and a NATO function without augmentation, leveraging the pooling and sharing concept through execution of mutual support. This challenge extends to MACAs beyond just Sigonella.

11.4 Deployable Multi-Mission Support Centre Capability (MMSC)

Although a standing requirement for a deployable MPA mission support system has been recognized for over 20 years, the resultant systems were developed nationally in concert with national upgrades to the MPA aircraft. The interoperability NATO MPA enjoyed has nearly atrophied completely.

During the height of NATO's ASW operations, deployment to remote airfields to minimize transit distance to the mission area was commonly practiced and a large number of Cold War ASW bases were established to provide ASW support to visiting MPA of every nation. Today, many nations' MPA retain the ability for remote site operations, though, unfortunately, many of the bases which supported this capability have either been closed entirely or have eliminated the ASW support capability.

During the 1990s–2000s, many nations which upgraded their MPA to an ISR role also developed a deployable remote site support capability so crews could download ISR mission data and broadcast that information back to their home nation. Some nations even developed a limited ASW support capability in these units. Many of these deployable units have also been decommissioned. In the US, the ten Mobile Operations Control Center (MOCC) were all disestablished as part of the conversion process to P-8A. Each Poseidon squadron has organic deployable technical support for operations away from a home base that is not compatible with other MPA. This resulted in the loss of deployable ASW support provided by the US to any airframe except the P-8A.

NATO has recognized the current capability gap and is working on several fronts to acquire systems to alleviate it. The Under Water Warfare Capability Group (UWWCG) oversees many Specialist Teams. The Team devoted to researching an MPA replacement aircraft (ST-5) is covered in detail in Chapter 8. Additionally, a related Specialist Team is focused on Maritime Air Support Interoperability (MASI) and has developed a CONOPS for a deployable Maritime Multi-mission Support Centre.

This CONOPS is presently in draft form, but it is expected to be formally presented to the UWWCG in 2016. The version of the CONOPS made available for this study indicates a deployable mission support centre capable of processing data from MPA Radar (including both SAR and ISAR), ESM, Imagery (still and video), Automatic Identification System (AIS), and acoustic data (both passive and active) has been conceived. Further development will not proceed beyond the current conceptual level without dedicated resources from the nations.

The key to moving toward interoperability stems from national compliance with STANAGs for data formatting. This may require the addition of an interface module for some aircraft that have already developed mission software which is not in a format compatible with the MMSC. The MMSC would provide the full mission support capability resident in national mission support centres or MACAs. It would also provide an interface with both the JFACC (for ATO coordination) and JISR collection process as well as MPA post-mission products (such as Purple, Contact Reports, Acoustic grams snippets, Bathythermograph data for inclusion into the meteorological prediction tools). Additionally, the MMSC CONOPS reviews other aspects of deployable mission support such as force protection and manpower.

Although significant details, such as agreements for manpower augmentation when deployed, need to be approved by the nations, the initial proposal is for three MMSC 'systems' to be hosted (two by nations, the third and 'first to deploy' at MARCOM Northwood UK). This deployable mission support concept would likely be more cost effective than rebuilding a full ASW mission support centre in Keflavik or Lajes, as those are increasingly likely to be used as temporary MPA bases for ASW missions as non-NATO submarine activity continues to increase.

11.5 METOC Support to ASW Missions

Chapter 6 and Appendix B address the fundamental principles of submarine-generated acoustic signatures. Accurate acoustic modelling is key to developing the proper sonobouy pattern, location, and depth. Here NATO experiences another interoperability challenge.

Modelling of the ocean is unclassified. In fact, many nations share data from MPA, MPH, or ship-launched bathythermal sonobuoys. This is one input to the development of the sound speed profile curve, which is then assessed against the target submarine's predicted sound intensity and frequency, to develop propagation loss curves (see Chapter 6 for further details). However, national restrictions on information sharing of submarine signatures complicate the process tremendously.

Each MPA and MPH crew must resort to their respective national meteorological support infrastructure for ASW acoustic modelling, even while being supported by another nation's MACA. The key is that this information is frequently not available real time if an aircrew is deployed outside of its national support structure to another MACA or ASWOC. Therefore, interoperability in support of effective mission planning is further challenged.

Furthermore, the most accurate acoustic prediction and tactical decision aids are based on the collection sensor as well as the target. Since multiple variants of P-3 Orion acoustic processors exist, multiple variants of active dipping sonar exist on NATO helicopters, and multiple variants of passive tail and bow-mounted active sonars exist on a myriad of NATO surface ships, target classification capability by each detection sensor also remains within national channels.

The result is MPA and MPH crews are forced to reside solely inside classified national channels and operate on classified national systems for mission planning, to include oceanographic prediction. Until NATO develops a NATO common database for submarine signatures and a NATO common acoustic prediction tool based on NATO sensors, this is unlikely to change. It is not uncommon for a NATO MPA crew to just 'figure it out' on station, to use generic pattern spacing or to react rather than plan when operating away from their home base where they do not have easy access to national support systems.

11.6 Summary

This study has been careful not to look back to the Cold War as the future. However, certain elements of historical operations existed and no longer function today that, if restarted, could alleviate many challenges experienced today by maritime air forces conducting ASW missions.

NATO's MPA ground support stations must re-develop the ability for full, mutual, and multinational mission support. Today's ASWOCs only provide visiting aircrew a 'Safety of Flight' brief with general SA about other operations in their flight region. NATO must rebuild the capability to provide all aspects of pre- and post-mission support to all variants of NATO MPA and MPH. This should include pre-mission acoustic planning and meteorological prediction tools, and post-mission acoustic analysis support for confirmation of valid contact or detection of missed contact.

Furthermore, NATO must rebuild the capability to operate MPA from remote sites such as Lajes, Keflavik, and bases in GBR. ASW missions have recently begun to operate from those bases due to the identified uptick in submarine patrols, but since those bases have closed their ASW Operations Centres, actual mission support remains limited and does not achieve the level a theatre ASW Commander will require for future peacetime ASW missions.

An Italian Atlantic-I from the 41 AeroStormo Squadron.

CHAPTER XII

The Environmental Forecast

12.1 Environmental Forecast

As we have already seen, Maritime Air ASW domain faces many challenges in the years ahead. Forecasting technology will provide leadership insight into the most likely future environments NATO Maritime Forces may anticipate in the 2020–2030 timeframe.

For readers not familiar with Forecasting, applicable terminology will be defined in each section as the forecast unfolds. The following forecast was generated primarily through Delphi modelling (referencing input from ASW experts at MARCOM, NATO HQ and within the Maritime Air ASW community, both current and prior service experts). Scenario planning, stemming from trends and environmental driving forces, are identified in the following section. This environmental forecast concludes with examples of likely possible futures in order to offer NATO's Maritime leadership insight into the most likely future environments NATO Maritime Forces may anticipate in the 2020–2030 timeframe.

What is Forecasting?

Forecasting and futuring are methods to explore the environment and are broken down into Social, Technical, Environmental, Economic, and Political (STEEP) issues to identify driving forces and change agents. They are analysed to project likely and possible outcomes or futures for which the organization can make preparations. This chapter will review dominant global trends across the STEEP spectrum and discuss potential future scenarios involving NATO's Maritime Air ASW forces.

Forecasting is not a prediction. Rather it is a systematic review of the current environment and an identification of socio-political forces at work. This is done to offer a glimpse at what might happen so organizational leaders may choose the best course of action for their organization's resources.

In general, three drivers shape the future. Each of the three drivers creates a different type of future with its own characteristics and tools:

- Trends – continuous change of some variable over time, often described by a mathematical function. Trends lead to the probable or most likely future (sometimes called the baseline future). The baseline future is expected and relatively predictable assuming nothing surprising happens. Logical and quantitative analysis are preferred ways to understand the baseline future.
- Events – a sudden change in some condition, usually closing one era and opening a new one. It is difficult if not impossible to say immediately how much change an event will create. Events lead to plausible futures. Alternative futures could happen instead of the baseline. Scenarios based on reasonable imagination and speculation are preferred ways to understand the plausible futures.
- Choices – decisions made by ourselves and others and the actions we take to implement those decisions. Choices lead to the preferred future. Individuals and groups strive for their preferred future. Visioning and planning are used to move in the direction of the preferred future.[1]

The intent of this study is to provide MARCOM and other stakeholders information from which to derive informed choices, thereby shaping NATO's future. This chapter will therefore focus on emerging global trends and provide derivative scenarios, review the basic forecast and likely futures.

It is also intended to provide insight into possible unplanned events, referred to as Wild Cards. Choices are made by stakeholders as emerging issues develop. Finally, it will offer emerging issues which may require a future choice within the Alliance.

'It may be useful in this context to remember three fairly unique characteristics of submarine warfare:

First, a lone submarine can do more damage in both a military and a political sense than probably any other single conventional platform, naval or military.

Second, one man – the submarine commander - can have enormous impact on the capability of that lone submarine.

Third, a small force of submarines can be supported by a tiny portion of the population of any country.'[2]

12.2 Trends and Driving Forces (STEEP)

The trends and driving forces identified below were developed synthesizing the trends cited in the UK Strategic Global Trends (Ed 5), the Allied Command Transformation Strategic Forecast 2017, and the Center for Strategic and International Studies (CSIS) Global Forecast 2015, the Johns Hopkins Future Undersea Warfare Perspectives (2000), as well as environmental scanning conducted by the author between July 2015 and March 2016, with specific focus on Maritime- and Air-related items using the STEEP modelling plan.

The diagram represents the significant trends impacting Maritime Air ASW as identified in the STEEP model and an assessment of the level of impact to NATO. From these most likely and most impactful trends, the possible future scenarios in the chapter have been derived.

12.3 Social Trends and Driving Forces

Resources and Funds Available to Defence Spending in NATO

The 2014 Wales summit identified a goal for each nation to spend at least 2 percent of national Gross Domestic Product (GDP) on defence. As of 2015, only three nations are meeting this agreed goal. Without

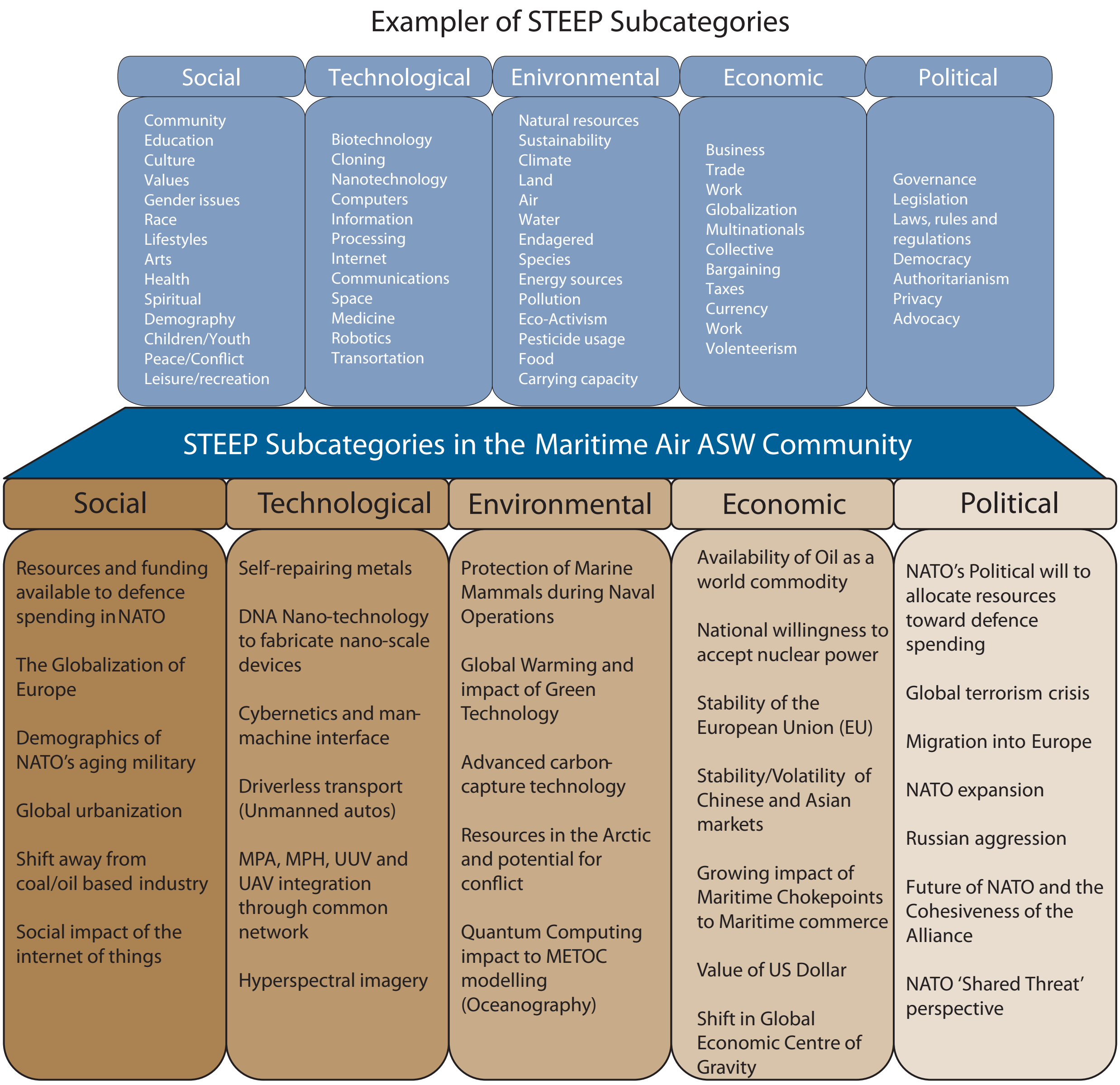


Figure 35 – STEEP Subcategories in the Maritime Air ASW Community.

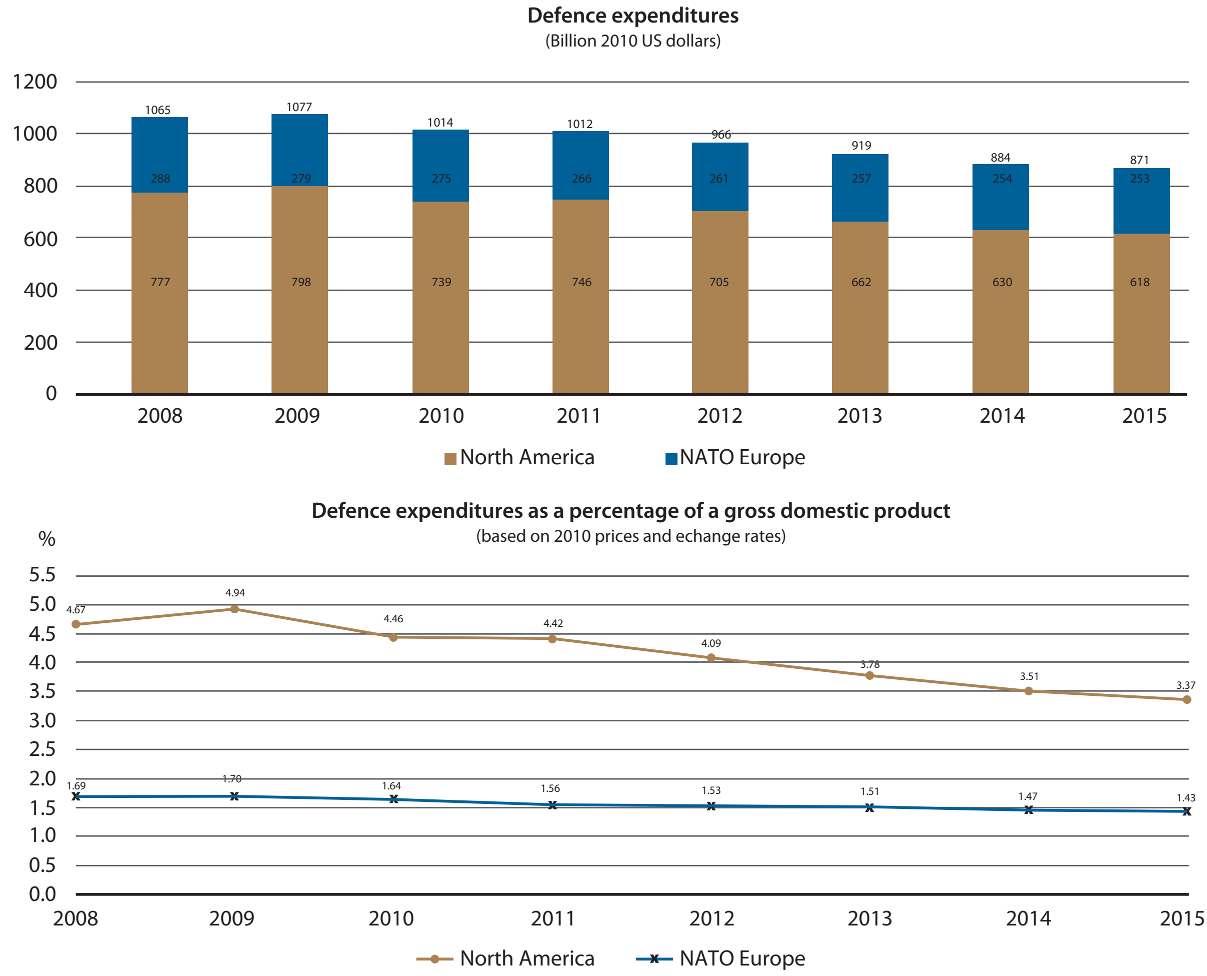
a major military threat emerging to stimulate a social and political response, this is unlikely to change in the next decade, continuing to strain national defence resources against planned operations and future requirements.

The Globalization of Europe

Globalization of Europe is likely to continue, not only due to the current significant uptick in immigration into the continent, but also the spreading of culture and social mores across international borders. This has the potential of eroding traditional, nationalist view-points. Approaching social and civil issues with a more homogeneous worldview will likely define the next 20 years.

Demographics of NATO's Aging Military

Due to national mandatory length-of-service retirement eligibility requirements juxtaposed with a reduction in total force size, many NATO nations are experiencing an aging military. There is a bow-wave approaching in the next 15 years. In this period, a significant amount of expe-



Source: NATO press release 28 Jan. 2016

Figure 36 – Defence Expenditures of NATO Nations.

rienced and aged personnel will retire and some nations are struggling to replenish the ranks at a similar pace.

Global Urbanization

The next two decades will likely see not only an increase in global population but also an increasing percentage of the population who will live in urban areas. Looking further, 'by 2045, the proportion of people living in urban areas is likely to have increased from a little over 50% to around 70% of the world's population.'[3] Not only does increased population density exacerbate impacts of natural disasters, resource shortages, and disease, but it also provides a potential breeding ground for civil unrest and instability in areas with poor governance.[4]

Shift Away from Coal/Petroleum Based Industry

The next two decades will likely see an increased focus by some nations to move further away from carbon-based fuel sources. Some project the US may shift from one of the world's largest consumer of oil to a 'net-exporter' by 2030.[5] This shift has the potential to create a technology gap and further strain the relationship between those countries who can afford to invest in this area and those who cannot. The driving force behind this investment will remain a social and environmental issue.

Social Impact of the Internet of Things

The tremendous growth of the internet has had not only a technological impact but a social one as well. The ever-expanding interconnectedness of things is either a symptom or a by-product of globalization. Regardless, the next generation of leaders will have grown up with the internet and its expanding level of global connectivity. Some project that by 2040, each person on the planet will have on average over ten separate 'connected' devices.[6] Any major conflict which develops (for example over resources) will have this global inter-connectedness as a correcting force (opposing the connectivity trend-line). In the next 20 years, the influence of that correcting force will expand.

12.4 Technological Trends and Driving Forces

Self-Repairing Metals

The next 15 years are likely to experience significant advances in metallurgy and nanotechnology. Scientists are exploring/have made progress on metal that can be damaged and actually repair itself.[7] The prospects for the military alone are overwhelming, let alone the potential civil applications.

DNA Nanotechnology to Fabricate Nano-Scale Devices

Breakthroughs in nanotechnology in the next 30 years will likely permit the self-assembly mechanisms of DNA to be harnessed to fabricate mechanical, electrical, and optical devices and circuits which may be microscopic compared to today's circuit boards.[8] Coupled with the increase in computer processing power (as evidenced by Moore's Law – the theory computer processing power will approximately double every two years[9]), dramatic results may be experienced in the development of nanobots and other unmanned systems (air, subsurface).

Cybernetics and the Man-Machine Interface

Related to the previous two trends, Cybernetics and the ability to integrate man and machine will likely advance in capability during the forecast period. Of note, availability of rare-earth metals may become a driving force in these three areas, perhaps even to the point of generating conflict. Cybernetics advances may realize external and internal electro-mechanical devices capable of enhancing human physical performance.[10]

Driverless Transport (Unmanned Cars)

The advancement of driverless cars may in many ways lead advances in see-and-avoid capabilities of UAS and UUV. This will potentially result in the development of future vehicles which are capable of executing a rudimentary set of mission parameters and slowly crossing the line from automation into rudimentary autonomy.

MPA, MPH, UUV and UAS Integration Through a Common Network

One of the significant challenges facing today's vision of an integrated ASW force spanning sensors in space to ships to manned/unmanned air vehicles to manned/unmanned undersea vehicles is a network capable of handling the bandwidth required particularly through the ocean. Research into this area is ongoing, and the slope of the trend-line will be a driving force to future UUV integration.

Hyperspectral Imagery

As the ocean environment will continue to challenge the use of passive sonar for submarine detection and tracking, research into other methods of detection is ongoing. Systems exist that permit imagery sensors to look through the ocean, but they are limited by the amount of processing power which can be mounted in an air vehicle to produce a clear image. Current trends show the likelihood of other types of non-acoustic submarine detection will evolve as the technology to support the mathematical theory is realized.

12.5 Environmental Trends and Driving Forces

Protection of Marine Mammals During Naval Operations

Protection of marine mammals during Naval Operations will presumably remain an enduring focal point, around which exercises and training must be planned. Although NATO currently has governing guidance for safe operations protecting many species (MC-0547), this will likely be a continual driving force behind the training, exercising, and tactical development of anti-submarine operations.

Global Warming and the Impact of Green Technology

Climate Change has been tied to an increase in natural disasters and hazardous weather events.[11] Although

Green Technology is developing, it will likely remain in the early stages for most of the world for the foreseeable futures. In those places where it is being implemented, the motive often has as much to do with resource management as it does with curbing climate change. By 2030, it is unlikely the world will see any significant deviation from current trends in this area.[12]

Advanced Carbon-Capture Technology

Tied to advances in 'Green Technology' are advances in both carbon drilling (fracking, etc.) and carbon-capture techniques. In the short term, these will likely serve as correcting forces on the oil resource trend but in the long term will not fulfil an alternative energy source. However, these new technologies might have a near-term impact on climate change.

Resources in the Arctic and Potential for Conflict

As traditional carbon based resources become more strained, coupled with the developing resource challenge for rare-earth metals, many nations are exploring new locations for resource acquisition. Competition over these locations is likely to rise, as other nations with a legitimate geographic claim to the same region will likely stake legal claims in an international forum. Conflict already exists between seven nations over small islands and submarine features (reefs, sandbars, etc.) in the South China Sea over this exact issue. In the future, competition between polar nations will develop regarding mining and access rights to mineral beds in the Arctic.[13]

Quantum Computing Impact to METOC Modelling (Oceanography)

A commonly accepted version of Moore's Law informs that as technology develops, computer processing power will approximately double every two years.[14] Some say a more realistic rate observed today is about three years. This would project computers equalling the processing power of the human brain by 2023 and exceeding that capability by 100,000 times by 2045.[15] Although the future regarding quantum computing is uncertain, when it arrives, not only will it potentially challenge information security (some postulate all codes are 'crackable' and data encryption as we know it will likely be impossible[16]), it will also provide increased capability for modelling and simulation which will augment environmental acoustic modelling.

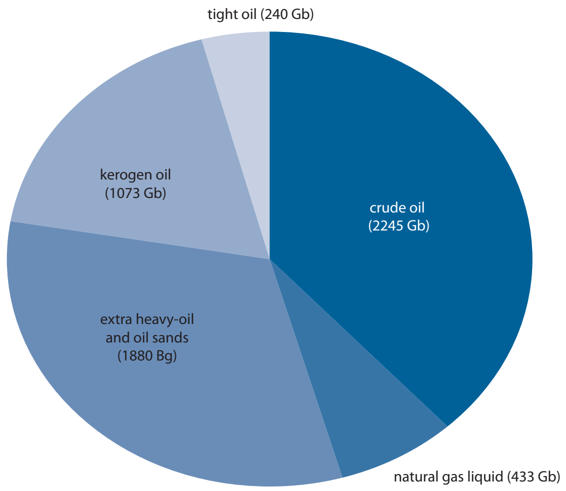
12.6 Economic Trends and Driving Forces

Availability of Oil as a Global Commodity

The availability of fossil fuels is a trend line which drives certain aspects of technology development. Many experts have spent significant resources trying to predict the amount of oil which may still be recovered. Estimates of the global Ultimately Recoverable Resource (URR) for conventional oil fall within the range 2000–4300Gb (Gb is a billion barrels). This is compared to cumulative production of 1248Gb through to 2011.

The IEA's most recent estimate is 3926Gb, which is higher than earlier estimates and reflects recent reassessments of the non-US YTF (731Gb) and future reserve growth (681Gb). Estimates of the URR of all-oil are much larger (e.g. 7119Gb from the IEA) and suggest only one-sixth of the total recoverable resources has been produced.[17] Although the interpretation of forecast models for URR vary, in some cases widely as some recovery is based on emerging and not mature technology, the trend line shows sufficient availability in the next 15-20 years and beyond. This implies that oil availability should not drive a drastic reformation in propulsion technology in the upcoming decades.

Figure 37 – Estimates of Ultimately Recoverable Resources.



National Willingness to Accept Nuclear Power

Nuclear power is as much a political issue as it is a technological one. Although a reliable source of renewable energy, Europe still feels the impact of the Chernobyl catastrophe. That event colours the political landscape in a manner similar to 2011 Fukushima incident, which a loud, vocal minority in Japan use to make persistent arguments against nuclear energy use in Japan. Recently in Europe, there has been some turmoil around the re-start of a Belgian reactor.[18] Should a significant accident happen anywhere on the globe, the level of political support for this energy source may alter the current trend line.

Stability of the European Union (EU)

'Economic stability is desirable for the EU because it encourages economic growth to foster prosperity and employment, and is one of the primary objectives enshrined in the management of Economic and Monetary Union and the Euro. Under Economic and Monetary Union, Member States must keep their government deficits and debt under specified limits (3% and 60% of GDP, respectively), according to the treaty and the rules set out in the Stability and Growth Pact. These limits are also one of the convergence criteria which a country must meet before it qualifies to adopt the Euro. The aim is to ensure sound and sustainable public finances in the Member States of the EU and the Euro area.'[19]

These are the published economic principles of the European Commission to ensure stability is maintained across the EU. However, challenges to the national debt and unforeseen (or even foreseen) crises could arise impacting an individual nation's ability to meet guidelines within the EU. If a single nation is forced to withdraw from the EU, as was seriously debated in 2015 and 2016 by different nations, it will have rippling effects across other nations in similar financial positions. It may in fact sound the death knell for the EU writ large.

Stability is also currently being challenged by disparate national views on a mitigation strategy to the refugee crisis, and supports the adage: 'where you sit is where you stand'. As such, it is unlikely a cohesive and common Alliance or EU response to this crisis will emerge. As this crisis strikes directly at the resources needed to address the immigration influx, it may further challenge the stability of the EU in coming years.

Stability/Volatility of Chinese and Asian Markets

The rapid rise of China on the global market is changing the relationship between other global powers in Asia, most notably between China and the US, Japan, and India.[20]

The Organization for Economic Co-operation and Development (OECD) Deputy Secretary General observed 'while the region's economic performance is still strong, structural reforms, underpinned by coherent macroeconomic policies, need to be put in place to maintain this positive momentum… Three specific medium- to long-term issues are important in shaping the future of the Asian economic and financial community: First, in the area of trade, the importance of measuring trade in value added terms; second, funding long-term investment, especially in infrastructure, and making these investments 'greener'; third, regional financial cooperation in Asia that should become more solid and robust.'[21] Recent volatility within the Chinese market has had a rippling impact across other inter-connected global markets.

Growing Impact of Maritime Chokepoints to Maritime Commerce

The interconnectedness of energy markets and transportation networks may also mean current maritime chokepoints become more congested. The consequences of blockages in areas such as the Panama Canal, Straits of Hormuz and the Malacca Straits could be felt far beyond their point of origin. Current forecasts predict the tonnage of goods transported by sea is likely to double within the next 30 years. If tensions rose between countries near to a vital maritime chokepoint, particularly if threats to block the sea lane were made, the international community would almost certainly act. Should diplomatic efforts fail to reduce tensions, the international community could approve the deployment of an international naval task force to ensure key sea lanes were kept open.[22]

Value of US Dollar

The Chinese Renminbi and to some extent the Euro may potentially challenge the USD as the global economic standard in the coming decades. Coupled with the slow migration toward Asia of the global economic centre of gravity, it is likely that the US and Europe will provide comparatively less percentage of the global economy than is seen today. Although it is unlikely either will replace the Dollar, current trends point toward a lessening of the Dollar as a central figure in global trading in the coming decades.[23]

Shift in Global Economic Centre of Gravity

The steady rise of emerging economies in Asia will likely cause the world's economic centre of gravity – the average location of economic activity by GDP – to continue its move eastward.[24] The trend in this area relates to NATO's relative buying power and could influence the availability of resources for defence expenditures relative to other nations.

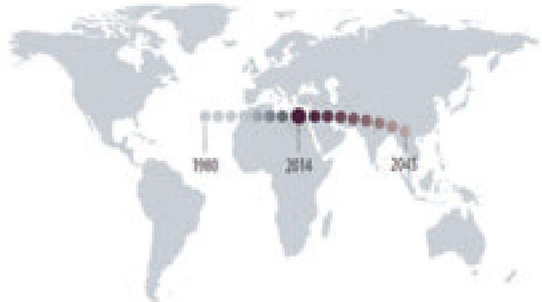


Figure 38 – Shifting Global Economic Centre of Gravity.[25]

12.7 Political Trends and Driving Forces

NATO's Political Will to Allocate Resources Toward Defence Spending

NATO nations are likely to be continually challenged by 'other than military' crises over the next 15 years. Addressing the challenges posed by the immigration crisis coupled with the recent increase in small-level high-impact terrorist attacks in major European cities will consume the majority of national decision makers' efforts. Resources may be deflected away from growing a defence capability to address a perceived future threat in lieu of solutions to address the crisis existing today.

Global Terrorism Crisis

Terrorist groups, such as Al Qaeda, ISIS, and Boko Haram are likely to continue to splinter and pop up as each specific group and threat is addressed. One of the main driving forces behind the creation of these networks is the multi-pronged challenge felt across the Middle East and Sub-Saharan African continent nations. A youth population 'bulge', coupled with resource shortages, low employment, and exposure to other quality of life and governance options through increased information sharing across the internet all result in fertile ground for religious extremist to sow jihadists and martyrs. All nations of the world must address this challenge, not just the few where this unrest is occurring. This is likely to be an enduring mission past 2030 requiring all the instruments of national power to address the symptoms and the root causes of the issue.

Migration into Europe

The continued crisis in the Middle East, Africa, and Syria will likely result in continued migration from areas of unrest to more stable areas of the world. Nations recognize that as long as these regional crises exist, families will look to leave those unstable areas in search of stability. This condition will likely continue for at least the next 10-15 years, although annual migration numbers may ebb and flow.

NATO Expansion

Bosnia-Herzegovina, Montenegro, Georgia, and Macedonia[26] have expressed interest in joining NATO. Recent Russian aggression has even caused some in Finland and Sweden to review their position on the issue. By 2030, it is likely that NATO[27] will have experienced some level of enlargement, provided the nations can meet the principles of the Washington Treaty and provide support to the collective security of the Alliance.

Russian Aggression

Russia's stated strategic goals of re-asserting itself on the global stage have been exemplified by its use of military (and paramilitary) force in Estonia, Georgia, Ukraine, and, more recently, Syria. Additionally, submarine deployments have increased significantly in the last few years and are expected to trend further upward. The challenge NATO has with Russian aggression is to not assume it is a Soviet mindset, nor to ascribe intent and capabilities of the Russian military based on observations of Russian activity since the fall of the Berlin Wall. Russia has modernized its military and has a leadership willing to use it to achieve national strategic objectives. This trend will continue in the future.

NATO 'Shared Threat' perspective

The lack of a 'shared perspective', hints at the existence of dynamics that could fray and possibly tear at the cohesiveness of the Alliance. Multiple and varied threat perceptions could pull NATO in the direction of too many national, regional, and functional priorities. It may find itself unprepared at the military-operational level and ineffective at the political-military consultative level, which is why a continuous strategic dialogue is essential among the 28 nations, and further underlining the NDPP's relevance.[28] However, although absence of a shared perspective also presents an opportunity for NATO to explore future ways to become a more dynamic and flexible organization, the driving force behind this trend will remain the national viewpoint of the 28 (or more) member nations.

12.8 Summary

Dominant trends and driving forces across the Social, Technological, Environmental, Economic, and Political landscapes will have great implications for the Maritime Air ASW domain. From them, a baseline forecast and future scenarios can be explored.

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A pair of Italian Atlantics flying formation on one of the airframe's final flights.

CHAPTER XIII

The Environmental Forecast: Likely Futures and Wild Card Events

'The basic question in evaluating a forecasting method is not "Can it tell us what will happen?" The question of primary value [of forecasting] in policy making is "Can it keep us from being surprised?"'[1]

This chapter begins with a discussion of futuring followed by the Baseline Forecast. The Baseline Forecast is the likely future scenario based on the dominant trends and driving forces identified in the previous chapter. From there, possible future scenarios which derive from modulations in the trends can be explored. Some of those alternate futures are inter-connected as they derive from similar driving forces. Beyond likely alternates are Wild Card events, which are not likely but could dramatically alter the landscape.

13.1 Futuring

'Choucri, like most other political scientists who have written about prediction and forecasting, defined prediction as the foretelling of a single future development. Single-outcome forecasts have long been recognized as dangerous. For example, a 1984 evaluation of intelligence estimates (analytic reports produced within the intelligence community on a particular issue or country) found 'the major factor in failed estimates was overly cautious, overly conservative, single-outcome forecasting … This addiction to single-outcome forecasting defied both estimative odds and much recorded history. It reinforced some of the worst analytical hazards – status quo bias and a prejudice toward continuity of previous trends.'[2]

Single-outcome forecasts 'do not reduce uncertainty. They only increase the margins of surprise'. The solution to this problem is forecasting, which Choucri and many others defined as being 'concerned with the ranges of possibilities and (the) contingencies and probabilities associated with each.'[3]

Possible futures are just that: possible. They are based on the environmental scanning conducted and STEEP modelling outlined in Chapter 12. Possible futures are not unique. That is to say, multiple possible futures may occur, interacting with one another. These futures differ in some ways from those outlined in other global strategic forecasts in that they have been distilled and refined for relevancy and impact to NATO's execution of the Anti-Submarine mission.

13.2 The Baseline Forecast

A lack of common, shared perspective and recognition of the growing threat will dominate the next 15 years. Submarines don't pose a visible threat until they do something nefarious. Those outside the ASW mission area, such as the general public, elected politicians, and even to some extent the Air and Land services (competing for the same resources as the Maritime), are unlikely to be swayed and convinced of the true challenge of the issue until there is a looming crisis. Europe will continue to be faced with economic challenges felt as the EU struggles to maintain its existence. It is further challenged by the resource requirements to handle the influx of immigrants (likely to consume much of the political dialogue in the next five to ten years). This will parlay directly into national defence spending.

It is unlikely many of the 28 nations will ever achieve the 2 per cent spending agreement in future years. Therefore, little progress will be made in defence spending to solve emerging capability gaps (MPA, etc.). Those nations operating the P-3 (series) and French Atlantic-II will likely opt for further life extensions in lieu of aircraft replacement. The inventory challenge seen today will be exacerbated as mission availability rates for MPA plummet as the airframe limps along toward 2030.

As the US transitions completely away from P-3C mission support, training, and maintenance in the early 2020s, some assumptions made by nations continuing to operate the P-3C may prove false. Many nations lean on the US very heavily for training, publication and doctrine, maintenance experience, and to some extent logistics support for an airframe for which new parts are no longer made (specifically engines). As the US transitions to the Poseidon, those nations that have opted for service life extensions to the P-3C may not have the same support for the 2020-2030 timeframe.

Additionally, the NATO ASW C2 issues are not likely to be fully resolved. Nations generally feel good enough is good enough. Although a TASWC construct may be the most efficient way to manage multinational resources, the demand signal isn't strong enough to jolt the system into changing. This feeling is exacerbated by a lack of shared perspective on the true nature of ASW threat. NATO nations differ in perspective on nearly all things maritime, as not all share a coastline. Even of those that do, not all have the same experience with ASW challenges from the Cold War.

A 'gentleman's agreement' to share information and make assets available when requested is the best the Alliance will generate in the next 15 years. Most submarines will continue to be tracked via national means rather than a more holistic Alliance approach. This will continue to hamper MARCOM's ability to manage the theatre-wide tracking and monitoring of non-NATO submarines. That doesn't mean those submarines won't be tracked. Rather, it is more likely a small cadre of nations will shoulder the load, and it won't be a NATO mission set. Therefore, the NATO command structure will remain outside the decision loop until an official crisis response operation has commenced and a Maritime Component Commander has been officially designated.

Although the P-8 Poseidon is expected to conduct its first full theatre deployment to Sigonella in 2018 (just prior to publication, CTF 67 informed the JAPCC that the US may deploy a squadron of P-8A to Sigonella as early as fall 2016 but that is not a final decision as deployment schedules are an evolving issue influenced by other global events) and maintain a continual presence thereafter, other global issues will consume the majority of the attention of the US MPA. Many of the Sigonella squadron's airframes will likely remain deployed to the Pacific and the Middle East on ISR missions, leaving a small contingent of assets available in Europe. As the MPA operated by FRA, CAN, NOR, DEU, ITL, ESP, and GRC will either have reached or be reaching end of service life between 2025 and 2030, the reduction in available MPA airframes as maintenance availability will become more of a factor for NATO in the next 15 years. Although the UK P-8 purchase (nine airframes) will offset the balance to some extent, the net result is by 2025, there will be fewer MPA than there are today.

Even though the US has publicly announced a strategic pivot to the Pacific, which will likely result in fewer resources available in the European theatre, the above trends will likely lead to an increasing reliance upon the US. Many after action reports from Operation UNIFIED PROTECTOR, global strategic studies, and even the Wales Summit identified over-reliance on the US as a significant risk for NATO moving forward.

Finally, the baseline forecast indicates a growing number of SSN and SSK deployments of non-NATO submarines into NATO's AOR. The rate of expansion may vary based on Russia's economic footing coming out of Syria. As the global oil price stabilizes in the next few years, the trend toward increased submarine interaction with NATO forces is clearly on the rise. Although the dominant trends do not indicate any type of kinetic or hostile interaction between maritime forces, there will be a turn toward Cold War-esque missions for submarines. This will be indicated by a move away from the surfaced transits NATO observes today toward fully submerged, lengthy SSBN and SSN deployments. These submarines will likely have the mission of tracking NATO maritime forces and resuming ballistic missile stationing patrols. Therefore, the requirement for a prosecution plan will grow.

The baseline forecast calls for an even more challenging future environment in Maritime Air ASW than is seen today. Chapter 14 offers conclusions and recommendations for NATO forces and nations to mitigate some of the challenges presented in both the baseline forecast and the possible future scenarios highlighted in the next section.

13.3 Other Possible Future Scenarios

An Increase in Russian Federation 'Show of Force' Submarine Deployments

Vladimir Putin has a stated strategic goal of increasing Russia's presence in world events by re-building and re-asserting naval influence in areas ceded to NATO over the last two decades. Additionally, his views on the impact of the submarine force as part of the ability to project naval power colour and influence those lines of thinking. To prove to both its citizenry and to the global powers Russia has re-emerged as a global force, Russia will use its Navy as a strategic communications tool. It will continue to increase its naval presence in the Mediterranean Sea, Black Sea, and patrols into the Atlantic. This will likely include increased use of submarines as well as naval combatant ships. The Mediterranean will see an increase in Kilo diesel-electric submarine deployments owing to the re-establishment of major naval basing in the Eastern Mediterranean and the Black Sea.

Russian nuclear submarines (SSN and SSBN) will deploy as single elements to conduct surveillance missions into the northern Atlantic. Russia will make 'show of force' deployments of its SSBN force. To prove to the world that these normally secretive ballistic missile deployments are occurring, Russia will find unique ways to allow the rest of the world to 'detect' these silent killers. This would include port calls in either South America or the Eastern Mediterranean or surfacing in an exercise with friendly (to Russia) naval forces in the Atlantic. Although it is unlikely that Russia will re-establish permanent deployments to known Cold War ballistic missile submarine operating areas, the increased range and superior targeting capability of today's missiles only require presence in the southern Atlantic for Russia to be within targeting range of nearly all of NATO. In the late 2010-2020 period, the ability of the Russian naval force to mount large scale deployments will be tempered by the economic impact of the price of oil in a manner similar to the late

80s-early 90s period, although this will not eliminate the likelihood of increased submarine deployments. It will have an impact on the scale and scope of naval ambition. Trends observed since 2013 show that this future is already beginning to unfold and is likely to continue toward the end state described above. Once Russia has proven to the world it has both the intent, capacity, and capability to conduct these 'detected' SSBN and SSN deployments, it will have achieved the goal of reminding NATO, and the rest of the world, about a force they neglected. From this point they can continue with more secretive deployments with no intentional detection opportunity. If NATO has not responded in a manner to ensure the ability to know where these submarines are operating, they will eventually cede much of the Atlantic, and potentially much of the Mediterranean, back to Russia.

Factors to Monitor to Determine if this Future is Unfolding:

1. Track not only the number of out of area submarine deployments, but also the correlation to specific hulls to determine whether a broader increase in capacity has been achieved or whether a small number of high readiness units are deploying.
2. Track the dimensions and duration of deployments. Is the distance from home expanding? Monitor ports of call.
3. Monitor the number of new hull construction Sea Trial completions. Is the hull construction schedule being met?
4. A key milestone will be monitoring whether submarine deployments are conducted Overtly (surfaced) or Covertly (submerged). The strategic goal of the submarine may be surmised by the level of covertness it employs in transit.

Russian Federation Submarine Arms Sales Continue

As they have for much of the last century, Russia will continue to provide high-spectrum weaponry to any buyer at the right price. Although, similar to the US and other countries who sell arms, the export variants are traditionally of lower capability than the indigenous version, Russia has and will sell quite capable submarines even if it chooses to reserve the most modernized models for themselves. The sale of the Kilo SSKs to China (2 Type 877 and 10 Type 636) dramatically impacted the balance of naval power in the region and jump started Chinese indigenous submarine building.

'India could have a defence budget equal to that of the entire EU.'
UK Global Strategic Trends to 2045

The sale of Kilo class submarines to Algeria and Egypt has the potential to do the same to the Mediterranean. However, in contrast to China, which has a well-established vision of maritime presence and influence, neither Algeria, Egypt nor Libya have turned their Russian Submarines into a robust naval force once the Russian trainers departed. In any case, it is extremely likely that Russia will continue to sell submarines, including nuclear submarines, to any country willing to pay for them, as it did with India. As discussed earlier, foreign military sales is a significant monetary source to Russia that will not evaporate in the coming decades. To whom Russia makes these sales becomes the challenge for NATO.

Factors to Monitor to Determine if this Future is Unfolding:

1. Monitor dates of known sales (Vietnam, Indonesia, Algeria) to determine if sales proceed as projected or if they are cancelled (similar to the cancelled Mistral sale from France to Russia in 2015).
2. Monitor the price of oil. As the Russian economy today is still heavily leveraged by the buying power of oil as a commodity, if oil remains low, Russian arms sales will likely increase to offset.

The Conflict Against Violent Extremist Groups Continues for the Next Two Decades

Although the current form of today's struggle against violent extremism is bounded by the West's relationship with ISIS and Al Qaeda, NATO forces have been dealing with this challenge for decades. There is no true defining 'start point', nor is there a true defining endpoint currently in view. NATO forces, whether as the Alliance or through national policy, are engaged in this issue across the Middle East and Africa. The global challenge spans from islands in the Pacific to bars and coffee shops in Europe to schools and military installations in the US. It is a global challenge manifesting itself in myriad forms.

Not only is this challenge engaging NATO's military forces, but there are second and third order effects impacting all four elements of national power: Diplomatic, Information, Military, and Economic. The migrant crisis being experienced across almost every nation in the Alliance is one example. Combating extremism will occupy much of the attention of NATO's political leadership in the future. This will in turn affect the direction and strategy of NATO's military forces.

The challenge stemming from this future that directly impacts NATO's ASW capability is one of funding and resourcing. Even following the 2014 Wales Summit where each nation of the Alliance voted to maintain or exceed 2 percent GPD spending on defence[4], few nations met this spending level. Even fewer are projected to meet it in the future.[5] This will have an impact on the resources NATO and NATO Nations have to address a future increase in airborne ASW requirements. Today, many of NATO's air ASW resources are tasked with ISR missions in support of operations against ISIS, or tasked with maritime security operations in support of the response to the migrant crisis. One impact of the global conflict on extremism is NATO will continue to face ISR resource challenges and in the meantime will have limited multi-mission aircraft available to address an increase in ASW requirements.

Factors to Monitor to Determine if this Future is Unfolding:

1. Does NATO continue to deploy forces to Afghanistan beyond 2017?
2. Do nations meet the 2 percent spending threshold by 2020?
3. Does the 2016 or 2018 NATO Summit provide a different strategic direction for defence spending?

New Battery Technology Will Revolutionize Diesel-Electric Submarine Capability

Driven by the push for increased capability in the automotive industry, research to improve hybrid electric motor capability will influence submarine capability. As previous trends have identified, many resources will become scarcer in the coming decades. They will be strained not only by the availability of the commodity itself but also by the burgeoning global population. 'Of the 23 cities expected to have 10 million or more inhabitants by 2015, 19 are in developing countries. By 2045 there are likely to be around 280 'mega-cities' (more than 20 million inhabitants)'[6] In this case, the development and urbanization of many countries is driving the national requirement for vehicles upward and pushing the research to develop cars capable of driving hundreds of kilometres on a single battery charge. Once this is achieved, it is a simple engineering modification to adapt to diesel-electric submarines, making the capability of today's AIP diesels into a close parallel with their nuclear-powered counterparts. This would nearly negate the need for a diesel-electric submarine ever to surface, further forcing a modification of detection tactics.

Factors to Monitor to Determine if this Future is Unfolding:

1. Monitor the automotive industry hybrid-electric cars battery capability.
2. Monitor the price, and availability of, oil.

Chinese Submarines will Operate in the Gulf of Aden and Eastern Mediterranean Sea

China, and to a lesser extent, India, has significantly increased, improved, and employed its submarine force in the last ten years. This is expected to continue for the next few decades. As the previous 'future scenario' outlined, the Middle East and Sub-Saharan Africa will continue to be a global focal point for combating violent extremism, a problem that is not likely to be solved by 2030. Although major naval force-on-force conflict will not be a result of the world's attempts to combat extremism, countries such as Russia, China, and other growing naval powers will continue to provide naval forces to the region to exert national objectives. That may be demonstrated by providing forces or support to shore forces from the sea, or just by 'being there', ensuring they remain part of the global conversation.

If China or India deploy a naval task force in this manner, it would be consistent with maritime strategy to employ a submarine (SSN, SSK) with this task group. It would either provide naval force protection or provide striking power ashore, as demonstrated by Russian Kilo SSK cruise missile strikes into Syria in late 2015. Therefore it is likely Chinese and Indian submarines will be seen operating with their national naval task forces in the Gulf of Aden or Eastern Mediterranean Sea within the next 15 years.

Furthermore, Exercise JointSea 2015 between the Russian Federation and the Chinese People's Liberation Army-Navy (PLAN) occurred in the Mediterranean this past May between three PLAN Frigates and five Russian warships of various classes. It is likely China will provide submarines to future Russian Navy bilateral exercises.

Factors to Monitor to Determine if this Future is Unfolding:

1. Monitor CH, IN, and other non-NATO submarine deployments to the Indian Ocean, Gulf of Aden, and the Red Sea. This will be a precursor event to operations in the Mediterranean Sea.
2. Monitor exercises between China and Iran.
3. Monitor the political relationship between Egypt and China.

Unmanned Undersea Vehicle Utilization Explosion

Just as the Air Traffic Control community is struggling with a logarithmic explosion in civilian and military unmanned aircraft of myriad types and capabilities, so will the undersea community become challenged in this same way. Although UUVs will not hold the same allure for the average citizen who today can experience the marvels of flight with a cheap drone and inexpensive high-definition camera, UUV use for scientific and military purposes will dramatically rise over the next two decades. Keeping submarines from 'bumping into each other' is a primary function of Commander Submarine Forces NATO. He expends significant effort in both peacetime operations and wartime operations ensuring safe separation of submarines through a process known as waterspace management.

As the Air Component is learning, unmanned systems are challenging traditional methods of airspace segregation, and there are direct parallels for seaspace. However, the future of unmanned underwater vehicles will actually lead to larger systems with higher sensor payloads and longer dwell time. Additionally, as western nations are just beginning to explore the military applications of UUVs, one can project the same into NATO's potential adversaries and extrapolate the undersea domain in the coming decades will see both manned and unmanned military vehicles of various types, displacement, and capability. If a submarine today were to have a collision with one of today's UUV's, the UUV would likely not fare well, and the submarine would probably have to touch up some paint or repair a scratch.

However, as the UUV size increases, not only does likelihood of collision increase, but the damage to the manned vehicle (submarine) will increase as well. With this comes the increased potential for damage to a controlled surface hindering the ability to surface and the worst case scenario of a hull rupture from a high-speed collision.

Additionally, as the time lag between early military development and early operational employment (late 1990s) to today's explosion in civilian commercial drone use has been approximately 20 years, there is a parallel to UUV utilization which may be drawn.

As of 2016, few nations have working prototypes for military application. In fact, the majority of UUVs in use today support scientific research projects of various types. Therefore the numbers of UUVs in use, even 25 years hence, will not even come close to the number of UAS in use across military and commercial sectors seen today. In fact, at the January 2016 Maritime Operations Conference, NATO's experimentation COE, the Center for Maritime Experimentation and Research (CMRE) assessed the current state of robotics and requisite underwater communications network is such that in the near term, a full transition of all aspects of ASW to UUV is not feasible. However, the technology is not far from where robotics/UUV could integrate with conventional ASW platforms in localized and limited geographic areas, such as choke-points, etc.

Finally, this future scenario is not forecasting collisions per se, but rather highlighting the increased use of the undersea domain by vehicles outside the military and highlighting the risk that brings.

Factors to Monitor to Determine if this Future is Unfolding:

1. Monitor COMSUBNATO's efforts to map known civilian underwater vehicle networks.
2. When NATO nations have achieved a level of synchronicity between UUV and other ASW platforms, it can be assumed adversary militaries have or are close to achieving the same.
3. Monitor the technical development of an underwater communications network significantly increasing bandwidth and transmission speed between submerged units over what is available today. This will be a precursor event to a significant ramp-up in UUV military employment.

13.4 Potential Wild Card Events

In many forecasting techniques and models, Wild Cards are assumed to have less than 0.1 percent chance of occurring, but would cause a severe shock to the forecasted environment[7] Wild Card events are characterized by latent trends leading to a sudden occurrence, an eruption which contains hyper- and over-reaction followed by a slow period of normalization as the shock of the event is folds into the environment.[8]

The intent of identifying a Wild Card event in this operational forecast, future Maritime Air ASW, is not to propose that these events are likely futures. These are only 'possible' futures, which are so far outside the box as to not normally warrant allocation of planning resources. However, identifying the most problematic Wild Card events is an attempt to stimulate thinking within NATO's maritime leadership about how to respond should this extremely unlikely future emerge. Solutions are not normally offered for Wild Card events; rather a brief discussion regarding how the Wild Card might manifest with a summary of the potential impact to the Alliance is offered.

EU Dissolves Due to Internal Conflict Over Common Currency and Migrant Issue

Stemming from a series of national economic crises, most notably Greece in 2015, in this Wild Card future, a series of nations emerge that are unable to meet economic obligations within the EU. EU member nations become disenfranchised with supporting economically unstable member nations and vote to dissolve the entire EU, including the common currency. Border crossings and checkpoints are re-established, and the continental economy slowly grinds downward. This same disparate level of economic support is felt within NATO as many of the nations who struggled to meet EU obligations are simultaneously challenged to meet Alliance obligations.

US and Partners go to war with China over Pacific Regional Security Issues

After decades of regional conflict over natural resources found in the seabed of the South China Sea, Indonesia, Vietnam, and the Philippines collectively push back against Chinese maritime expansion in this area and simultaneously attack Chinese ships. The US and Japanese naval forces in the area are drawn into a kinetic conflict with the Chinese navy. The impact to NATO is a temporary re-alignment of all aircraft carrier and MPA forces out of NATO and into the Pacific until the conflict is concluded. NATO is left with no US maritime MPA or carrier presence to conduct alliance ASW missions.

'The result of the 'Y2K non-event' was that many people subsequently rejected the possibility of other Wild Cards ever coming to pass. As a result, 9/11 was a much bigger surprise than it should have been.'

'6 Rules for Effective Forecasting'. Saffro, Paul
Harvard Business Review | July–August 2007 pg 122–132

NATO Accepts One too Many Eastern Block Country and Russia Responds Kinetically

[Former Soviet States] understood Moscow regarded security cooperation, especially the presence of NATO or US forces, as a red line, and steered clear – or paid the price. Georgia's courting of NATO, which contributed to the 2008 war with Russia, and Kyrgyzstan's hosting of US forces at the Manas Transit

Center, which helped fuel Moscow's role in ousting former President Kurmanbek Bakiyev, served as object lessons of the cost of seeking outside security assurances.[9]

By 2025, Georgia, Latvia, Ukraine, Finland, and Sweden have all petitioned for acceptance into the Alliance in an effort to generate increased national security in the face of a growing Russian military power. Hoping to achieve protection status under Article V, these nations have spent a decade stabilizing internal economic and security challenges and met all of the NATO pre-requisites. In 2025, member status is offered to each. Russia interprets this as the final stage of NATO's preparation to invade the Rodina. It pre-emptively conducts a simultaneous naval and air strike against softer NATO targets, including sinking an entire naval task force conducting an exercise in the Mediterranean. Russia correctly assumes the vast majority of this exercise force would be unarmed and unable to respond to a short/no-notice submarine torpedo attack. The entire Russian submarine fleet sets sail, the SSBNs heading into the Atlantic and the SSNs and SSKs taking up station in the Mediterranean and throughout the Atlantic in preparation for follow-on strikes against naval and merchant re-supply forces.

Information Insecurity

The submarine community has seen a true challenge in the area of information security. Spies, such as Walker and Ames in the US and others throughout NATO's history, have divulged critical information over the last 40 years. This has led to a significant closure in the capability gap between Western submarines and those of Russian and Chinese design. For example, a secret propeller design gave the West a huge advantage until the Russians acquired them in the late 1980s.[10]

In this Wild Card event, design elements of the latest generation of Western SSN and Unmanned Underwater Vehicles (UUV) are compromised. This may lead to the complete loss of the technical advantage of Western submarine models. This results in non-Western nations having increased ability to locate and track Alliance submarines. Additionally, future models of non-NATO submarines will not only exploit the best quieting technology but also reduce any vulnerabilities which NATO forces use against them.

A Terrorist Group Acquires an SSK

Whether by overthrowing an unstable government that possessed a submarine or through direct acquisition, a terrorist organization acquires a high-end SSK and intends to use it. Then, either through coercion or conversion, the same organization acquires a crew competent enough to operate this submarine. Armed with cruise missiles and torpedoes, it covertly sets sail with the intent of attacking either a NATO base or major city or to sink as many merchant ships as possible to inflict as much economic damage to the Alliance as able. There is no Intelligence surrounding the target's location and there are no associated forces travelling with the submarine. It is the ultimate suicide mission. NATO's naval forces must locate a submarine intent on attacking an Alliance member.

13.5 Other Perspectives on Possible Futures

The Future Vector Project

In the 2014 JAPCC Future Vector Project, Dr. Hans Binnendijk identified eight Global Megatrends:

- European Complacency
- An Aggressive Russia
- Relative American Decline
- Shifting Power
- Malthusian Future
- Impact of Technology
- Inadequate Rule of Law
- Complex Conflict

His subsequent conclusions about the impact of those megatrends to NATO's use of Air and Space Power published in the JAPCC Future Vector Project (FVP) Part 1 remain valid. They have a direct parallel when viewed through the lens of NATO and potential adversary submarine operations. The entire three part FVP is available through the JAPCC website.

Figure 39 – A French Atlantic-II Visits the Birdbath after Tracking a Submarine.

The Future Operational Environment 2035
As an output of the UK's MOD Development, Concepts and Doctrine Centre's recently published Global Strategic Trends (2045) forecast, the Future Operational Environment 2035 was recently released, expanding on some of the themes.

Janes Defense Editor Richard Scott's review of the FOE 2035 highlighted many items of interest to the ASW community. These included 'by 2035 there is an expectation that many Western militaries (with the exception of the US) will almost certainly have been overtaken in some technologies and may need to become accustomed to being overmatched by derived capabilities. Additive manufacturing [3-d printing] is singled out as a disruptive technology and could allow individuals, non-state actors and developing states the capability to produce very large numbers of cheap precision weapons [or technology]. By 2035 the majority of missiles will operate at supersonic or even hypersonic speeds, with new technologies designed to defeat advanced electronic countermeasures. There is also an assumption that in 20 years, physical and cognitive performance will be artificially enhanced via biomechanical systems such as exoskeletons or prosthetics, wearable devices and memory enhancing drugs.'[11]

Russia's Breakout from the Cold War System
Dmitri Tenin of the Carnegie Moscow Centre published a forecast outlining the driving forces affecting Putin's future. His conclusions parallel the findings of this study as elaborated in Chapter 14 but are provided in this chapter as additional context for possible futures shaping the NATO – Russia relationship.

'In 2014, Russia broke out of the post-Cold War order and openly challenged the US-led international system. This was essentially the result of the failure of attempts to integrate Russia into the Euro-Atlantic community. The new period of rivalry between the Kremlin and the West is likely to endure for years. Moscow's new course is laid down first and foremost by President Vladimir Putin, but it also reflects the rising power of Russian nationalism.

In the next few years, there is unlikely to be any let-up in the US-Russian confrontation. The United States will not accept Russia carving out a sphere of influence in its neighbourhood. For its part, Moscow will continue to defy US global hegemony. It will act in its own self-interest, guided by its own set of values and without seeking prior US or EU approval. It will only agree to the norms and principles that are negotiated by all relevant actors and apply equally to them all. From the Chinese perspective, Russia is not an all-round 'major power.' It has territory, resources, and a sizeable nuclear arsenal, for all that is worth today, but it lacks real economic strength. Unless it deals with this massive deficiency, Russia will not be able to play in the top league. Given the present circumstances, it will have nowhere to go other than to China. Exit Greater Europe stretching from Lisbon to Vladivostok, enter Greater Asia reaching from Shanghai to St. Petersburg. What Russia needs is to turn inward if it is to avoid squandering its resources and ultimately losing its cherished independence to China, if not to the United States.'[12]

13.6 Summary

The previous two chapters reviewed the driving trends across the Social, Technological, Economic, Environmental; and Political spectrums which have an impact on the future environment of ASW in the NATO domain. These STEEP driving forces and trends were then used to develop the Baseline Forecast or likely future. Further analysis resulted in additional possible futures and trigger events to monitor for the development of that future. Finally, Wild Card events were identified. Not so that NATO may assign resources against the Wild Cards, but rather that they may be identified and discussed so that in the event one comes to pass, the shock is lessened.

The purpose of the forecast for the future Maritime Air ASW environment is to benefit strategists and policy makers as national and NATO resources are allocated and future resources are procured.

1. 'Forecasting for Policymaking in the post-Cold War Period'. Feder, S. A. (2002). Annual Review of Political Science, Pg 112
2. Ibid. Pg 111-125
3. Ibid. Pg 111-125
4. Wales Summit Declaration official text. 5 Sep. 2014. Available online at: http://www.nato.int/cps/en/natohq/official_texts_112964.htm
5. 'Just Five of 28 NATO Members Meet Defense Spending Goal, Report Says' Bendavid, Naftale. Wall Street Journal, 22 Jun. 2015. Available http://www.wsj.com/articles/nato-calls-for-rise-in-defence-spending-by-alliance-members-1434978193 online at:
6. UK Global Strategic Trends Out to 2045. 5th Edition. Pg. 17
7. BIPE Conseil, Institute for the Future, Copenhagen Institute for Futures Studies 1992, pg. 5
8. Dr. Karlheinz Steinmüller The Foresight Company. Presentation at the Future Scene 2004 Conference 'Seize the Future', UIMC, Jul. 6, 2004
9. 'The Calculation of Russia's Neighbors'. Mankoff, Jeffrey. Center for Strategic and International Studies 2015 Global Forecast pg. 34
10. The Taming of the Screw: Johnston, Paul. Curator of Maritime History National Museum of American History Available online at: http://americanhistory.si.edu/subs/anglesdangles/taming.html
11. 'Known Unknowns' Scott, Richard. IHS Jane's Defense Weekly 13 Jan. 2016 Vol 53 Issue 2 pg. 30-32
12. 'Russia's Breakout from the Post-Cold War System – the Drivers of Putin's Course'. Trenin, Dmitri. Carnegie Moscow Centre. Dec .2014. Available online at: http://carnegieendowment.org/files/CP_Trenin_Putin2014_web_Eng.pdf

A P-3C Orion and a P-8A Poseidon fly over NAS Jacksonville.

CHAPTER XIV

Findings and Recommendations

14.1 Critical Findings

This study has identified four Critical Findings and 14 additional findings. All findings will be discussed in detail in this chapter. However, identification of the four critical elements will provide context for the remainder of the chapter. The key critical findings are:

- The re-organization of the NATO Command Structure inadvertently severed critical C2 relationships between the Maritime Command and subordinate elements. This critically impacted MARCOM's ability to coordinate peacetime ASW functions. The conclusions drawn on C2 during the research phase of this project have been identified due to challenges experienced in recent ASW prosecutions. Unfortunately, NATO has not reached consensus on a C2 structure to mitigate the resource coordination challenge. This study concludes the designation of a formal C2 arrangement, led by a Theatre ASW commander is the most appropriate method to resolve the current situation.
- NATO's MPA Inventory is in danger of falling below a key threshold. This has the potential of challenging large area submarine operations with no identified mitigation strategy in place for MPA replacement aircraft.
- The interoperability of ASW forces has declined dramatically in the last 15 years as nations pursued their own unique aircraft and sensor replacement plans without consideration of a NATO common standard. Mutual international support of MPA and MPH by MACAs is no longer possible. NATO must identify a common mechanism for MPA and MPH acoustic analysis and request national MACAs adopt this standard.

- ASW Doctrine has not advanced in parallel with the development of more capable systems and sensors. NATO must develop EXTACs to address both the development of active search tactics and the better integration of new sensor technology found in many ASW helicopters.

The remainder of this chapter reviews in detail all findings and recommendations found within this study. They are organized by DOTMPLFI function.

14.2 Doctrine

Findings:
The detection of submarines by passive sonar, upon which the majority of NATO doctrine is founded, is approaching a point of diminishing returns. It is unlikely passive sonar will serve as the primary detection and tracking sensor in the future.

- Ambient Noise (AN) at most of the initial detection frequencies has risen. There is more merchant traffic and more seabed exploration and drilling than ever before. The ocean is getting louder by the day.
- Perhaps most notably, the design of modern submarines has reduced noise generation to the point where soon there may be insufficient sound energy to distinguish the submarine from other noises in the ocean.
- Non-NATO submarines have grown increasingly quiet with each subsequent class fielded. Technology to address propulsion plant and propeller-generated noises has been implemented. As well, anechoic coating to both reduce hull noises and to mitigate active sonar detection has been fielded.
- With more submarines operating in the littorals, the water column does not have sufficient depth excess to support the regeneration of sound energy into a convergence zone for distant detection.

Therefore, in the future, NATO must rely on other detection and tracking methods instead of passive sonar.

Many of NATO's ASW helicopters have a significantly improved active sonar capability over previous models. This fact has not been fully explored nor captured in current doctrine. Improvements in dipping sonar and other sensors have been realized, yet the doctrine has not evolved to acknowledge new, realistic search dimensions. In the normal course of review for each of NATO's ASW publications, particular attention should be given to ensure the tactics employed align with the capability of today's aircraft.

Additionally, further research into multi-statics is warranted. Once that technology is more mature, development of appropriate tactics should shortly follow. It is important to note even if not all nations procure multi-static sonar suites, all maritime air nations will retain the capability to serve as a Pouncer aircraft to a multi-static detection.

Of note, both COMSUBNATO and COMMARAIRNATO indicate abiding by the construct of the current mammal mitigation doctrine and procedures has not affected either operations or exercises/preparation for operations.

Recommendations:
Specifically ATP-1 and ATP-28, but, in general, all tactical level doctrine should be reviewed for currency, relevancy, and applicability based on the technical capability of sensors embarked on today's ASW helicopters and MPA.
Recommended Custodian for this Action: MAROPS Working Group

EXTAC 193 should be reviewed by STRKFORNATO for concurrence and to ensure all types of CVN and Amphibious Assault Ship flight operations are reflected with appropriate ASW tactics derived accordingly.
Recommended Custodian for this Action: MARCOM in Coordination with STRKFORNATO. Note: France is the Lead Nation Developing EXTAC 193.

For nations' which that are not procuring a multi-static sensor system for their MPA or MPH, address training to a 'Pouncer' role. UAS might also have a future role in this area.
Recommended Custodian for this Action: ASW RTT (Research, Tactics, and Technology) Forum

14.3 Organization

Findings:
Formalizing a Theatre ASW C2 chain of command must be done to move beyond the current state of ad hoc, nationally directed and stove-piped monitoring of submarines. NATO must return to the level of fidelity and more efficient utilization of resources to locate and track non-NATO submarine operations, which it had previously employed in the Cold War. The EXTAC 197 proposed by COMSUBNATO is a step in the right direction, but further steps, including the formalization of reporting schema between national MOCs and MACAs as well as identifying the process by which assets/resources would be temporarily assigned to MARCOM to execute Theatre ASW is necessary. Supporting points to this position include:

- Providing clear and universally implemented direction for all nations in each specific submarine prosecution is critical to achieving NATO's strategic objectives. Tracking efforts on all submarines do not need to achieve the same effect, and the goals for each prosecution may vary. Any future C2 structure must include a link into each national element capable of conducting C2 of MPA, MPH, Submarine, and 'other' special mission ships (for those nations with the capability such as Surveillance Towed Array Sonar System-SURTASS and Low-Frequency Active ships).
- No formal information sharing mechanism exists between the national MACAs (or Maritime Ops Centres). Rather, there is a decades old 'arrangement' stemming from the days of COMMARAIRSOUTH's relationship with the MACAs. It functions today only at a rudimentary level.
- MARCOM is not vested with the authority to directly allocate or support MPA or submarine forces. MARCOM operates under a 'gentlemen's agreement' with the nations. Some choose to support by making forces available for ASW when it aligns with national objectives, others choose not, or are not able to, based on the availability of forces. Furthermore, MARCOM is not permanently assigned any aircraft or submarine forces to execute a submarine prosecution.
- The Standing Naval Groups (ships) over which MARCOM does have OPCON are scheduled by SHAPE for maritime engagement activities (Schedule of Operations). This prevents MARCOM from redirecting and employing them for ASW without SHAPE and potentially NAC approval. SHAPE is currently exploring modifications to the SAVANT (Ships at sea AVAilable for NATO Tasking) process as part of a holistic Maritime Governance effort. Unfortunately, friction within the NCS structure makes these assets very challenging for MARCOM to control, even if vested with Operational Control of those units. Additionally, according to a recent Maritime Strategy Paper briefed to the Atlantic Council, those Standing Naval Groups are 'consistently under-resourced and lack the ability to sustain high-level operations over a prolonged period of time.'
- Many believe a NATO-coordinated prosecution of a fully submerged submarine to be beyond the capability of NATO forces today. Some nations retain a robust national capability, but the numerous challenges identified to NATO's C2 structure make a NATO-coordinated prosecution nearly impossible.
- ASW capable ships and their embarked MPH have sufficient sensors, tactics, and inventory to conduct localized ASW under the Naval Task Force Commander's C2 construct. However, MPH and surface ships are unable (due to inventory and speed limitations) to replace MPA or to be the primary asset for deep ocean or theatre–wide, peacetime ASW.

Recommendations:
This study recommends a standing Task Force be created with the authority to conduct coordinated theatre-wide ASW operations, including peacetime submarine monitoring. This should include the authority to task and organize subordinate forces from NATO's aviation, submarine, and ship inventories as needed to effect a multinational, multi-platform solution with the most efficient use of NATO's ASW resources and sensors.

Recommended Custodian for this Action:
MARCOM

14.4 Training

Findings:
A common theme heard in almost every single ASW forum visited during the research phase of this study was NATO's current ASW exercises are not conducted at a high enough level of difficulty to represent a truly competently sailed submarine trying to evade detection and achieve a kill against an HVU. Without exception, exercise planners lamented the current level of ASW proficiency seen by MPA, MPH, and shipboard ASW operators. This detracts from the level of complexity designed into the exercise scenario.

In a time of austere budgets, it comes as no surprise that nations view exercises as unit level training opportunities. The objective is to maintain currency rather than arrive with a level of proficiency to handle varsity scenarios. This study concludes that at least one ASW exercise each year should be reserved for highly trained and competent aircrew working with a trained and competent ASW ship against a highly manoeuvrable and evasive target. This exercise should rebuild the spirit of camaraderie lost when various 'challenges' went by the wayside. For example, Commonwealth nations that operated MPA crowned a FINCASTLE champion from 1971 to 2005. But even that event, like the MPA which conducted it, has today turned from ASW into an ISR competition (when held). Also, the US recently began a program presenting a 'Championship belt' to the winner of its annual ASW Rodeo. This rodeo consisted of a series of graded simulator events held amongst its non-deployed squadrons.

Recommendations:
The entire NATO Maritime Air community would benefit from restarting a high-level ASW competition to reward the best MPA and potentially best ship/MPH team annually. There is manoeuvre room within the current exercise schedule to regenerate this level of training. This is not only to promote esprit de corps amongst the Maritime Air community, but also to strike directly at one of the core challenges: increasing ASW experience against a highly manoeuvrable and competent submarine target. Additionally, continued emphasis by all nations on solid ASW fundamentals and regular participation in ASW exercises will bolster NATO's overall capability in this area.

Figure 40 – Fincastle Champions.

Recommended Custodian for this Action: MARCOM

Some effort to integrate new models of MPA and MPH has been made, but NATO should continue to focus specifically on integrating ASW-capable aircraft developed by nations relatively new to the ASW mission area (Turkey and Poland for example) into ASW exercises. The objective should be to enhance joint interoperability, grow experience, and explore integration and capability seams brought on by differing levels of acoustic capability so future operations may efficiently use the capability brought by these nations new to the submarine prosecution domain.

Recommended Custodian for this Action: MARCOM

Figure 41 – ASW Rodeo Champions.

NATO should incorporate EXTAC 181, 193, and 197 into the 2017 Maritime Exercise scenarios at the earliest opportunity. EXTAC 197 (Area ASW CONOPS), once drafted and endorsed by nations, must be exercised as soon as possible and then ratified/codified into doctrine. Opportunities to conduct this include the existing DYNAMIC MANTA/MONGOOSE series of ASW exercises as well as BALTOPS, which additionally provides the unique opportunity of involving a Naval Task Force centred on either an aircraft carrier or amphibious assault ship. Although not every year, many BALTOPS do see participation of a Carrier Strike Group. This could be specifically targeted to explore the handover relationship between a theatre-wide prosecution to a local ASW problem as this is the biggest challenging to both C2 and resource allocation.

Recommended Custodian for this Action: MARCOM

As a direct result of perceived deficiency in MACA's ability to provide mutual support to other nations MPA, MARCOM, through the MACAs, should coordinate cross training on current and future MPA acoustic systems to ensure mutual support capability is regenerated. This will require training of both information systems technicians for hardware and acoustic operators for the grams. This applies to those countries with MACAs (Italy, Greece, Turkey, France, US, Spain) as well as MPA nations who operate through ASW Operations Centres embedded within national Maritime Operations Centres (ie Norway, Germany, and likely the UK once C2 capability is restored following the decision to re-acquire an MPA).

Recommended Custodian for this Action: MOCs, MACAs and MARCOM

NATO should practice the TASWC C2 concept on the next submarine deployment even if the EXTAC is not ratified. As Russian (and potentially other non-NATO submarines) will most certainly conduct extended submarine deployments in the NATO AOR, consideration should be given to conducting a future prosecution using the C2 framework identified in the EXTAC even if it has not been exercised and ratified. It is unlikely the political situation with any potential NATO adversary will devolve so rapidly as to pose a direct and imminent threat to naval forces. However, without planning, NATO may find itself with an opportunity to 'practice' theatre-wide ASW on a live non-NATO submarine prior to a scripted 'practice' in an exercise.

Recommended Custodian for this Action: MARCOM

COMSUBNATO should brief the Theatre ASW CONOPS/EXTAC 197 details at the 2016 MACA Conference. This should be done provide more details to the Maritime Network MOU between MACAs / MOCs and MARCOM proposed by COMMARAIRNATO at the 2015 MACC and MACA Conferences. This conference will occur prior to formal publication of this study, but this recommendation has been coordinated with both COMMARAIRNATO and COMSUBNATO in time to accomplish the recommendation.

Recommended Custodian for this Action: COMSUBNATO

14.5 Materiel

Findings:

The trend for submarine operations in both the Atlantic and the Mediterranean Sea is rising. Almost every nation which boasts a submarine capability is expanding its current inventory while nearly every NATO nation has reduced its MPA inventory by approximately 120 airframes in the same span. *In 2016, the ratio of MPA to submarines has fallen from 1.8 : 1 (MPA to submarine) to be nearly the opposite 1 : 2 (MPA to submarine).* Of note, many current NATO MPAs will reach their end of service life inside a decade, further skewing this inventory ratio even more in favour of the submarines. This imbalance is exacerbated by the fact many nations are increasing their submarine shipbuilding while few nations are increasing their MPA inventory.

Stemming from the results of the 2012 IMS DI MPA Study, the UWWCG M3A team was specifically created to research options for a potential replacement airframe. The inability of this team to significantly advance toward defining the problem and proposing a solution in the subsequent three years can be directly tied to a lack of a common shared perspective on the nature of the threat and a lack of a cohesive national position on the future of MPA/MMA requirements. This team has also been distracted by related, but not integral, issues such as the potential for establishing a Maritime Patrol Centre of Excellence. Nations participating in the M3A team were more comfortable discussing the merits of a COE (and where it would be established) than the more challenging discussions of future MMA requirements.

At the Spring 2016 meeting, tied to the generation of the LOI discussed in Chapter 8, it appears the teams re-achieved a modicum of focus, but there remains a significant amount of detailed work to be done. This is challenged by the fact the majority of the nations represented on this team have either already procured an MMA solution or are comfortable with their nation's current or projected capability. This team has shown the tendency in the past to lack the cohesiveness and focus needed to address the MPA shortfall looming in the next decade. Effort should be made at all levels to better integrate the nations who have a defined need but as of yet have declined to participate in the M3A development process.

Furthermore, NATO's sonobuoy inventory has also decreased in parallel with the MPA inventory. The passive sonobuoy employment rate has increased (due to decrease in sound generated by target submarines). In the tracking phase of prosecution, instead of the buoy utilization rate of 7-9 buoys per hour which was the goal in the 1990s, crews today are experiencing double or treble hourly utilization rate. This is due to decreased passive ranges on modern submarines. This stresses both aircraft on-station time (planned for four to five hours based on a typical sonobuoy load and aircraft turnaround time) and total force sonobuoy inventory.

Further exacerbating this challenge is the national sonobuoy inventory. As the cost to build each sonobuoy has increased, and the stockpiles are no longer kept at Cold War levels, inventory of sonobuoys has dramatically fallen across NATO. It is not uncommon for national restrictions to impose carriage limitations on aircrew. This will limit the number of buoys brought for training missions to well below the carrying capacity of the airframe. This has a measurable and observed impact on the decision making of less experienced aircrew who show a tendency to be hesitant and overly conservative when employing sonobuoys. This hesitancy has, in many cases, led to lost contact during dynamic phases of the prosecution such as the initial period following a submarine submerging or during aircraft on station prosecution turnover.

Radio Frequency Interference with sonobuoys will be an enduring challenge. In operations close to land, or with the aircraft at higher altitude, signal inference from based systems operating in the same frequency spectrum can be severe. This will only get worse in the future and in some of today's ASW hot-spots RFI can be excessive (examples include the Mediterranean Sea, Arabian Gulf, South China Sea). Some level of investment in the ability to filter non-related data on a given channel has been done, but this is a problem which is likely to increase in the future, especially when operating in the littorals.

Overall, MPA and MPH passive sensors have improved sensitivity and processing capability somewhat in parallel with the advancement of submarine quieting technology. The challenge to passive sonar is not a function of sensors' capability aboard aircraft. Rather, it is a function of the amount of sound energy generated by submarines relative to the amount of background noise in the ocean. Currently, aircrew are still able to use passive sonar in the search, localize, track, and engage phases of prosecution.

Although the passive detection ranges have decreased and exploitation of some raypaths (CZ for example) is no longer viable, aircrew today still utilize passive sonar systems to a great extent because direct path active sonar is not a viable search sensor or tactic to cover large areas of water and multi-statics are not mature enough to take the role as the principle wide area search sensor. Therefore, despite its limitations, passive sonar remains the principle system used in the search phase, which results in frequent instances of crews not detecting submarines which are operating in the designated search area. The author confirmed this during observation of the recent DYNAMIC MANTA exercise (Feb 2016).

Furthermore, most NATO models of airborne, lightweight torpedoes use a combination of passive and active sonar through the acquisition and targeting phases. They are similarly challenged by a reduction in passive ranges but still are deemed 'effective' against the submarine classes underway today.

Recommendations:

The International Military Staff should put pressure on the UWWCG's MPA Specialist Team to identify a timeline for an airframe decision which would yield a fielded airframe NLT 2025. The ASW Roadmap stemming from the 2014 Wales Summit identified three pillars to ASW operations: MPA, Surface Ship (including embarked helicopters), and Submarines. To date, technological advancements in MPA have kept pace with the counter-detection technology developments of submarines, and there is not a true capability gap between sensors/submarines. Rather, the capability gap in the MPA pillar is in quantity of NATO MPA against quantity of non-NATO submarines. In comparison, ASW surface ship and embarked ASW helicopter inventories remain relatively healthy. Although some nations are replacing aged MPA with a new aircraft model, some are electing to pursue a wait-and-see approach and refit older model aircraft with the hopes of extending service life for another ten to 15 years.

A common replacement airframe should be pursued by NATO nations. Assuming a ten-year turnaround from decision to aircraft availability, there is limited time to resolve this issue. The replacement of the US P-3 with the P-8 Poseidon (to be complete by 2019) and the UK's recent decision to acquire the P-8 (nine airframes) does not actually alleviate the challenge. In fact, it magnifies the issue for the remainder of NATO Nations operating MPA aircraft in many ways, not the least of which is a hard end to logistics (parts) and training support for the P-3C airframe.

Recommended Custodian for this Action:
NATO MC / UWWCG ST-5 (M3A)

UUV development should continue. More effort should be put into defining the requirement and future integration milestones as there is no clearly defined way ahead on this. NATO's Centre for Maritime Research and Experimentation has been identified by the MCMSB as leading the ASW Roadmap's stated goal of UUV integration into the ASW domain. However, this is slightly misaligned, since the nations have responsibility for developing assets and resources. CMRE can then explore technical capabilities and propose interaction models to further the development of UUVs into the ASW domain.

Recommended Custodian for this Action:
NATO MCMSB / CMRE

Conduct further research into either encrypting the signal to prevent Radio Frequency Interference or migrate the communication medium to an entirely different spectrum. Until this is complete, RFI will continue to challenge littoral ASW.

Recommended Custodian for this Action:
NATO MCMSB / CMRE

Coordinate with the nations to increase sonobuoy production and available reserves to the point where mission inventory is not a factor and crews are not 'negatively' trained with buoy conservation being a factor over contact generation.

Recommended Custodian for this Action:
IMS / UWWCG

14.6 Leadership and Education

Findings:

In future conflicts, NATO JTF commanders will have to relearn the Sea-basing concept and how to operate from contested seas rather than assuming the luxury of maritime supremacy at the onset. Should a future Maritime Component Commander (MCC) have to fight their way to the beach, the defence of naval force requirements would impact Joint Operations in many ways. Assets would have to be allocated for defensive purposes to counter a threat posed by adversary surface ships and submarines. Some strike aircraft from carriers would have to be re-allocated from a strike role to defensive anti-Surface Combat Air Patrol (SUCAP) stations. This would have the two-pronged result of reducing the support to the land-based target striking plan and potentially raising the requirement for land-based aircraft from the JFACC to be apportioned over-water to fill naval defence roles (Anti-Air and potentially Anti-Surface) when the aircraft carrier and her embarked carrier air wing could not meet the requirement. Additionally, MPA would fulfil their primary role of ASW and Anti-Surface Warfare (ASUW). Those MPA which normally support the ISR Collection Plan may not be available. This would further impact the target strike plan and campaign phase timing.

Additionally, as an example of potential stovepipes within various teams working to address ASW as an identified Priority Shortfall Area until May 2016, the Maritime Operations Working Groups ASW Syndicate and the UWWCG did not have an awareness of each other's portfolio, efforts or current challenges. There existed little to no interaction between the two and no effort to ensure overlap or mission creep was not occurring. As part of a larger education campaign, more awareness is needed across the full spectrum of Maritime-related COEs and various working groups involved with ASW as to the program of work and priority of effort of other entities within the domain.

Recommendations:
Introduce the concept of a lack of maritime superiority into JHQ and higher table-top exercises. This would help to educate Joint leaders about the challenge submarine operations bring to joint operations. Be candid about the potential loss of a capital warship unless the submarine threat is defeated or deterred. Advance this education campaign in the appropriate forums for discussion and enlightenment of NATO's civilian leadership.

Recommended Custodian for this Action: IMS / MARCOM

Assess the models for creating a combined afloat and ashore ASW planning staff for utility within NATO. Chapter 3 outlined the model of combining both the tactical-level staffs aboard one flagship and the theatre-wide ASW planning staffs at the MPA headquarters (for bi-lateral MPA planning) and CTF-HQ (for overall C2 of the theatre-wide prosecution). This concept is a model NATO should assess for utility within the MARCOM command structure.

Recommended Custodian for this Action: MARCOM

This study conducted extensive research across a broad spectrum of components of the ASW domain. As part of the research into this study, many different ASW forums and working groups were contacted. To date, the existence of the ASW Roadmap is not widely known outside of the NATO HQ, nor is that of the associated country books and recommended mitigation plans for each nation. It is recommended that DI Division should conduct an education campaign on the existence, purpose, and intent of the ASW Roadmap to a broader audience. Education will stimulate more national investment into the process. Furthermore, it is recommended conclusions from this study be incorporated into the more holistic ASW Roadmap overseen by the Defence Investments division.

Recommended Custodian for this Action: NATO IMS/Defence Investments Division Maritime Capabilities Section

To improve education into future challenges in the air aspect of the ASW domain, JAPCC has presented/will present findings from this study over the last month/next 18 months at the following meetings/conferences:

- Maritime Air Coordination Conference (May 2016)
- MACA Coord Conference (May 2016)

- UWWCG (May 2016)
- Amphibious Operations WG (June 2016)
- ASW RTT (Research, Tactics, and Technology) Workshop 2016
- Maritime Operations WG ASW Syndicate Jan 2017
- Other conferences as requested by MARCOM

14.7 Personnel

Findings:
Although manning and manpower will always remain a national issue, the following manning challenges should be considered:

If EXTAC 197 is ratified in its current form, or if a formal TASWC is re-established within NATO, the manning for this staff should ideally come from ASW subject matter experts/staff officers within the CMAN and CSN staffs. As of 2016, neither staff is sufficiently manned to operate a full-time ASW planning cell in addition to the voluminous MARCOM ASW exercise portfolio.

As discussed in Chapter 11, this study concluded a Deployable ASW support centre is needed to assist MPA and potentially MPH crews operating in remote locations where the former ASW Operations Centres have been closed and the Mobile Maritime Operations Centres (MOCC) disestablished.

Recommendations:
MARCOM should refine the staff officer requirements to execute the predicted future ASW exercise portfolio and what requirements then exist to support a stand-up of a part-time or full-time theatre ASW planning and operations staff. CMAN is normally supported by only a single SME with background in each of the MPA, MPH, aircraft carrier operations and IT fields. CSN has similar staffing challenges. Pulling from these two small teams to build a competent and enduring theatre-wide ASW operations staff in the long run will require billet increases to both.
Recommended Custodian for this Action: MARCOM

As part of the procurement process for a Deployable Mission Support Centre, augmentation manpower from existing MACAs should be explored. Also, opportunities for cross-training on mission support systems (such as NATO ASW Exercises) must be identified and implemented. The next section will have further details on this initiative as related to 'Facilities'.
Recommended Custodian for this Action: UWWCG

14.8 Facilities

Findings:
With the US as lead nation, the Maritime Air Support Interoperability (MASI), and associated Interoperability Specialist Team generated a CONOPS solution to an identified MPA ground station shortfall which was discussed in Chapter 11. As of 2016, this Deployable Maritime Multi-Mission Mission Support Centre concept is unfunded, but it will solve many of the logistics challenges exacerbated by the stand-down of ASW MPA support centres at remote locations to which MPA used to deploy, such as Lajes, Keflavik, and Gibraltar. These geographic locations will remain critical bases for MPA in the future. Although the permanent support structure no longer exists to provide ASW mission planning and post-mission analysis, this study finds that providing a support capability at those remote sites, whether by re-opening those ASW Centres in a semi-permanent 'warm readiness' status (which could be brought to full-online/hot status in short notice), or though procurement of a deployable unit with associated MPA support hardware is a requirement.

MACAs have nearly completely turned away from NATO's support to focus solely on national missions. Many MACAs only utilize their MACA function to support NATO exercises and the occasional operational mission in the Mediterranean. This study found, based on in-person observation of the author, the ASW aircrew briefing cell utilized in recent NATO exercises provides only rudimentary safety of flight briefs to aircrew while mission support for detailed tactical level planning was significantly lacking. This was likely due to the ad hoc nature of the briefing team's composition.

Recommendations:
Restore the capability for sustained multinational MPA/MPH ASW operations from remote bases around NATO, such as Keflavik, Lajes, Rota, and others. Acquire a capability for multinational ASW mission support to include pre-mission planning and post-mission acoustic analysis.
Recommended Custodian for this Action: UWWCG Maritime Air Syndicate and Maritime Air Support Interoperability (MASI) Specialist Team

MARCOM should coordinate with MACA Nations and nations who operate MPA/MPH but who do not have an established MPA support centre or MACA to ensure alignment of information exchange systems and that sufficient personnel are retained to perform both NATO and national mission support.
Recommended Custodian for this Action: MARCOM

14.9 Information/Interoperability

Findings:
Numerous interoperability challenges face today's maritime air community. Not only is aircraft-to-aircraft interoperability being challenged by non-common national procurement of digital systems such as sonobuoy uplink encryption, but also digital acoustic recording devices have become so varied almost none of them can be processed by other nations. This is further exacerbated by disparate ground support systems. All of these issues can be tied directly to the drawdown in the ASW mission in the late 1990s, when nations pushed their MPA into ISR mission areas, resulting in an accelerated and non-uniform procurement process.

Additionally, an unintended consequence arose during the creation of the current NATO Command Structure. When the C2 relationship between MARCOM and MACAs changed, NATO lost a cohesive ASW vision and lost unity of effort. It now must spend significant energy to rebuild capability and interoperability it once possessed. Investment must be made to support interoperability of aircraft and ground systems. It must also expand and re-establish the deployment capability of MPA ground support stations to remote locations from which ASW operations are expected to recommence in the next decade.

Chapter 6 reviewed the challenges the ocean environment presents to forces working to detect, track and engage adversary submarines. As submarines have historically grown quieter, it is likely submarines will eventually be quieter than the background ambient ocean noise. This will dramatically impact current passive detection, tracking, and engagement tactics and likely prevent their use entirely. This will result in a shift entirely to the use of active sonar throughout the submarine prosecution.

A significant limitation to the use of active sonar has always been the lack of ability to classify the return. Passive signals can be used to determine submarine class; however, the technology supporting processing active returns has not evolved to be able to definitively identify the submarine class or even friend from foe. Future development, not only for initial submarine detection but in the realm of target classification via active sonar, will become a necessity.

Finally, if a complete copy of the Consolidated Maritime Briefing Book were to be located in any national archive, it would fill many current information gaps identified in Chapter 3. Perhaps it is worth the effort to regenerate the data before the last ASW officer or sailor with Cold War ASW experience and first-hand use of this publication were to retire from service.

Recommendations:
Address shortfalls in interoperability of ground support stations by establishing a standard minimum capability requirement and ensuring nations ASW support centres meet this interoperability standard.
Recommended Custodian for this Action: UWWCG Maritime Air Syndicate and Maritime Air Support Interoperability (MASI) Specialist Team

NATO should explore development of the capability to record active sonar for post-mission analysis and the fidelity for active sonar to classify submarines by type in real time while on station.

Recommended Custodian for this Action: ASW Research, Tactics and Technology Workshop (under UWWCG).

14.10 Limitations of the Study

This scope of this study was limited to an assessment of ASW capable air platforms currently or projected to be available to the Alliance. This is not a holistic view of all ASW capability. Further analysis is needed regarding developments in NATO Submarine and Surface Ship detection and engagement capabilities which will compliment Maritime Air's capability to conduct ASW. As the study determined that the sensors and tactics employed on modern ASW helicopters, along with their inventory and aircraft inventory, meet the current and projected need, this study focused mostly on the challenges with MPA. This aligns with findings in the NDPP review conducted after the 2014 Wales summit.

Additionally, beyond identifying the benefits of a common MPA replacement airframe and exploring the timeline of the remaining service life of today's MPA force, this study did not undertake a detailed review of the benefits of a NATO-operated MPA squadron as compared to nationally developed and operated squadrons but did offer considerations for the MPA Replacement Specialist Team.

Finally, the author was unable to personally observe the Turkish CASA or Polish Bryza MPA. Therefore, this study was unable to make an assessment of the acoustic capability of those airframes. As this study recommends MARCOM focus on integrating those nations MPA into future ASW exercises, perhaps an assessment may be made in the near future.

14.11 Conclusion

This study began as a thought piece discussing the disparity between MPA force structure (P-3 capability and inventory) balanced against Russian submarine capability and inventory from 1995 as compared to 2015. As discussion with the primary stakeholder requesting the study unfolded (Commander Maritime Air NATO), it expanded to include a more holistic view of all air aspects of the ASW problem.

The study conducted thorough research into NATO's MPA current and projected status. It determined the technical aspect of ASW has remained relatively balanced (as submarines got quieter, tracking technology evolved at a relatively consistent pace), but the dramatic drawdown in MPA inventory across the Alliance has resulted in a potentialy significant future shortfall. Although this problem has been identified in numerous forums, NATO is fast approaching the time where the normal acquisition timelines will be unable to provide the resources to meet the future requirement.

ASW is, and always has been, conducted with a layered and overlapping sensor approach, so the loss of one sensor would not necessarily result in lost contact. Bottom-mounted acoustic systems, long-range MPA, and even longer dwell time submarines worked together to continuously keep track of multiple submarines across the vast NATO AOR, from off Bermuda to the GIUK Gap to the extremes of the Eastern Mediterranean Sea. In a similar manner to the drawdown of MPA across almost every NATO nation, as the adversary submarine deployments ceased in the late 1990s, the ground support stations that conducted ASW pre- and post-mission support to MPA were closed. The command structure organizing the layered prosecution was dissolved, relationships between nations and the Maritime Commander dissolved, and NATO forgot how to efficiently conduct no-notice, wide-area submarine detection and tracking.

In strict dichotomy to the MPA inventory reduction, MPH inventory has remained relatively constant and the sensors and capability on today's MPH far exceed that of 15 years ago. Improvements to other aspects of ASW, including surface ships' passive tails and the slow migration toward acceptance of the use of active sonar for submarine detection, have continued.

Where NATO truly suffered was in manpower and experience, but a focus on ASW exercises in the last five years is already starting to show an uptick in both proficiency and depth of experience across the board.

This study concluded with an environmental forecast of possible futures and potential wild card events to provide NATO's planners insight for resource allocation and milestones to monitor in order to help determine which future is unfolding.

Now that submarines are starting to resume long deployments away from the coastline (out of range of land-based ASW MPH), NATO is scrambling to rebuild the capability at which it once excelled. Fortunately, Russia is also slowly coming out of a 15 year submarine deployment hiatus. It is also experiencing growing pains, re-learning things that used to be standard procedures. NATO is not the same NATO of the Cold War, and today's Russia is not the Soviet Union. Global challenges affecting both NATO nations and Russia have an impact on this domain. Although national defence spending is and will be challenged by other social/political influences, nations have begun to recognize a tipping point is approaching from which NATO might not be able to recover.

In addition to the 21 recommendations spanning the DOTMLPFI spectrum, **the study yielded four vital conclusions:**

- **NATO should re-organize its current ASW Command and Control organization into a single C2 construct under a single commander to allow MARCOM the authority and resources to respond to the current uptick in Russian submarine deployments.** MARCOM is currently taking steps to address this through the generation of EXTACs and the proposals regarding Area ASW Operations; however, the proposed information sharing agreement is just the first step toward addressing a significant C2 shortfall. Even so, this small step is still likely to be received with a modicum of pushback from nations who don't share the perspective of MARCOM on the nature of the threat and do not feel a need to change.
- **NATO should rapidly pursue a replacement aircraft for the seven countries whose highly capable MPA reach the end of their service life in approximately a decade.** The status of NATO's dwindling MPA force is a known issue. The challenge moving forward is there is currently not a shared perspective of the threat or of the capabilities required to combat the threat. This issue is growing in importance as time advances. Benefits from a common airframe should not be overlooked.
- **An investment must be made to support interoperability and expand the deployment capability of MPA ground support stations to remote locations from which ASW operations are expected to recommence in the next decade.** This issue has also been identified, but no common NATO solution has yet been approved, forcing action back into national channels if any action is to be taken at all. Therefore, this study recommends approval of and funding for the Deployable Ground Station concept proposed to the UWWCG in 2015.
- **ASW doctrine must be thoroughly reviewed and updated to account for and maximize the capabilities of newer acoustic and active sensors already in use across NATO's ASW force.** Refinement of ASW doctrine to mirror today's more capable MPH sensors, continued stress on force interoperability between MPA, MPH and ASW ships, exploration into new technology (multi-statics and UUV specifically) are also identified as important steps to improve NATO's overall ASW capability.

'Without a sufficient NATO deterrent policy, NATO's hesitancy will further embolden Russia to exert pressure along NATO's periphery.'
Andres Michta, CSIS Global Forecast 2015

NATO forces have not completely given up their supremacy and skill. However, failing to respond to observable trends and provide correcting action to identified driving forces will cede the advantage to a potential adversary, which has already twice this decade surprised NATO with hybrid military operations at NATO's borders.

APPENDIX A

The Russian Federation in the Post-Cold War Era

Transforming the Post-Cold War Russian Military

In January 1990, General Mikhail Moiseyev, then chief of the Soviet general staff, announced at a Military Doctrine Seminar in Vienna a set of guidelines for a new Soviet military doctrine. First, war will no longer be considered a means of achieving political objectives. Second, the Soviet Union will never initiate military actions against any other state. Third, the Soviet Union will never be the first to use nuclear weapons. Fourth, the Soviet Union has no territorial claims against any other state nor does it consider any other state to be its enemy. Fifth, the Soviet Union seeks to preserve military parity as a decisive factor in averting war, but at much lower levels than at present. Also, war prevention – instead of war preparation – emerged as the predominant political objective of the new doctrine.

'The questionable performance of the Russian armed forces in the conflict in Georgia in 2008 provided the impetus for a program of far-reaching reform in the Russian military … The depth and scale of change that the Russian military has undergone during the last 5 years of transformation is impossible to overstate.'
Russian Military Transormation – Goal in Sight?
Giles and Monoghan

Extremely strategic in nature, there was little of substance to help a military chief plan, reorganize and prepare a battle-ready armed force. Only the fifth guideline had any meaning at all, but except for the nuclear strategic balance with the United States, preserving 'military parity' was out of the Russian military's reach as the Soviet Union collapsed. There was no longer any conventional 'military parity' and there could never be 'parity' between NATO and the fragments of the once proud Red Army. In fact, many in the West may have thought that this new Soviet 'military doctrine' was just a strategic deception to screen the Kremlin's real and insidious intentions. But there were no real plans. The 'new doctrine' only reflected the demoralized state of the Russian military chiefs.

However, extrapolations to the naval service from Russia's recent Operations in Georgia, Estonia and Crimea provide insight into the Russian perspective of hybrid forces and how to integrate asymmetric capabilities (such as submarines) into a larger holistic goal. Many have maligned the Russian Navy of being incapable of standing against Western naval elements due to force-ratio disadvantages experienced in the post-Cold War era. The Russian military underwent more than a decade of economically imposed drawdown of inventory and associated minimizing the deployments of the submarines which remained. The Chechnya campaign had nearly bankrupted the Army. In fact, many of its troops were near starving levels. Corruption was rife in the senior General ranks. Modernization of the fleet was ignored while Moscow dealt with cash and oil shortfalls. Russia's Navy has been called 'more rust than ready.' Observers have also cast doubt on the notion that the Russian Navy, and specifically the Black Sea Fleet, can sustain prolonged operations. However, NATO cannot continue to extrapolate that reality onto future projections of Russia's military capability. Only fifteen years after Vladimir Putin took office, Russia's military is bigger, stronger, better equipped and more capable than at any time since the end of the Cold War.

Today NATO is faced with a Russian military who has devoted significant effort not only to upgrading and replacing aged equipment but to streamlining processes in manpower, acquisition, and C2 which are resulting in new capabilities and realized operational efficiency across the force.

'Russia will likely increase her defense spending, although not quickly enough to match China, the US or India.'
UK Global Strategic Trends to 2045

How Did Russia's Military Modernize?

'Putin's rise to power coincided with the worldwide commodity boom. The spectacular rise in the price of Russian oil and gas and metals (2003–2013) allowed the Russian economy to grow at a rapid rate while the Russian state increased its regulation of the economy and began to restore its military.' To affect this remarkable transformation, Putin then seized upon the one thing that had united the country in the past, its remarkable nationalistic pride.

> ***'The two most brutal transformations of Russian society – carried out by Peter the Great and Josef Stalin – were in the long term accepted by Russians because they modernized the army and bolstered the country's defenses.'***
> *Pavel Felgenhauer*
> *Defense and national security editor.*
> *Sevodnya newspaper, Moscow.*

He realized that after ten years of unsuccessful attempts to reform the former Soviet military, there might be only one glimmer of hope left – the possibility that an obvious external threat could unite the Russian nation behind its military as has happened several times in Russian history. For several centuries, defence was considered the most important responsibility of any Russian government. The well-being of individual citizens was always much less important. Now the strategic position of Russia is much clearer: an expanded NATO will build a new 'cordon sanitaire' on Russia's western borders and it is the role of the government to protect its people, at all costs, against this external threat to the nation.

> ***'Russia decisively overran the Georgian military in that conflict, but confirmed in the process that the way its troops were organised and equipped was out of date. Since then, Russia has been working hard to overhaul almost every aspect of its military, including massive investment in new weapons systems – everything from nuclear weapons down to the uniforms and equipment carried by individual soldiers … and improved use of electronic warfare, unmanned drones and better logistical support. Russia has taken what was left of the Soviet Army and finally turned it into a fighting force designed for 21st-Century conflict'***
> *Kier Giles*
> *Director, Conflict Studies Research Centre*
> *Defense and National Security editor.*
> *Sevodnya newspaper, Moscow.*

In assessing the role submarines play in executing Russian strategy, a look at the recent interaction between NATO and the Russian Federation since the fall of the Berlin wall reveals a consistent and systematic worldview.

'Putin … concluded that the West's approach to Russia offered scant respect for its interests or views. In the brief Russo-Georgian War … the Western media and political circles sided with Tbilisi against Moscow. The US response to the 2010 Russian proposal to create a joint ballistic missile defence, a joint defence perimeter with Russia and NATO as de facto military allies, was so tepid that it allowed Putin to conclude that the West continued to view Russia as a potential adversary. Thwarted in his attempt to build defences with NATO, he went ahead with plans to build them against NATO. In Libya, Russia's major concession of allowing NATO to use force against a sovereign government – which caused considerable tensions within Russian political circles and the senior bureaucracy – was not appreciated by Moscow's nominal partners, but taken for granted and then misused. This led to a feeling in Moscow of being deceived and then ignored, as well as a firm resolve not to allow such things to happen again – for example, in Syria. Putin also inferred that the West's treatment of Russia was not linked to a particular person in the Kremlin.'

Putin's View of Russia

Putin, in tapping into that Russian feeling of nationalistic pride, seeks to reassert Russia on the global stage as a peer of other global powers. In his view, 'full sovereignty demands both independence of Russian domestic politics from outside influence and Moscow's diplomatic equality vis-à-vis Washington.' Much of

Figure 42 – A Norwegian NH-90 Flies over a German Submarine in a NATO Exercise.

Russia's actions over the last 15 years can be traced to the fundamental national pride and desire to be seen as a dominant global power.

The Impact of Sanctions

Western economic sanctions against Russia as a result of its actions against and Georgia had the unintended effect of internalizing the Russia Federation's acquisition process and jump-starting her defence industrial base. As concluded by the Centre for Research on Globalization, 'the Army needs hardware to defend the Motherland, and advanced Russian industry gets more orders from the Ministry of Defence. Factories and workers laid off or semi-retired get a new life, foreign customers queue up and the rouble is steadied. Young men get some purpose beyond watching television and complaining. A feeling of national pride – after the terrible humiliations of being unheard and taken-for-granted in Yugoslavia, Ukraine and elsewhere – comes back.'

The often-heard 'narrative that Europe is heavily dependent on Russian energy sources is true for some European countries. Yet Europe receives overall about 30 percent of its oil and gas imports from Russia. The less understood dynamic is that Russia is even more reliant on Europe as the market for 80 percent of its total oil and gas exports. While much has been made of Russia's recent energy mega-deals with China, diversification of Russia's export markets to Asia will take a decade or longer, if ever, to reach a level comparable to its exports to Europe.' This would lead many to speculate that sanctions would serve as an effective deterrent. However, that has not proven to be the case.

The sanctions and Putin's push toward transformation invoked initial austerity and an economic recession whose results were exacerbated by a worldwide plummet in one of Russia's largest economic drivers, oil. The cumulative impact of this decade-long Western offensive culminating in the current wave of severe sanctions was to provoke a recession in Russia, to undermine the currency (the Ruble declined 23 % in 2014), drive up the cost of imports and hurt local consumers. Russian industries, dependent on foreign equipment and parts, as well as oil companies dependent on imported technology for exploiting the Arctic reserves were made to feel the pain of 'Putin's intransigence'.

After nearly a decade of military and economic transformation, Russia has not only become more self-reliant but has been able to modernize, upgrade and replace much of its military force while following a Western approach of streamlining force size to reduce cost. 'All the indications we have from the Russian economists and business leaders is that they now consider sanctions the new normal, and they are working around those sanctions.' NATO has demonstrated a tendency of mirroring likely western responses onto their prediction of Russian responses; the true impact of sanctions on the Russian Federation must be considered when projecting future submarine activity.

The Influence of the Russian Federation on European Politics

'Putin, like his Soviet predecessors, has avoided reform, and the Russian economy has continued to stagnate (1.3 percent growth in 2013) even before Crimea annexation and the war in Ukraine despite historically high oil prices. It appeared that Putin had already decided to abandon economic growth and prosperity as the foundation for his political popularity and authority. This risky political strategy would require a new political narrative to justify his indefinite leadership if economic growth and prosperity were no longer the essential thread.

This new political narrative began to form in 2012–2013 with a growing emphasis on traditional Russian values captured in the 19th-century Russian policy of 'official nationality' revolving around the triptych of autocracy, orthodoxy, and Russian nationality. The crisis over Ukraine offered an ideal opportunity to further consolidate this new political narrative. Previously, President Putin had always been careful to avoid inflaming Russian nationalism. However, in his seminal speech to the Russian Assembly formally annexing Crimea on March 18, he articulated a highly chauvinistic form of Russian nationalism that does not accept the legitimacy of post – 1991 borders let alone post – World War II and even post–World War I borders.'

Putin clearly has made a Faustian bargain with Russian nationalism and oligarchic predators with unpredictable consequences for Russia's neighbours, regional security, and the Russian people.

Kuchins, Andrew, 'Putin's Dilemma' 2015 Center for Strategic and International Studies Global Forecast, pg 31

Analysis shows a linkage between Russian influence and the rise of populist, nationalistic, and xenophobic political parties as many of these entities receive financial support from Russian affiliated nongovernmental organizations (NGOs).[1] Taking advantage of Europe's economic malaise, these increasingly successful fringe parties have contributed to the weakening of political support for the European Union and governments across Europe. Their impacts are most evident in the former Eastern Bloc, where institutions and civil society remain underdeveloped and susceptible to the revitalization of former Soviet networks. 'Although the 21st-century East-West confrontation does not bear the same ideological vestiges of the Cold War, there is a clear ideological component today … The unqualified success of Central Europe's transformation from Communism to liberal democracies and market economies is not immutable, and we should not trick ourselves into believing it is so.'[2]

1. Conley, Heather. Russians Influence on Europe. 2015 Center for Strategic and International Studies Global Forecast. Pg. 31
2. Ibid.

APPENDIX B

Tactical Oceanography and the Sonar Equations

Oceanography

As discussed in Chapter 6, each type of submarine generates acoustic noise through a variety of different sources. Each of these sources operates at a specific sound frequency. That frequency will travel through water according to a known set of standards. Understanding how sound behaves in the ocean is the key to exploiting the acoustic vulnerability of submarines. 'The speed of sound in sea water is a fundamental oceanographic variable that determines the behaviour of sound propagation in the ocean.'[1] This study discusses the three dominant factors to sound velocity. ATP-1 provides further details on environmental planning considerations such as upwelling, deep ocean currents, and eddies.

Three things affect the speed of sound in water: Temperature, Salinity, and Pressure. As Salinity is generally around 34–36ppm worldwide[2], it is assumed for the purposes determining the velocity of sound in a given column of water to be a constant.

Temperature

Temperature tends to either decrease or remain constant throughout the water column as depth increases. There are instances of temperature inversions where cold water is on top of warmer water. In shallow water, above the Mixing Layer or in the top portion of the Deep Sound Channel, the Sound Velocity Profile will closely resemble the temperature profile and sound will generally propagate perpendicularly from the sound velocity curve. Therefore a decrease in temperature with depth will result in sound being pushed back toward the surface whereas isothermal water will push sound parallel to the surface. Whether the near surface water column has a negative temperature slope or not, as a general rule there is a depth at which most water becomes isothermal. At this point, the influence of Pressure on sound will dominate.

Water in the northern portions of the European theatre may tend to be more isothermal than water in the Mediterranean Sea, which displays a more traditional temperature profile. However, it is important to remember Temperature, more so than Pressure, is affected by local weather conditions. The Mixed Layer Depth (MLD) is that shallow water point where temperature begins to show a reduction as a function of depth. The near surface water may show influences of diurnal heating and therefore the shallow water portion of the water column above the MLD will treat sound differently than the portions below the MLD. The Sonic Layer Depth (SLD), which is the point of near surface maximum sound velocity, is approximately the same depth as the MLD. As the MLD can be measured with bathythermal sonobuoys (while the SLD cannot), the SLD is assumed to be located at the MLD as well. MLD/SLD as a general rule will be located in the first 50–300 feet of the water column.

The Sonic Layer Depth

Oceanographic modelling is important for ASW operations for two reasons. As discussed earlier, as a function of the mission of the target submarine, they may exploit different portions of the water column. A diesel submarine will generally remain near the surface both to facilitate recharging their batteries and to aid in targeting of surface shipping. Additionally, diesel submarines will generally operate in littoral areas, which tend to be shallower water. Therefore, it is common for a diesel submarine to operate above or near the SLD. When determining the best acoustic tracking frequencies for each class of submarine, the depth of the SLD will play an important role. If the MLD (and therefore the SLD) is deep due to shallow water mixing, the spectrum of frequencies trapped and exploitable inside the surface duct (or layer of water above the SLD) increase. If the SLD is shallower, only the highest frequencies (the ones most subject to attenuation loss) remain inside the duct.

Secondly, the SLD plays an important role for determining the depth of air launched passive receiver hydrophones contained in passive sonobuoys. Until recently, the depth of a passive buoy could not be

Temperature/Depth and Sound Velocity Profile

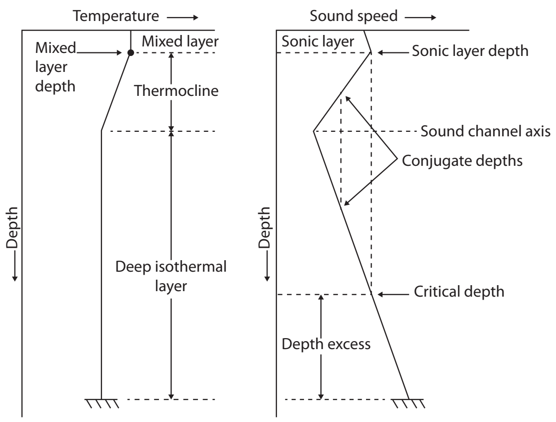

Figure 43 – Temperature/Depth and Sound Velocity Profile.[3]

changed once the aircraft was airborne (as most ASW aircraft sonobuoys are externally mounted and inaccessible while in flight for reprograming). Therefore, if the SLD was significantly different than predicted, the MPA crew ran the risk of having the passive hydrophones on the wrong side of the layer when searching for a diesel submarine. Newer models of passive sonobuoys permit employment with an initial shallow depth setting, after which the hydrophone may be remotely commanded to a deeper depth. This is less of a factor when searching for an SSN or SSBN, which are most likely operating well below the SLD. However, it may also impact search tactics for an SSGN, which may also be operating above or near the SLD.

Pressure

Pressure increases at a constant rate of 1 bar (14.5psi) for every 33 feet of depth (10.06m). In the thermocline and Deep Sound Channel, Pressure dominates the behaviour of sound propagation and in effect, forces sound back toward the surface.

Sound Speed Profile

The resulting graph generated from an analysis of Temperature and Pressure as a function of water depth is referred to as the Sound Speed/Velocity Profile (SSP or SVP). When discussing the Sound Speed Profile, an important element is the behaviour of sound in water. Sound is 'lazy' and is always trying to find that point in the water column where it will travel as slow as possible. Therefore sound near the surface, unless trapped in a surface layer duct, will try to go deeper (due to the influence of Temperature) and sound below the deep sound channel axis will return toward the surface (due to the influence of Pressure) in an effort to travel slower. The result is the generation of a sound wave where sound remains inside the deep sound channel. Provided there is sufficient sound intensity at that particular frequency, this sound may be exploited by passive acoustic receivers.

'The speed of propagation has a very complicated dependence on (Temperature, Salinity and Pressure). Some rules of thumb that you can use to relate the dependence of the speed of sound in seawater to each of the factors are

- 1 C increase in temperature equals a 3m/s increase in speed
- 1 ppt increase in salinity equals a 1.3 m/s increase in speed
- 100 meters of depth equals a 1.7 m/s increase in speed'[4]

Many scientists have noted an increase in ocean temperatures over the latter half of the previous century. Not only are ocean surface waters getting warmer, but so is water 1,500 feet below the surface, albeit with less of a defined temperature increase. These increases in temperature lie well outside the bounds of natural variation. This data is the results of one particular study and likely needs further analysis to determine the true impact to passive ranges, but extrapolation might indicate a subtle shortening of ranges due to this phenomena. If the near surface temperature increases, which it has, while the deeper ocean remains at the same (cooler) temperature, this increases the downward bending of acoustic energy in the Direct Path raypath, in effect shortening passive ranges in the tracking and engagement phases of prosecution.

Acoustic Raypaths

Although many different raypaths (the direction of travel sound takes from the source to the receiver as influenced by the variables outlined above) exist, and are well discussed in NATO ASW publications, two are worth highlighting in this study: Direct Path and Convergence Zone.

The Direct Path Raypath

On the Direct Path raypath, as the name indicates, sound travels directly from the source (submarine) to the receiver (sonobuoy) without undergoing a refraction (change in direction due to pressure etc …) or reflection (bottom or surface). This is the most common raypath exploited in the tracking and targeting phase of prosecutions and provides the most accurate locating data on the submarine. However due to attenuation, spreading and other forms of signal loss, the frequencies used in Direct Path exploitation have much shorter detection ranges. As a general rule, loud submarines may provide direct path ranges in excess of 2nm whereas against very quiet submarines the range is measured in few hundreds of yards. Specific ranges for each submarine class and hull are classified.

The Convergence Zone Raypath

As the Sound Speed Profile outlines, sound generated below the Sonic Layer Depth (and any sound generated above it that penetrates below) will initially bend downward as Temperature is the largest near-surface impact to sound velocity. As Temperature cools and the water depth increases, pressure begins to take over and will eventually bend that sound wave back up toward the surface. This takes place over the course of many miles and requires both significant water depth and initial signal strength/source level in order for there to be sufficient detectable sound signal remaining when it returns to the near surface environment.

Due to variances in the waveform and the effects of Pressure, Temperature, Salinity and other influences, this sound won't re-converge in a single spot, rather over an annulus of a few miles of varying sound intensity. This annulus is referred to as the convergence zone. Tactics for exploiting this sound have evolved in both the submarine and maritime air communities. As a general rule, modern submarines do not generate a high enough source level to provide sound in the convergence zone detectable by today's air-launched sonobuoys. Nonetheless, the raypath may still be exploitable by ship/submarine passive towed array sonars or by air-launched mono/multi-static active sonobuoys.

Passive Acoustic Detection

The Sound Velocity Profile discussion above served to highlight the importance of understanding the propagation pattern of sound as it travels through the water. This, when assessed against the likely location of the target submarine, is used to determine the depth that passive receiver sonobuoys are employed in order to maximize the opportunity for detection of submarine generated noise. This best receiver depth is largely independent of the submarine, and is most impacted by the properties of the water itself. However, when determining how far apart to space the receivers, analysis of the sound generated by that class of submarine is critical.

Chapter 2 identified that each class of submarine generates sound at different frequencies and different sound intensity levels based on the design of that submarine and to some extent to the speed at which the submarine is operating. When planning pre-mission buoy spacing or even when conducting a study of the adversary submarine against the ocean environment, each frequency and source level needs to be assessed to determine the most readily identifiable and longest range frequency for tracking. This assessment is done using the Passive Sonar Equation and Prorogation Loss Curves, or other software decision aids with these two principles incorporated.

The Passive Sonar Equation

$$SE = SL - AN - PL + DI$$

SE = Signal Excess (dB). The amount of leftover noise when all other factors are considered. If this number is above zero, sufficient sound exists at that frequency to be detectable by ASW passive sonar systems.

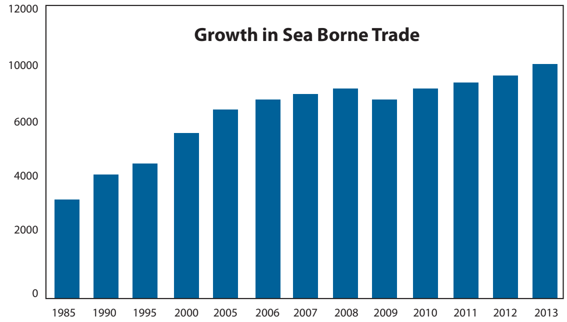

Figure 44 – In Recent Decades, Seaborne Trade has Increased by 4% per Year (with the Exception of the Global Recession in 2009). Source: 'How we fight' – Handbook for the Naval Warfighter.

SL = Source Level (dB). The amount of noise generates by the submarine at a given frequency.

AN/BN (dB) – the Ambient or Background Noise in the ocean observed at a given frequency. Factors which increase AN include merchant shipping, biologic, seabed drilling activity, wind/rain/sea noise, and aircraft noise or other sources not related to the submarine.

PL – Propagation Loss or Transmission Loss (dB) is the amount of noise lost as a function of distance measured one meter from the source to the receiver. PL/TL will vary by frequency; higher frequencies experience more rapid loss due to propagation and attenuation.

DI (dB) – Directivity Index: The amount of 'gain' you can apply to the detection probability based on the sensitivity of the acoustic detection system in use, the skill (or fatigue) of the acoustic detection system operator, and whether the system is used in Directional or non-directional (360 degrees) search mode. Some of the newer MPA systems allow planners to use as much as 10dB gain at this point; however, it is not uncommon to leave DI as zero in the planning stages to account for on station performance reduction due to fatigue and offset any lack of operator proficiency or ASW currency.[6]

Of the elements in the Passive Sonar equation, two components stand out which separate today's ASW challenge from operations in the Cold War.

First, Ambient Noise at most of the initial detection frequencies has risen. There is more merchant traffic and more seabed exploration and drilling than ever before; the ocean is getting louder by the day. Lower frequencies travel further in water. Therefore, the frequencies most suitable for initial submarine detection are in the lower frequency spectrum. However, in this same spectrum, the noise by merchant shipping and other non-submarine noises has dramatically risen. For every dB increase in AN, there is a direct corresponding decrease in dB to the excess signal available for detection at that frequency.

The Passive Sonar equation is frequently re-written and reflected in terms of FOM (Figure of Merit). This is the maximum amount of one-way PL (source to receiver) an SL can experience and still retain sufficient signal strength to be detected by the sensor (i.e., remain above the AN threshold). Further information regarding the capabilities of passive detection systems installed on NATO MPA and ASW Helicopters is included later in this Appendix.

Secondly, and perhaps most notably, the design of modern submarines have reduced SL to the point where SE may be a negative number when using the passive sonar equation. This means submarines today may be so quiet that the background ocean noise is louder than the source the ASW force is attempting to detect.

Sound Pressure Level

Submarine source levels are measured in decibels which exert sound pressure upon the passive receiver. As discussed earlier, the submarine generates noise (sound pressure) at a given frequency, dependent upon each piece of machinery. A decibel is a unit used to measure the intensity of the sound level of a signal by comparing it with a given level on a logarithmic (non-linear) scale. A 3db change is a doubling of sound intensity whereas a change of 10 db is a change in sound intensity by a factor of ten.[7] Therefore, the 636 Kilo class (SSK) with an acoustic signature of 105 decibels is 10 times as loud as the 95 decibel acoustic signature of a more advanced NATO SSN.[8]

The key takeaway is that as improvements in submarine design are achieved, reducing the SPL generated at each frequency, for a given 10db drop due to improvements in design, there is a corresponding 'significant' decrease in the passive detection ranges using the propagation loss curves discussed above. This is the crux of the issue and the true challenge with passive detection today.

Today's Challenge with Traditional Passive Detection

In the 1970s-80s, it was not uncommon to measure submarine passive detection ranges in miles. MPA crews across NATO learned to exploit initial detection in the first or second convergence zone (a point where sound, which retains enough Signal Excess to overcome long distance propagation loss, converges in small zones at increments of 30–32 miles from the sound source). Tactics were employed to convert this CZ initial detection to direct path contact and leverage the fact submarines generated sufficient sound levels to support these tactics.

Figure 45 highlights the traditional raypaths for passive detection. Of note, the Propagation loss Curves at the top utilize a Figure of Merit of 85dB which provides acoustic detection opportunity even out to the second CZ. This is where the Cold War methods of submarine detection begin to falter in today's ocean environment. The following three changes to modern submarines are impacting current and future passive acoustic detection techniques.

1. Whereas the example in Figure 44 yielded a detection range of almost 18,000 yards (9nm), it is unrealistic for today's modern submarines to yield that type of range. More realistically, modern submarines, both nuclear and diesel, provide passive detection ranges better characterized as hundreds of yards instead of multiple miles. Non-NATO submarines have grown increasingly quiet with each subsequent class fielded. Technology to address propulsion plant and propeller generated noises have been implemented, and anechoic hull coatings to both reduce noise and mitigate active sonar detection have been fielded.

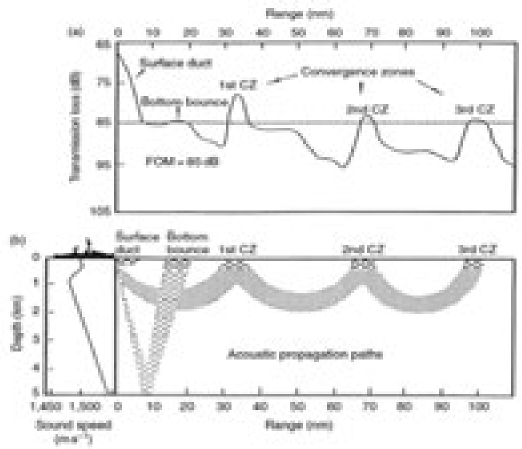

Figure 45 – Hypothetical Relationship Between (a) TL Curve and (b) the Corresponding Propagation Paths and Detection Zones (Cross-Hatched Areas near the Sea Surface) Associated with a FOM of 85 dB. A Plausible Sound-Speed Profile is shown at the Left Side of Panel (b). Source: 'Underwater Acoustic Modeling and Simulation' 3rd ed, pg. 62.

2. With the increase in submarines operating more in the littorals, the water column does not have sufficient depth to support the regeneration of sound energy into a convergence zone.
3. Many nations have upgraded both the processing capability and display functions of their onboard acoustic processor. This was done in an effort to maximize the crews ability to employ passive sonar. Color displays have been part of many MPA and MPH upgrades, not just to provide a change to the old green on black gram display, but to permit color display by sector of noise received by the wafer (microphone) in the DIFAR buoys receiver. This permits the operator to filter noise not related to the submarine out from their display but which may be occurring at the same frequency level (i.e. nearby shipping) and obscuring the actual submarine noise. This upgraded capability is captured in the passive sonar equation in the DI variable. It still reaches a point of diminishing returns as it does not generate enough of a counter to the decrease in Source Level and remaining Signal

Excess generated by modern and future submarine designs.

'Over the last half century, as cargo shipping and deep sea oil exploration has increased, background noise in the ocean has doubled roughly every decade.'[9]

Furthermore, the ambient, or background, noise in the ocean has been notable increasing over the last few decades. This has a dramatic impact on the ability to exploit submarine generated noise against the background noise, and as quieting technology improves, eventually a point of diminishing return will be reached.

Sound Pressure Level

Submarine source levels are measured in decibels which exert sound pressure upon the passive receiver. As discussed earlier, the submarine generates noise (sound pressure) at a given frequency dependent upon each piece of machinery. A decibel is a unit used to measure the intensity of the sound level of a signal by comparing it with a given level on a logarithmic (non-linear) scale. A 3db change is a doubling of sound intensity whereas a change of 10db is a change in sound intensity by a factor of ten. Therefore, the 636 Kilo class (SSK) with an acoustic signature of 105 decibels is ten times as loud as the 95 decibel acoustic signature of a more advanced NATO SSN.

The key takeaway is that as improvements in submarine design are achieved, reducing the SPL generated at each frequency, for a given 10db drop due to improvements in design, there is a corresponding 'significant' decrease in the passive detection ranges using the propagation loss curves discussed above. This is the crux of the issue and the true challenge with passive detection today.

Active Acoustic Prosecution

In addition to passive detection of submarine generated noise, MPA and ASW helicopters can employ active sonobuoys. However, unlike surface ships and friendly submarines' hull-mounted active sonar systems, the air launched active sonobuoys do not provide sufficient source level to serve as an efficient 'search' technique. They are, therefore, predominantly reserved for use in the Localization, Tracking and Engagement phases of prosecution. This is the Active Sonar Equation:

$$EL = SL - 2TL + TS - (NL\text{-}DI)/DT$$

EL (dB)= Energy level of the Active Return available to the sonobuoy.

SL (dB) = Source Level of the Active Ping

2TL1 (dB) = Transmission Loss from Source Buoy and returning along the same raypath to the receiver in the active buoy (therefore TL is doubled).

TS (dB) = Target Strength, the reflectivity of the submarine to provide a return. This is a function of the construction of the submarine to include the type of hull material used, the size of the submarine, and effectiveness of any anechoic coating/tiles.[10]

In addition to the decrease in noise generated by smaller, modern submarine classes, another challenge presented to Maritime Air ASW forces by smaller submarines, namely SS/SSK, in the use of active sonar is their size, which has a direct correlation to the amount of the active signal return. The smaller the submarine, the less sound is reflected back. This smaller signal is then subject to the same propagation losses and attenuation that affects other sound in the water. Submarine coatings have also become more efficient at dampening the active signal as a counter-detection technique. Finally, the operating environment for the submarine also has an impact on the use of active sonobuoys.

Chapter 2 described the submarine missions based on class and propulsion type. As discussed there, it is more common for a diesel-electric submarine to work in the littorals than a nuclear power one. Therefore, SSKs are better able to make use of the bottom topography, pinnacles, walls and even excess signal reverberation noted in shallow water to mitigate detection by active sonobuoys.

These issues are not new to the ASW domain and will continue to be a planning factor for all aircrew conducting an ASW prosecution. Improved acoustic processors aboard MPA, MPH and ASW capable ships have, to some extent, countered technology improvements as they are better able to filter out ambient noise from passive systems and non-target active returns. However, the constant battle and slowly closing the gap between quieting technology and subsequent limitations of traditional active and passive sensors has resulted in exploration into other methods of target detection.

Monostatics

In the late 1990s, some nations explored the potential of large area active search using a source buoy providing a much larger initial source level than traditional DICASS. The SSQ-110 and SSQ-110A Extended Echo Ranging (EER) sonobuoys contained a small explosive charge constructed as a rapidly burning fuse. This would provide broadband incoherent noise at a high signal strength. Initially, it was used in conjunction with the SSQ-77 Vertical Line Array DIFAR (VLAD) buoy to exploit the Convergence Zone raypath as outlined above. The equation used in EER/IEER operations is similar to the Active Sonar Equation discussed above but takes into account that the receiver and source buoys may not be co-located. Therefore, the active signal (EER source) will travel along two different paths from the source buoy, first to the target and then to a receiver, experiencing two different amounts of transmission loss (TL) along the way.

$$\mathbf{EL = SL - TL1 - TL2 + TS}$$

EL (dB) = Energy level of the Echo returning to the receiver.

TL1 / TL2 (dB) = Transmission Loss from Source Buoy to Target (TL1) then Target to Receiver Buoy (TL2), since they aren't necessarily collated.

TS (dB) = Target Strength, the reflectivity of the submarine to provide an echo of the incoherent sound signal generated by the EER sonobuoy.[11]

EER is no longer utilized, as two primary challenges were insurmountable. First, the system was designed to exploit the convergence zone with an active source. The signal return was maximized when impacting the submarine's beam. Beginning even slightly off-axis, the signal strength of the return signal dropped off significantly to the point of being undetectable against background noise. This implied that a rather good initial datum was known in order to place the source buoys at the correct distance from the submarine, and the receiver buoys oriented to receive a beam on reflection. Second, EER was significantly challenged in a bottom reverberation-limited environment such as in shallow water. Advances into Improved EER (IEER) were explored using a new receiver buoy but have mostly been abandoned due to the emergence of multi-statics.

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APPENDIX C

Maritime Patrol Aircraft and Helicopters

P3C Orion

NATO Countries Canada, Germany, Greece, Norway, Portugal, Spain, United States of America **Non-NATO Countries** Australia, Brazil, Chile, Iran, Japan, New Zealand, Pakistan, Republic of Korea, Singapore, Taiwan, Thailand	

General Aircraft Data

Crew composition	Wingspan	Length	Max Speed	Transit Speed	Loiter Speed	Endurance	Range with 3 hours Onstation
11	30.38 m 99 ft 8 in	35.61 m 116 ft 10 in	405 kts	328 kts	206 kts	12 hr 20 min	1.346 nm

Aircraft Systems	Payload
Radar APS 115 / APS 137 **EO / IR System** FLIR, AIMS or Star Saphire (varies by country) **ESM** ALR-66 (series) **Accoustic Suite** USQ-78 (series) most common (varies by country) **Datalinks / FMV** Link 11, some Link 16 depending on model	**Weapons** 6 Bombay stations (NTE 4800 lbs total) for Mk 46/50/54 Torpedo and various mines/bombs 10 Wing stations for mines/bombs, 6 AGM-84 Harpoon or mix of 4 AGM-56F Maverick/AGM-84K SLAM-ER **Sonobuoys** 84 external, 48 internal 3 internal pneumatic single launchers
Equipment and sensors may vary from the baseline P-3 depending on the operating country and level of system upgrades which have occured.	

Other Information

BMUP Block Modification upgrade to U-II models to bring them to near P-3C U-III level. Added Link-16 and included upgrades to the Mk50 torpedo and Harpoon anti-ship missile, improved data processing, high-resulution colour displys, an AN/USQ-78B accoustic system complete with improved acoustic receiver and data recorder, and AN/ALR66-B ESM.

AIP ISR Variant of the P-3C which added imaging radar (APS-137), EO capability and improved communications. Added IR weapons capability (Maverick, SLAM-ER). The AIP P-3 poved its value tracking time-sensitive targets over land during Operations 'Iraqi Freedom' and 'Enduring Freedom'. Subsequently, Lockheed Martin installed a new real-time-air-to-ground transmission system, the tactical Common Data Link (TCDL), in 24 AIP P-3CP-3C update IIIs. Altough initially intended for the update III P-3Cs, AIP was later applied to five low-hour Update II.5 P-3C airframes. The latest additions to AIP aircraft include Link 16 and IMNARSAT (commercial International Maritime Satellite) connectivity, identified by a new antenna on the upper fuselage just aft of the cockpit. NATO Nations operating the P-3C Orion have included various national upgrades (CIP, CUP etc...) which incorporate many similar design features to the AIP model. This includes CAN, ESP, GER, GRC, NOR and POR.

ARTR/APTR The Acoustuc Receiver Technology Refresh (ARTR) enhanced the Orion's ability to receive and 1 sonobouy data. The upgrade is a part of a program that is intended to bridge the gap in a technology between the P-3C and the P-8A. A subsequent Acoustic Processor Technology Refresh (APTR) ugrade enables the P-3C and its replacement to operate a similar set of acoustic software. It establishes a common, but not identical, configuration of processors, recorders and receivers between the two aircraft. The US Navy also plans to equip the Orion with a nw computer system that will provide for broader network capabilities to support the anti-submarine warfare mission. Known as C4 for ASW (Command, Control, Communications and Computers for Anti-Submarine Warfare), the system includes Link 16, which provides enhanced situiational awareness and interoperability with surface fleet, other military services, allied forces and an international maritime satellite (INMARSAT), which provides encrypted broadband services for the fleet. Aircraft with the AMT-50 Inmarsat antenna are indentified by bulge above the cockpit.

Breguet Atlantique II

Countries
France

General Aircraft Data

Crew composition	Wingspan	Length	Max Speed	Transit Speed	Ceiling	Endurance	Range
10-22	37.46 m 122 ft 10 $^{3}/_{4}$ in	31.71 m 104 ft 0.5 in	350 kts	310 kts	30.000 ft	18 hours	4.900 nm

Aircraft Systems

Radar
Thales Iguana

EO / IR System
SAT/TRT Tango FLIR

ESM
Thales Arar 13A

Datalinks / FMV
Link 11

Payload

Weapons
8 Mk-46/50/54 torpedoes

NATO series of bombs

Up to 4 missiles (surface or air)

Sonobuoys
More than 120 sonobuoy capacity

Internal pneumatic launcher

Other Information

The French Navy announced plans to upgrade its Atlantique 2s in a project designed to keep the ATL-II in service until 2030. A digital sonobouy acoustic processing system planned as well as mission system upgrades. Upgrades were reduced 2013 to 18 aircraft from the 22-aircraft fleet. Work is expected to include structual refurbishment in order to extend service of life to around 2031. The Thales AMASCOS system is planned as the main mission system. LOTI (Logiciel Opérationnel de Traitement de l'Information) mission software is now planned for subsystems integration for overall tactical picture and weapons employment. New Thales radar system planned, based on the RBE2-AA AESA radar.

Like other nations, France has pressed the maritime patrol Atlantiques into overland operations. Five aircraft were deployed in 2013 to Dakar, Senegal, in support of Operation Serval over Mali. These carried out overland ISR duties, and also dropped 500lb GBU-12 Paveway laser-guided bombs, but with use of buddy-designation by Harfang unmanned aerial vehicles.

P8 Poseidon
Countries Australia, India, United Kingdom, United States of America

General Aircraft Data						
Crew composition	**Wingspan**	**Length**	**Max Speed**	**Transit Speed**	**Loiter Speed**	**Range with 4 hours Onstation**
9	37.67 m 123 ft 7 in	39.47 m 129 ft 6 in	490 kts	490 kts	440 kts	2.222 km 1.380 miles

Aircraft Systems	Payload
Radar Raythoen AN/APY-10 **EO / IR System** L-3 Wescam MX-20HD **ESM** Northrop Grumman AN/ALQ-240(V)1 **Datalinks / FMV** Link 11, 16. FMV capeable	**Weapons** Weapons bay: 5 stations up to 658 kg (1.450 lb) for MK-46/50/54 torpedoes, bombs, mines 4 additional wing hardpoints (1.361 kg (3.000 lb) and 658 kg (1.450 lb)) for Harpoon missiles, bombs and mines **Sonobuoys** Three in-flight reloadable 10 round rotary sonobouy launchers, three additional ‚single-shot' internal launchers with total capacity of 126 sonobuoys
Also equipped with Terma AN/ALG-123(V) with DIRCM counter-missiles system. Magnetic Anomaly Detection (MAD) capability is not installed in the US or UK variants.	

CASA CN235

Countries
Ireland, Spain, Turkey

General Aircraft Data

Crew composition	Wingspan	Length	Max Speed	Transit Speed	Loiter Speed	Ceiling	Range
	25.81 m 84 ft 8,15 in	21.40 m 70 ft 2,5 in		245 kts		30.000 ft	2.732 miles 985 nm w/5.000 kg payload

Aircraft Systems

Radar
Thales Ocean Master

EO / IR System
AN/AAQ-21 Safire or BEA Systems MRT

ESM
Litton AN/ALR-93(V)4

Payload

Weapons
unarmed

Other Information

Maritime patrol and surveillance versions. In service with Spain (five, three Security Agency, two for Guardia Civil, of which only one delivered to date) and Turkey for Maritime (nine: six for Navy, three for Coast Guard, assembled by TAI at Ankara). In mid-1999, Turkey sought proposals from at least even potential integrators of surveillance systems to provide radar, FLIR and an acoustics suite for naval CN235s; on 6 September 2002, contract valued at USD 350 million signed with Thales covering supply and integration of AMASCOS (Airborne Maritime Situation and Control System) ,ission equipment. First flight of first modiefied aircraft (TCSG-551 of Coast Guard) took place on 18 June 2007; first flight of of modified Navy aircraft (TCB-651) on 13 November 2008; all three Coast Guard and six Navy aircraft beeing upgraded to Meltem II standard by Thales, which will install similar equipment on 10 Turkish Navy ATR 72-500ATR 72-500 MPA aircraft in Meltem III project. First delivery, to Coast Guard, on 28 Jauary 2013. Both aircraft of Irish Corps upgraded in 2007-08, including istallation of new radar and FLIR sensors as well as tactical dara management system, all forming part of Airbus Military FITS (Fully Integrated Tactical System) mission equipment.

The CASA 295 is a stretched version of the CASA 265 and may be ASW modified (CN295 Persuader).

M-28 Bryza

Countries
Poland

General Aircraft Data

Crew composition	Wingspan	Length	Max Speed	Ceiling	Range with 3 hours Onstation
6	22.065 m 72 ft 4.75 in	13.10 m 42 ft 11.75 in	189 kts	19.700 ft	809 nm

Aircraft Systems

Radar
ARS-800 X-band synthetic aperture radar

EO / IR System
FLIR

Accoustic Suite
National bouy RF Processing

Datalinks / FMV
National Datalink
MAG-10 MAD system

Payload

Weapons
Hand deployed bomb capability

Sonobuoys
inernally launched

Other Information

Poland has one ASW variant, the other Bryza in the Polish inventory are more traditional Maritime Surveillance. The ASW variant ist reconfigured for special missions such as detection of objects on sea surface; lead-in and call-in search and rescue; maritime patrol and submarine detection. Installed equipment to meet these objetives includes ventral ARS-800-X-band synthetic aperture radar coupled with FLIR system; MAG-10 magnetic anomaly detector; radio-bouy airdrop system with data receiving and precessing system; and national datalink system. To optimise radar performance, the main landing gear has been modified to retract into the fuselage.

ATR72

Countries
Italy (Maritime Surveillance version only), Turkey (ASW Variant)

General Aircraft Data

Crew composition	Wingspan	Length	Max Speed	Transit Speed	Ceiling	Endurance	Range
6-10	27.05 m 88 ft 9 in	27.17 m 89 ft 2 in	4275 kts	248 kts	82.000 ft	11 hr	6.5 hours Onstation at 200 nm range from base

Aircraft Systems	Payload
Radar AESA SELEX Galileo Sea Spray 7000E **EO / IR System** Star Saphire **Datalinks / FMV** Link 11, Link 16 Laser and missile Warning system, Chaff/Flares	**Weapons** 4 hardpoints Mk 46/54 torpedo

Other Information

The ATR 72 ASW (Anti-Submarine Warfare) is a multi-role, special mission aircraft based on the ATR 72-600 modern regional turboprop aircraft from Alenia Aermacchi. The aircraft is designed to perform anti-submarine and anti-surface warfare (ASuW) missions. It can also be deployed in maritime patrol, search and identification of submarines and search and rescue (SAR) operations. Reconfiguration of the aircraft can take place to perform missions such as protection of territorial waters, anti-piracy, anti-smuggling, monitoring and intervening of environmental disasters. It can also be used to protect the sea and coastline. The ATR 72 ASW has been selected by The Turkish Navy for maritime patrol and personnel / cargo transportation. The Italian Navy meanwhile has acquired four ATR 72 MP variants of the aircraft offering maritime patrol capabilities, along with future provisions for the ASW capabilities.

The ATR 72 MP serves as a low-cost, consistent, sea-surface surveillance platform for the military forces across the world. The aircraft helps to detect, locate and rescue people from broken ships and aircraft. It offers cost-effective surveillance and exclusive economic zone patrol and search-and-rescue (SAR). The side-looking airborne radar (SLAR) installed on the aircraft helps to detect water pollution from long range and trace underwater activities close to the sea surface. The Hyper Spectral Scanner (HSS) of the aircraft helps to find the type of polluting agent.

MH-60R

NATO Countries
Denmark, United States of America
Non-NATO Countries
Australia, Japan

General Aircraft Data

Crew composition	Main Rotor Diameter	Length	Max Speed	Ceiling	Endurance
3	16.4 m 53 ft 8 in	19.8 m 64 ft 10 in	144 kts	14.847 ft	1.6 hour onstation with 50 nm radius Nominal 2.7 hours configured for ASW

Aircraft Systems

Radar
AN/APS-153 Multi-Mode Radar

EO / IR System
FLIR/NVG Capability

ESM
ESM with integrated avionics over a 1553 databus

Datalinks/FMV
Link 16, FMV video stream to CDL/CV-TSC equipped units

Payload

Weapons
MK-46/50/54 Torpedoes, Hellfire Missiles.
4 weapons mounting stations.
7.62 mm and 50 cal. guns

Sonobuoys
MH-60R has both the Airborne Low Frequncy Dipping Sonar (ALFS) and air launch sonobuoy capability

Other Information

The MH-60R Seahwak helicopters are a significant upgrade over the LAMPS Mk-III (SH-60B). Employing mix of sophisticated sensors, they are assuming the US Navy's primary anti-submarine and anti-surface warfare roles.The MH-60 is designed to operate from frigates, destroyers, cruisers and aircraft carriers. Its state-of-the-art mission system make it an integral part of the layered Task Force ASW defensive screen, and in a departure from the capabilities of previous models of helicopters, can now be used in the search role, rather than being restricted primarily to detect and engage.

Equipment and sensors may vary depending on the operating country.

NH90 NFH (NATO Fregate Helo)

Countries
Belgium, France, Germany, Italy, Netherlands, Norway

General Aircraft Data

Crew composition	Main Rotor Diameter	Length	Max Speed	Cruising Speed	Ceiling	Endurance	Range
4	16.30 m 53 ft 5.75 in	19.54 m 64 ft 1.15 in	157 kts	132 kts	6.005 mt	3 hr 20 min	491 n miles

Aircraft Systems

Radar
European Navy Radar (ENR)
(EADS Defence Electronics/Thales/Selex Galileo)

EO / IR System
High focal-length tactical FLIR
EUROFLIR 410 sensor turret

ESM
Elettronica-ELT ALR-733 V(4)

Acoustic Suite
Alenia or Thales FLASH dipping sonar

Datalinks/FMV
Link 11

Payload

Weapons
2 torpedoes (Sting Ray, Mk46, MU90)
2 Air-to-Surface Missiles (Marte Mk2/S)
Machine guns
Chaff/Flares

Sonobuoys
Sonobuoys storage, launch and processing system

Other Information

Equipment and sensors may vary depending on the operating country and what level of system upgrades have occured.

EH101 Merlin

Countries
Italy, Uinted Kingdom

General Aircraft Data

Crew composition	Main Rotor Diameter	Length	Max Speed	Cruising Speed	Ceiling	Endurance
4–5	18.59 m 61 ft	22.8 m 74 ft 9.75 in	167 kts	150 kts	4.570 km	5 hr

Aircraft Systems

Radar
Selex Galileo Blue Kestrel 5000
Selex Galileo APS-784

EO / IR System
Selex Galileo GaliFLIR
BAE Systems MST-S

ESM
Racal Orange Reaper ESM
Alenia SL/ALR-735 ESM

Acoustic Suite
L-3 HELRAS low frequency dipping sonar
Thales AQS-950 ADS active dipping sonar

Datalinks/FMV
Link 11

Payload

Weapons
4 torpedoes (Sting Ray, Mk46, MU90)
2 Air-to-Surface Missiles (Marte Mk2/S)
Machine guns
Chaff/Flares
Mk11 Depth Charges

Sonobuoys
2 sonobuoys dispensers

Range
610 n miles (four tanks, offshore IFR equipped, with reserves)
750 n miles (five tanks, offshore IFR equipped, with reserves)

Other Information

Equipment and sensors may vary depending on the operating country and what level of system upgrades have occured.

APPENDIX D

Acronyms and Abbreviations

AEW	Airborne Early Warning
AMDC	Air and Missile Defence Commander (CWC structure)
AOR	Area of Responsibility
ASWC	Anti-Submarine Warfare Commander (CWC structure)
ASW	Anti-Submarine Warfare
ASUW	Anti-Surface Warfare
ATO	Air Tasking Order
CATOBAR	Catapult Assisted Take-off Barrier Arrested Recovery
CONOPS	Concept of Operations
CMAN	Commander Maritime Air NATO
CSN	Commander Submarines NATO
CTF	Commander, Task Force
CWC	Composite Warfare Commander
CVN	Nuclear Powered Aircraft Carrier
DD/DDG	Destroyer/Guided Missile Destroyer
DIFAR	Directional Frequency and Ranging (Passive) sonobuoy
DICASS	Directional Calibrated Sonobuoy System (Active) sonobuoy
ELINT	Electronic Intelligence
EXTAC	Experimental Tactics
GMTI	Ground Moving Target Integration (Radar)
IOC	Initial Operations Capability
ISAR	Inverse Synthetic Aperture Radar
ISR	Intelligence, Surveillance and Reconnaissance
IUSS	Integrated Undersea Surveillance System
JFACC	Joint Force Air Component Commander
JFMCC	Joint Force Maritime Component Commander
JISR	Joint Intelligence Surveillance and Reconnaissance
JOA	Joint Operations Area
LFAS	Low Frequency Active Sonar
MACA	Maritime Air Control Authority
MDR	Median Detection range
MOC	Maritime Operations Centre
MMA	Multi-Mission Aircraft
MMSC	Maritime Multi-Mission Support Centre
MPA	Maritime Patrol Aircraft
MPH	Maritime Patrol Helicopter (ASW capable)
MSA	Maritime Situational Awareness
RFI	Radio Frequency Interference

ROE	Rules of Engagement
SAR	Synthetic Aperture Radar
SIGINT	Signals Intelligence
SLBM	Submarine Launched Ballistic Missile
SLCM	Submarine Launched Cruise Missile
SOSUS	Sound Surveillance System
SSN	Nuclear Powered Submarine
SSBN	Nuclear Powered Ballistic Missile Submarine
SSGN	Nuclear Powered Guided Missile Submarine
SS/SSK	Diesel-Electric / Guided Missile Diesel Electric Submarine
STOVL	Short Take-Off Vertical Landing Aircraft Carrier (Amphibious Assault Ship)
SUCAP	Surface Combat Air Patrol
TACC	Tactical Air Control Centre
TASWC	Theatre ASW Commander
TSC	Tactical Support Centre
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
VLAD	Vertical Line Array DIFAR (Sonobuoy)

APPENDIX E

List of Figures

Joint Air Power Competence Centre
von-Seydlitz-Kaserne
Römerstraße 140 | 47546 Kalkar (Germany) | www.japcc.org