

Submarines and Naval Layered Defence in the First World War

A thesis submitted for the
Degree of Doctor of Philosophy

By

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Abstract

This dissertation provides an entirely new understanding of British submarine policy and Royal Navy submarine operations during the First World War. British submarines operating in the North Sea were an enabling technology that freed the different surface warship types to be used to achieve their full potential. The Admiralty was thus able to implement flexible layered defence systems that were developed and modified to meet the changing strategic demands. The immediate prewar commissioning of overseas type submarines capable of conducting an observational blockade off the German North Sea littoral relieved the dangerous need for surface warships to operate such a blockade. These submarines provided a solution to the “North Sea Problem” that had been causing such great concern to the Admiralty. This rather than secret and unwritten plans to defend Britain by so-called ‘flotilla defence’ drove British submarine policy. During the war, the Admiralty was very quick to identify new operational requirements and new submarines were designed and built to provide specialist capabilities. The infrastructure to support submarine operations was also established with fixed bases and mobile depot ships. Submarines were integrated with surface warships in mutually supporting layers. In addition to the observational roles, the fleet submarines were to accompany the Grand Fleet, and in a fleet action to manoeuvre to attack the High Seas Fleet on its disengaged side. Minelaying submarines penetrated deep into the Heligoland Bight to positions inaccessible to surface minelayers. In anti-U Boat warfare, submarines were positioned in layered patrol areas integrated with surface warships. Weapon systems and equipment were also developed rapidly that expanded submarine capabilities. Postwar layered defence systems continued to be enhanced with new naval technologies and new strategic requirements, and they are still relevant today.

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Acknowledgement

I owe a great deal to Professor Matthew Seligmann for his patience, guidance, and advice during the last six years. Sharing his knowledge of naval history, of naval archives and libraries has been vital to my progress. I also owe a great deal to Professor Matthew Hughes for his critical but always constructive comments and suggestions on my many drafts. As I am a non-historian both were very patient, and I am fortunate they permitted me to attend some of their student lectures. The academic staff of the Department of Politics and History have helped in their formal progress reviews. It is also important to acknowledge the support given by Brunel University London's administrative, library and computing support departments.

My research has been almost exclusively archival. My initial research was as a volunteer at The National Archives at Kew where I worked on a naval project with Bruno Pappalardo and my colleague Mac Mowat, to whom I am very grateful. The other volunteers I met working there also provided encouragement. The staff in The National Archives are always helpful delivering requested documents during countless visits. The Brass Foundry Woolwich part of the National Maritime Museum is very useful for obtaining technical information on British submarines and warships, with the guidance of Andrew Choong. The staffs of the British Library London, the Imperial War Museum London, the National Maritime Museum Caird Library Greenwich, the Churchill Archive Centre Cambridge, the Hydrographic Office Taunton, and the Naval Historical Branch Archive and Naval Library Portsmouth have also been very helpful, as are the staffs of the National Archives Washington DC, the Library of Congress, and the Australian National Archives. My research gave me reasons, or perhaps excuses, to attend naval history conferences in this country and in the United States. The lectures and presentations were always interesting, but more important was the opportunity to meet historians and be inspired by their enthusiasm.

I am grateful to friends Dr. Roy Fenton, Professor Hugh Murphy, and Dr. Ian Buxton for their advice about getting started and for their on-going support. My colleagues in the World Ship Society, particularly Maurice Napier, Robin Neale and Tom Eddy, have also given me their encouragement. My family has given me much encouragement, particularly my fellow amateur historian Maureen, and my good friend Gillian for checking on progress. Throughout my research I have received unlimited encouragement and support from my daughter Alison and her husband Daniel. I had discussed doing this with my late wife Helen, who was very supportive, so I pray she is happy with the result.

Introduction

This dissertation provides a new interpretation of British submarine policy before and during the First World War. In opposition to existing revisionist theories (discussed later), it will argue that between 1900 and 1914 the Admiralty reconceptualised how it would defend the British Isles, most especially in response to the challenge of a war with Germany. Over time, this led to the security of the British homeland being built up by distinct, though mutually reinforcing, defensive layers. This dissertation has identified that the Admiralty established different naval modules-of-force, with unique capabilities, and specific roles. Dependent on the defensive or offensive operations in which they were involved, they were assigned mutually supporting, often adjacent positions, hence the use of term “layered defence”. This dissertation reveals that as the war progressed, the Admiralty was quick to learn from experience, and modified the composition of the modules-of-force and their integration into layers to meet evolving defensive threats and offensive opportunities. The inherent flexibility in these enabled the Admiralty to apply their available naval forces to change quickly from a defensive disposition into an attacking offensive disposition. Further, this dissertation reveals that the system of modules-of-force and their integration in layers created naval way-of-warfare in which submarines constituted the key component. The resulting analysis of the Admiralty’s control of the naval operations requires that naval historians reconsider their interpretation of the First World War.

The creation of the modules-of-force and layered systems were made possible by rapid advances in warship design and the development of innovative and sophisticated naval technologies including new and better types of warships alongside enormous advancements in propulsion machinery, weapons systems, and communications equipment.¹ By far the most critical of these was the designing and building of viable ocean-going submarines capable of operating off the German North Sea coast and, while remaining there for extended periods, communicating with the naval authorities in Britain. Once these had been ordered – and even before they had come into service in numbers – the Admiralty consciously integrated the emerging, although unproven, submarine capabilities with its fleet of surface warships and with other technologically centred assets in order to evolve its layered system. As will be shown, this system then underpinned naval war plans from 1912 until the outbreak of war in 1914. As will further be shown, when war was declared on 4 August 1914, layered defence

¹ D K Brown, *The Grand Fleet, Warship Design and Development 1906-1922* (London: Chatham, 2003); O Parkes, *British Battleships* (London: Seeley, 1966); N. Friedman, *British Submarines in Two World Wars* (Barnsley: Seaforth, 2019); E.J. March, *British Destroyers* (London: Seeley, 1966).

was not only implemented from day-one, but it was enhanced and, in various iterations, employed throughout the war.

The layered system developed out of necessity. The Admiralty's traditional war plan, hallowed by centuries of practice, was predicated on an observational blockade of the enemy's coast. Light forces would be positioned close to the enemy main ports and harbours, from where they would be able to observe any attempt by enemy forces to sortie into open water. If this was undertaken, these light forces could give warning and so enable the main fleet to arrive and give battle to the enemy. As applied to Germany, this required a military blockade of the German North Sea coast, which would be maintained by destroyers and cruisers supported at a distance by heavier units. Such dispositions were included in the 1905 war plan and in all subsequent war plans up to and including 1911.² However, by early 1912 the Admiralty had come to realise that stronger German coastal defences alongside enhancements in torpedo and mine warfare techniques rendered it impossible to use surface warships to operate an inshore observational blockade off the German North Sea coast, as the warships would be vulnerable to surprise attack from superior German forces. The consequence of pursuing such a strategy would be the gradual attrition of the British blockading force to no discernible end. Unfortunately, withdrawing these forces to a safe distance was also problematic as it left open the question of how to obtain timely warning of any sorties by the whole High Seas Fleet or by raiding forces. This dilemma was referred to in the Admiralty as 'The North Sea Problem'.³ Although it was seemingly insoluble, the Admiralty definitely needed to find a solution. One proposal was for an 'intermediate blockade' in the North Sea to surround the Heligoland Bight. This would have required around fifty cruisers and, as the 1912 manoeuvres demonstrated, would also have been vulnerable to surprise attack by heavier German forces.⁴ Another proposal was to seize a German North Sea Island with a view to turning it into a secure local base for a blockading squadron.⁵ However, an amphibious assault on a defended German base was considered impractical by the army and too risky by many naval officers. However, if surface ships could not operate off the German coasts for the reasons given, the same constraints did not apply to submarines. All that was required were submarines of sufficient

² S T Grimes, *Strategy and War Planning in the British Navy 1887-1918* (Woodbridge: Boydell, 2012).

³ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics, and British War Planning 1880-1914* (Oxford: OUP, 2017).

⁴ D G Morgan-Owen, 'An 'Intermediate Blockade British North Sea Strategy, 1912-1914' *War in History*, 2015, Vol .22 (4), pp 478-502.

⁵ 'Seizure of Advanced Bases', Report by Rear Admiral L Bayly, 30 June 1913, Papers of Admiral A K Wilson, September 1914-April 1915, ADM 137/452, TNA.

range, power, and sea-keeping qualities to maintain a constant in-theatre patrol. Such submarines did not exist at the start of the twentieth century, but after over a decade of development they could be envisaged. This dissertation will confirm that by the outbreak of war in August 1914, the timely commissioning of overseas E Class submarines provided, and were intended to provide, a close observational blockade off the German North Sea naval bases. Although initially with insufficient numbers to provide contiguous observational patrols, they freed the surface warships from this dangerous task. These patrols were extended and developed throughout the war in the Heligoland Bight and beyond. This dissertation will concentrate on the role of submarines and argue that the deliberate and rapid enhancement of their capabilities empowered the surface warships and weapon systems to achieve their full potential within an integrated, layered system; thus, submarines were a force multiplier. This has not been examined previously and this dissertation fills this gap.

Naval Layered Defence

Implied above is the idea that layered defence was made possible by technological progress and, accordingly, this dissertation explicitly argues that from 1900 to 1914 the Admiralty consciously integrated the developing submarine capabilities with surface warships and other technologies to evolve progressively layered systems, and this underpinned naval war plans before 1914 and operations once war had begun. The evolution of layers depended upon several interlocking technological developments that had reached sufficient maturity in the pre-war era to enable them to combine into layered systems. Firstly, the period saw rapid developments in warship design.⁶ The creation of dreadnought-type battleship and battle cruisers was accompanied by many associated technological developments in gunnery, torpedoes, turbine machinery, aviation and, of course, submarines. The Admiralty encouraged such developments and allocated these new warships with a view to creating balanced, homogeneous modules-of-force within the layered scenarios. In addition, the period saw major improvements in long-distance communications technology. Telegraph cables had already linked shore establishments during the mid to late nineteenth century but had not made instantaneous ship to shore communications any more feasible. This, however, was achieved by the invention of wireless telegraphy, a technology in which Britain, the home of the Marconi company, was a leader and in which the Royal Navy, courtesy of Henry

⁶ D K Brown, *A Century of Naval Construction, The History of the Royal Corp of Naval Constructors* (London: Conway, 1983).

Jackson, a pioneer.⁷ As the range and effectiveness of wireless telegraphy increased, so it became possible for the Admiralty remotely to command, control and co-ordinate the diverse modules-of-force necessary for viable layered systems.

The Admiralty clearly understood that each layer would have different capabilities and clearly envisaged that the different layers would be combined together to meet specific defensive and even offensive requirements, for example to implement an economic blockade, to maintain sea control and to deal with the unrestricted U-Boat warfare. As a result, when the system was in place, each distinct layer mutually supported the other layers, and thereby all Admiralty assets were combined in the most efficient and effective manner. In effect, the strengths of each layer were applied to complement the strengths of the other layers. To illustrate this point, which is central to this dissertation, it is important to begin with details of the respective layers and how they worked together to constitute one integrated system. In the context of the crucial North Sea theatre, the inevitable central conflict zone in any Anglo-German war, there were five main layers assisted by several subsidiary layers.

The first element consisted of mine fields. Mines, both defensive and offensive, had been envisaged as playing a crucial role before the outbreak of war and once the fighting began they played a progressively greater part in British naval planning.⁸ As the war progressed and more reliable mines were developed and became available in large numbers, offensive minefields were laid in the Heligoland Bight and off the North German coast. Germany also laid defensive minefields and the whole area became very dangerous to all ships. British offensive minefields were intended to restrict severely the ability of the High Seas Fleet to operate in the Heligoland Bight for trials, exercises, and gunnery practice. The German navy had to allocate increasing resources to undertake extensive minesweeping operations to create and maintain mine-free routes to enable the High Seas Fleet and U-Boats to break out of the Heligoland Bight into the North Sea and beyond. A small number of British submarines were converted to enable them to lay mines. These were then used extensively to lay new minefields in the German mine-free routes, particularly in locations that were inaccessible to surface minelayers. This dissertation will identify that these submarine-laid minefields were a major element in naval warfare in the Heligoland Bight.

⁷ Vice Adm. Sir A Hezlet, *The Electron and Sea Power* (London: Davies, 1975).

⁸ R Dunley, *Britain and the Mine 1900-1915, Culture, Strategy, and International Law* (London: Palgrave, 2018).

Behind the mine fields, which were essentially a passive form of defence, came the overseas submarines. Submarines were classified initially in two main types, namely coastal and overseas. The overseas submarines, which are the significant theme of this dissertation, were capable of patrols off the German North Sea coast and in the Heligoland Bight and, as such, formed the first active layer in the overall layered defence architecture. As more were commissioned and the demands of the war progressed, they patrolled in many areas, undertaking operations in the North Sea, the Skagerrak, the Kattegat, off the Norwegian, Swedish, Danish, and Dutch coasts, and into the Atlantic off Ireland. The "Overseas" submarines were a major leap forward in submarine technology, in terms of both overall design and onboard machinery, equipment and weapon systems.⁹ The first were the D Class ordered in the 1906/07 Naval Estimates with D.1 commissioned in September 1909. As conceived, their role was to operate within the North Sea to attack German surface warships. The 1912 and 1913 Naval manoeuvres provided experience on the capabilities and limitations of submarines.¹⁰ It was recognised that compared to the German surface warships, the slow surface speed of the submarines necessitated them being pre-positioned to intercept them either off their North Sea bases or in transit typically returning from a coastal bombardment. Their submerged manoeuvrability was also very poor compared to surface warships. Their role was defined in a Report by the War Staff in 1913, where they were referred to as 'submersible blockaders'.¹¹ On the D Class submarines, two torpedo tubes were mounted in the bow to fire forward and one in the stern to fire aft. To maximise the probability of firing a torpedo, on the subsequent larger E Class submarines, further torpedo tubes were mounted to fire to port and starboard. The size of the early overseas submarines limited the number of tubes that could be mounted in the bow thus precluding firing a salvo. The commanding officer had to sight the target through the periscope and estimate its course and speed. The whole submarine had to be positioned and aligned to fire a torpedo on an intercepting trajectory. Firing had to be short range, ideally 500 yards, to maximise the probability of a hit. The hit and explosion of a single 18-inch diameter torpedo warhead was insufficient to sink a well armoured surface warship with efficient damage control, but the flooding damage and the concussion effect on the propulsion machinery and on-board equipment might slow the warship sufficiently and degrade its fighting efficiency to be caught by the chasing British fleet.

⁹ 'The Development of HM Submarines, From Holland No.1 (1901) to Porpoise' (1930)', A N Harrison. BR 3043.

¹⁰ 'Notes on the Use of Submarines, 1913 Manoeuvres', Drax 1-11, Churchill Archive Centre, Cambridge.

¹¹ 'Submarines. Report by Naval Staff on War Duties', 14 July 1913, ADM 1/8331, TNA.

The submarine command and control systems were primitive due mainly to their lack of adequate communication capabilities, particularly wireless telegraphy equipment, and probably mistrust in the competence of their relatively junior commanding officers. In pre-war exercises and in early wartime operations, command and control was often exercised by Captain (S) or a senior officer of each flotilla, located in a fast destroyer, accompanying the overseas submarines, scouting and endeavouring to place them in intercepting positions.¹² Wartime experience showed that this was ineffective, so overseas submarine began patrolling in planned locations and with clear orders for their objective. The importance of these overseas submarine operations as the outer layer of the layered defence system has not been recognised fully and constitutes the major topic and contribution of this dissertation.

The Harwich Force consisted of modern light cruisers and destroyers was established to carry out regular sweeps of the southern and central North Sea.¹³ Its principal role was reconnaissance to obtain visual contact and to report the composition, course and speed of any German surface warships leaving the Heligoland Bight. Such operations, it must be stressed, were often in collaboration with the Harwich-based overseas submarines. The surface warships also supported the Dover-based warships protecting the eastern approach to the English Channel, particularly against German destroyers based in nearby Zeebrugge. A further role was escorting merchant ships trading with the Netherlands. Groups of merchant ships sailed between the Thames and Rotterdam on a weekly basis and were subject to potential attack from the German Zeebrugge-based destroyers. Should a fleet action be imminent, the Harwich Force was available to work with the Grand Fleet.

Supporting this and of the most significance in terms of its offensive power was the Grand Fleet.¹⁴ The Grand Fleet operated initially from Scapa Flow and later from Rosyth to intercept the High Seas Fleet when it emerged into the North Sea. It was the final deterrent to a German military invasion or raid against the British east coast. The Grand Fleet consisted of squadrons of battleships, from 1915, exclusively of the dreadnought type. Armoured cruisers were employed to report on the position, course and speed of the High Seas Fleet. These were replaced progressively by light cruisers that also provided added protection against the German light cruisers and torpedo armed destroyers. There were squadrons of destroyers to

¹² Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes, Volume 1 The Narrow Seas to the Dardanelles 1910-1915* (London: Butterworth, 1954) p42.

¹³ A Temple Paterson, *Tyrwhitt of the Harwich Force* (London: MacDonald, 1973).

¹⁴ C M Buckley, 'Forging the Shaft of the Spear of Victory, The Creation and Evolution of the Home Fleet in the Pre-war Era 1900-1914', PhD Thesis (University of Salford, 2013).

launch torpedoes against the German warships and to provide protection against U-Boats. There were also plans to integrate submarines with fleet operations, a topic that will be closely examined in a subsequent chapter.

Supporting the Grand Fleet was the Battle Cruiser Force, later renamed the Battle Cruiser Fleet, based at Rosyth.¹⁵ This unit was an element of the Grand Fleet. During a typical sortie, it would rendezvous with the Grand Fleet and be positioned ahead to find and report on the composition, position, course, and speed of German warships. The higher speed of the battle cruisers enabled them to be used also in more independent roles.

In addition to the five main layers, other modules-of-force of the layered defence were available and could be included in diverse operational scenarios.

Foremost were the coastal submarines and patrol forces.¹⁶ Many patrol warships such as torpedo boats and old destroyers were deployed to provide warning of any German warships approaching the British coasts. Coastal submarines were deployed in a few east coast ports to be used against any German invasion or military raid. Much had been expected of these pre-war, but experience during the early German raids showed that coastal submarines were ineffective. Later these coastal submarines were valuable in training officers and crews for the overseas submarines and against the increasing number of German U-Boats operating off the British coast.

There were also the pre-dreadnought battleships of the Third Battle Squadron. This squadron was based at the Nore from April 1916 to provide protection against a German raid against the southern part of the East Coast. It was available should the Germans attempt a surface raid of heavy ships into the English Channel, particularly against the transports and troop carriers supplying the army.

Also important was the Northern Patrol. Armed Merchant Cruisers patrolled the Shetlands-Norway gap to intercept German trade and raiders providing a distant economic blockade based upon contraband control.¹⁷ In the English Channel, neutral ships were also inspected to check if they were carrying contraband material destined for Germany. Following America's

¹⁵ R K Massie, *Castles of Steel, Britain, Germany and the Winning of the Great War at Sea* (London: Cape, 2004).

¹⁶ 'East Coast Patrol 1914', ADM 137/1001, TNA.

¹⁷ J D Grainger Ed., *The Maritime Blockade of Germany in the Great War: The Northern Patrol, 1914-1918* (Aldershot: NRS, 2003); Adm. Sir D de Chair *The Sea is Strong* (London: Herrap, 1962).

entry into the war and agreements with other neutral countries, by April 1917 these ceased to be necessary.

Further backing came from the Dover and Flanders Coast Operations. Light surface forces operated from Dover to protect the eastern entrance to the English Channel against raids by German light forces and prevent German submarines transiting the Dover Straits. Warships, particularly heavy gunned monitors, were used to bombard the German defences along the Flanders coast.¹⁸

As the war progressed, another vital element consisted of anti-U-Boat warships.¹⁹ Once Germany implemented unrestricted U-Boat warfare against British, Allied and neutral merchant ships, the Admiralty commissioned a very large number of specialist anti-U-Boat vessels. These vessels were fitted with progressive developments for U-Boat detection and anti-U-Boat weapons. British submarines were also deployed as a frontline force in anti-U-Boat operations.

Finally, there were aviation assets. The Royal Naval Air Service (RNAS) developed airships, seaplanes and wheeled aircraft. Their operations included anti-U-Boat patrols, attacking Zeppelins raiding Britain, ship-launched scouting and bombing Zeppelin bases.²⁰ The RNAS was responsible for the air defence of Britain until 1918 and its absorption into the Royal Air Force. By the end of the war, an operation was planned to launch torpedo-carrying aircraft from warships to attack the German High Seas Fleet in their Wilhelmshaven base.

Overlaying these was intelligence gained from intercepted wireless telegraphy messages. Wireless traffic analysis was developed to evaluate German intentions, for example an increase in transmissions from the German High Seas flagship, could forecast an imminent sortie.²¹ A major intelligence capability was the direction finding of intercepted wireless telegraphy messages that revealed the position of German warships, Zeppelins and U-Boats. Research for this dissertation examined the Admiralty's handling and use of this intelligence. During the first few months of the war, the Admiralty was fortunate in obtaining copies of the three major German naval signal books. A wireless telegraphy listening capability had been established, and intercepted German messages were telegraphed directly to the Admiralty, where a very secret decoding unit, manned largely by civilians, was established in Room 40.

¹⁸ Adm. Sir R Bacon, *The Dover Patrol 1915-1917* 2 volumes (London, 1919).

¹⁹ R H Gibson and M Prendergast, *The German Submarine War 1914-1918* (London: IWM, 2017).

²⁰ D Hobbs, *The Royal Navy's Air Service in the Great War* (Barnsley: Seaforth, 2017).

²¹ P Beesly, *Room 40 British Naval Intelligence 1914-1918* (London: Hamilton, 1982)

The decoded signals could provide the Admiralty with unique intelligence of the German Navy's activities and plans, and the wireless telegraph direction finding technology provided a good indication of the position of each transmission. Fear of the German navy discovering these, and changing their codes and wireless telegraphy practices, led to excessive secrecy within the Admiralty. A further problem was that senior Admiralty officers were prejudiced initially against the largely civilian staff of Room 40. Vice Admiral Oliver, the Chief of Staff during 1915, 1916 and 1917, received the decoded signals, decided their significance, and dictated signals and orders sent to the naval commands. This over centralization and excessive secrecy meant that other Admiralty departments did not receive valuable, timely intelligence and this led undoubtedly to opportunities being missed. In May 1917, Room 40 was integrated into the Naval Intelligence Division under the dynamic Rear Admiral Reginald Hall, enabling much better use of the intelligence obtained. Relevant intelligence was sent quickly to senior commanders and to Admiralty staff departments.

Thus, as can be seen, there were thus five main layers and subsidiary layers operating together as one system. The most crucial of the layers, however, was the overseas submarines.

The overseas submarines were the crucial layer in the layered systems because they allowed operations closer to the German coast than would otherwise have been possible. These submarines were always a serious threat to German forces in the Heligoland Bight.²² In addition, the six overseas submarines converted to minelayers greatly enhanced the Royal Navy's minelaying capability. Equally important they freed-up cruisers and destroyers that would otherwise have been needed for blockade and observational patrol duties. These cruisers and destroyers were then available to join the Grand Fleet and other surface forces. The cruisers provided vital scouting capabilities and protection against attack by the numerous German torpedo-armed destroyers within the High Seas Fleet. The destroyers provided escort capabilities against attacks by U-Boats and were available to deliver torpedo attacks against German heavy warships. In more modern terms, the submarines were an 'enabling technology' in addition to their capability to attack with torpedoes.

Layered Defence in the First World War

The first operational use of layered defence was the protection of the British Expeditionary Force in crossing the Channel to France in August 1914. British submarines were positioned

²² Adm. R Scheer, *Germany's High Sea Fleet in the World War* (London: Frontline, 2014).

in the southern corner of the North Sea together with layers of supporting destroyers and cruisers. Submarines positioned off the Dutch coast were to report sightings of German warships to warn the destroyers and cruisers positioned further south. Other submarines were positioned in the entrance to the Channel to torpedo German warships that had got so far south. In the event, Germany did not attempt to attack the transportation, but it showed the early implementation of a layered system integrating the capabilities of each type of warship.

The use of submarines in 1914 in a layered system was not restricted to the Channel. In October 1914 British submarines undertook their first reconnaissance into the Kattegat. They were able to observe and report on merchant ship traffic off the Danish, Norwegian and Swedish coasts. They also reported on merchant ship movements to and from the Baltic via The Sound, and the Lessor and Great Belts and check for the presence of German warships and U-Boats.²³ This assisted the planning of the subsequent entry of British submarines into the Baltic through The Sound. The Admiralty intended that these submarines operating within the Baltic would interdict merchant ships transporting ore and other contraband products from Sweden to Germany. Although they had some success, the Russian commanding Admiral retained the submarines within a layered defence with the Russian Fleet protecting the flank of their army and the approached to St. Petersburg.

Layers could also be used offensively. An early example of such a scenario was the first Battle of Heligoland Bight. A plan developed originally by Commodore (S) R. Keyes commanding the 8TH Submarine Flotilla containing all the available overseas submarines and Commodore (T) R. Tyrwhitt commanding the light cruisers and destroyer force, both based in Harwich.²⁴ Their plan was to operate off the German North Sea bases and entice their light cruisers out where they would be attacked by the British force. Admiral Jellicoe, Commander-in-Chief Grand Fleet added a force of battle cruisers and cruisers to be in support. Although approved by the Admiralty, poor staff work resulted in Keyes and Tyrwhitt not being informed of its presence which could have resulted in a blue-on-blue confrontation. Despite this the battle was an early example of layered system of submarines with light surface forces supported by heavy warships. Another 1914 example was the December seaplane raid on Zeppelin sheds near Cuxhaven. The Harwich-based force of light cruisers and destroyers escorted three carriers to be off the German North Sea coast from where the seaplanes were launched. A

²³ 'Commodore (S) War Records Volume 1 to 11', ADM 137/2067 to ADM 137/2077, TNA.

²⁴ Rear Adm. J Goldrick, *Before Jutland, The Naval War in Northern European Waters, August 1914-February 1915* (Annapolis: NIP, 2015).

force of overseas submarines was positioned closer to the coast from where they rescued seaplane crews who landed nearby. Later such seaplane and aircraft raids were planned with the primary objective of enticing the German High Seas Fleet to come out where they would be attacked by the supporting Grand Fleet.²⁵

At the start of the war, layered defence did not always operate as envisaged nor always function successfully. The 1914 German raids by fast battle cruisers against Yarmouth and Scarborough-Hartlepool were not stopped by a minefield, were not spotted by surface ships, and were unopposed by the few British coastal submarines detailed for this purpose. The problem was that for this to work these submarines would have had to be pre-located in exactly the right position and then hit a fast-moving target with a torpedo. That this was nigh impossible thus demonstrates the fallacy that coastal submarines could defend the British Isles as part of a 'flotilla defence', (to be discussed later). Should there have been a German military raid or invasion, such coastal submarines would have also faced the difficulty of getting into a firing position against transports or warships protected by German fast, proficient torpedo boat destroyers. Such an outcome was not a surprise: it had been forecast following the 1912 and 1913 fleet exercises.²⁶

However, despite these problems, layered systems did prove itself viable in 1914. Given the early successes of an outer submarine layer in the Heligoland and Cuxhaven operations it is unsurprising that the Commander-in-Chief of the Grand Fleet, Admiral Sir John Jellicoe, was desirous of having submarines that could operate with the fleet in any battle with their German adversary. This wish was heightened by the fact that on 15 May 1916, the Admiralty had received intelligence from a decoded signal, suggesting that "the Germans are developing their submarines tactically for fleet work".²⁷ This was later discovered to be erroneous, but it added to concerns. At the start of the war, British submarines were incapable of the speed necessary to keep up with the fleet, so plans were developed to rectify this. Initially the limited number of British overseas submarines were located at Harwich to facilitate observational patrols off the German North Sea coast. When sufficient submarines became available in late 1916, a submarine flotilla was based in Blyth under the direct command of the Commander-in-Chief. In anticipation of a fleet action, the slower submarines would be ordered to sail to a

²⁵ D. Hobbs, *The Royal Navy's Air Service in the Great War*.

²⁶ 'Reports, Naval Manoeuvres 1912', ADM 116/1169; 'Reports Manoeuvres 1913', ADM 116/1214, TNA.

²⁷ P Beesly, *Room 40, British Naval Intelligence 1914-18*.

rendezvous with the faster Grand Fleet coming from Scapa Flow.²⁸ Although this never occurred, throughout the war submarines on patrol had orders to divert to predetermined positions to work with the Grand Fleet. These positions were to create lines of submarines to intercept German warships prior to or after a battle. During the 1916 battle of Jutland, it was considered that the High Seas Fleet had escaped destruction by reversing course when engaged by the Grand Fleet. When available, the fast K Class submarines were therefore to be deployed in the van of the Grand Fleet with orders to get to the disengaged side of the enemy and launch mass torpedo attacks, some of which would hit their battleships. Following the engagement, they were to torpedo and sink any damaged ships endeavouring to return to Germany.²⁹ The theory was not so easy to put into practice as on the night of 31 January / 1 February 1918, a sortie of the Grand Fleet from Rosyth, in low visibility in the Firth of Forth, a series of accidents and mistakes resulted in multiple collisions with the sinking of two K Class submarines and a serious loss of life. Among other failings, operating submarines directly with the fleet required much better command and control systems than were available in that era. It should be noted that the concept was ahead of its time and today nuclear attack submarines are integrated routinely within naval task groups. Patrol submarines were ordered initially to attack emerging German warships and then to report their position, their course and speed. Later in the war it was assumed that should such an attack occur the High Seas Fleet would retreat to their bases thus precluding the opportunity for a decisive fleet battle. Submarines were ordered therefore that upon sighting a German sortie, they were to withdraw to a safe distance and report its position, its course and speed. Submarines were only to attack German warships returning to their bases.

Layered Defence and Anti-Submarine Warfare

Layered defence was not a static policy but evolved in relation to the threats posed by Germany. An important development was the German decision to use their own submarines against floating trade. Accordingly, this dissertation will also reveal and explain in the context of layered systems the largely ignored but extensive operations by British submarines against German unrestricted U-Boat warfare. U-Boat warfare against merchant ships trading with Britain reached a crisis in 1917 and threatened Britain's ability to remain in the war. Much has been written about the protracted implementation of escorted convoys and the development

²⁸ 'Secret Packs of the C-in-C Grand Fleet 1914-1918: 10TH Submarine Flotilla', ADM 137/1923; '11TH Submarine Flotilla', ADM 137/1924, TNA.

²⁹ 'Secret Packs of the C-in-C Grand Fleet 1914-1918, 12TH, 13TH & 14TH Submarine Flotillas', ADM 137/1925, TNA.

of submarine detection and anti-submarine weapons.³⁰ Little has been written about British submarine operations against German submarines. British submarines operated in an anti-U Boat role in the Heligoland Bight, North Sea, Kattegat and off the coasts of Scotland and Ireland. Intelligence information was used extensively to enable the interception of German U-Boats. Even if the German U Boats were not sunk, the presence of British submarines forced them to submerge during daylight prolonging their transit time thus reducing their time on station to operate against the merchant ships. Anti-U Boat operations were also carried out together with other weapons in a layered defence, for example in the Kattegat and Dover Straits the presence of British submarines forced the German U Boats to dive into deep laid minefields. The need for submarines with high underwater speed and the capability to fire a salvo of torpedoes was identified and resulted in the R Class. The less-than-successful, steam-powered K Class with their high surface speed, were reconfigured for an anti-U Boat role, and were to be armed with depth charges.

Research Methodology

This dissertation is based principally on archival research, the most important and most comprehensive source being The National Archives in Kew, the repository that holds the Admiralty, Air Ministry and Cabinet Office papers. Unfortunately, the official papers of government departments held at the National Archives are not complete. Prior to deposit a selection process, colloquially termed 'weeding', takes place. Theoretically, this involves the removal of routine and unimportant papers from the collection, thereby ensuring that the records on deposit only consist of important and historically valuable files. In practice, the process involved the destruction of numerous invaluable historical documents. Fortunately, it is sometimes possible to work around the loss of these official records by turning to other sources. For this research, the most useful documents came from the large collection of wartime reports, signals, minutes, correspondence, etc. in the ADM 137 series. These papers were collated by the official historians for the writing of *Naval Operations*, the official history. The ADM 116 series of document is useful for reports on pre-war naval manoeuvres, and reports by senior personnel, on the experiences of using submarines for the first time.³¹

The Caird Library, within the National Maritime Museum, holds private papers from some senior Naval officers who were in office before and during the war. Of particular use to this

³⁰ Seligmann M S, 'Sir Henry Newbolt, the Naval Staff, and the Writing of the Official History of the Origins and Inauguration of Convoy in 1917', *The Journal of Military History*, January 2023, Vol.87, pp 125-144.

³¹ 'Admiralty Historic Section ADM 137 series; 'Admiralty Record Office Cases ADM 116 series', TNA.

research are the papers of Admiral H.F. Oliver, Chief of Admiralty War Staff from November 1914 to May 1917, as he had first-hand insight into the war. His private papers include an unpublished autobiography. It also holds the papers of Admiral H.W. Richmond, Assistant Director of Naval Operations from April 1913 to May 1915, and later a naval historian and author. Richmond was an outspoken, controversial figure and his private papers include documents and reports he kept from his time in the Admiralty. Admiral Madden was Chief-of-Staff, and later Second-in-Command of the Grand Fleet. His diaries provide a day-to-day detailed records of operations and ship movements, including the operations of fleet submarines and patrol submarines under the direct command of the Grand Fleet. Their private correspondence includes numerous references to decisions and policies not detailed in the official records. Of particular use to this research are the papers of Eustace Henry William Tennyson d'Eyncourt, Director of Naval Construction during the war. These include technical details and drawings of submarine designs built and considered, and also memoranda and correspondences that provide insights into design decisions that are often missing from the submarines' Ships Covers.³²

The Brass Foundry in Woolwich, also part of the National Maritime Museum, holds technical information from the Director of Naval Construction's Department of the Admiralty. These include design drawings and Ship Covers that should contain the design history of each class.³³ The latter are disappointing as they often lack details of why particular design decisions were being made. This was due to the early classes being designed by Vickers, a commercial shipyard, and the pressure of wartime design work on the Royal Corp of Naval Constructors probably caused that all the relevant papers were not always put into the Ships Cover.

The Imperial War Museum archive contains the private papers of some of the personnel who served on board wartime submarines. Notable among these are the diaries of Lieutenant Commander C.P. Talbot who commanded E.6 on the first submarine patrols in the Heligoland Bight, and by 1918 had been promoted to command a submarine flotilla. In the 1930s Talbot was appointed Rear Admiral (S) in command of the submarine service.³⁴ Also, the papers of

³² Papers of: Admiral H F Oliver OLV; Admiral H W Richmond RIC; Admiral C. Madden MAD; E T d'Eyncourt DEV, Caird Library, NMM.

³³ Ships' Covers, SC, Brass Foundry, NMM.

³⁴ Papers of C P Talbot, Documents 20134, IWM.

Lieutenant Commander C. de Burgh who had extensive wartime experience in command of the patrol submarines D.7 and G.8, followed by the fleet submarines K.22 and K.16.³⁵

The British Library has the private papers of senior naval offices, and of particular value to this research, of Admiral J.R. Jellicoe, Commander-in-Chief Grand Fleet and First Sea Lord. In addition to correspondence there are drafts of his books. Admiral R. Keyes' papers are also of use as he was Commodore (S) from 1910 to February 1915 commanding submarine operations including the first Battle of the Heligoland Bight. In 1918 Keyes was Commander-in-Chief Dover and was active in improving the Dover Barrage and in the Zeebrugge and Ostend raids.³⁶

To better understand the narratives of submarine operations it is beneficial to refer to the charts that were available, particularly those for the Heligoland Bight with its difficult navigation problems. The Admiralty Hydrographic Office has an archive of charts including those used during the war.³⁷ Churchill Archive Centre within Churchill College Cambridge has private papers from senior naval officers, in particularly Admiral J. Fisher. Selected correspondence from Fisher and Churchill are also relevant to this research.³⁸

The National Archives in Washington DC has documents on the participation of United States Navy submarines operating in 1918 from the south of Ireland against German U Boats. There are also copies of British papers in the form of fortnightly reports on British and American submarine operations, copies of which often no longer exist in the UK.³⁹ The United States Library of Congress in Washington DC has the private papers of leading Americans. There are some, but not all from Admiral Sims, USN while he was in London in 1917 and 1918.⁴⁰

Other useful sources include the Annual Transactions of the Royal Institution of Naval Architects that contain technical papers on the designs of British submarines.⁴¹ The World Ship Society's library located within Chatham Historic Dockyard has many out-of-print naval books. These include academic and popular naval history books, autobiographies,

³⁵ Papers of C de Burgh, Documents 12165, IWM.

³⁶ Papers of Admiral J R Jellicoe, and Admiral R. Keyes MSS. 82373-82578, British Library

³⁷ Charts, Admiralty Hydrographic Department 1914, Hydrographic Office, Taunton.

³⁸ Papers of W.S. Churchill; Papers of Adm. J Fisher, Churchill Archive Centre, Cambridge.

³⁹ 'Submarine Service, Monthly Reports', RG38, and 'US Navy Submarines' RG38 & RG45, National Archives, Washington DC.

⁴⁰ Papers of Adm. Sims USN, Boxes 22, 23, 24 & 47 1917-1919, Library of Congress, Washington DC.

⁴¹ Annual Transactions, The Royal Institution of Naval Architects, London.

biographies, and reference books such as Janes.⁴² Admiralty documents and private papers were also available in the National Museum of the Royal Navy Library in Portsmouth which now also contains the archive previously held in the Submarine Museum archive. The Naval Historical Branch Archive and Library in Portsmouth have a collection of unique naval papers and books. Relevant information was obtained also from a range of journal articles, and technical literature.

Collectively, these sources enable a fresh examination of the role of submarines in British naval policy. To explain why this matters and how they make a contribution, it is necessary to look at the historiography of this period.

The Historiography of Naval Planning 1900-1914

British naval policy between 1900 and 1914 is a highly contested topic that has been the subject of considerable debate among naval historians. The destruction of numerous Admiralty documents, as explained above, explains some of these differences as different historians fill in the gaps in different ways. However, while this complicates the historiography, there is also considerable dispute about the interpretation of the surviving documents. Historians have diverged in their conclusions on naval policy and three historiographical groups have emerged. This section will outline these schools of thought and show where and how this study fits into, contradicts or adds to their interpretations. The three major groups can be classified as orthodox, revisionist and post-revisionist.⁴³ These schools will be examined in turn, taking them chronologically in terms of their evolution before turning to the place of this dissertation and its interpretation within this body of scholarship.

1 Orthodox Historians

In 1938 and again in 1956 the American historian Arthur J. Marder was given unique access to naval documents in the Admiralty Record Office which were then closed to other historians. While visiting Britain, he also met British naval officers, journalists and politicians who had participated in the events he was studying and was able to record their recollections and build them into his analysis. Marder's first major publication was a monograph on British naval policy covering the period 1880 to 1905.⁴⁴ He followed this up with a five-volume series covering the period 1900 to 1919.⁴⁵ These books were wide-ranging in their scope and

⁴² World Ship Society Library and Archive, Chatham Historic Dockyard.

⁴³ This typology comes from C M Bell, 'Contested Waters: The Royal Navy in the Fisher Era', *War in History*, 2015, Vol.25 (1), pp.115-126.

⁴⁴ A J Marder, *The Anatomy of British Sea Power* (London: Cass, 1972).

⁴⁵ A J Marder, *From the Dreadnought to Scapa Flow*, Five volumes (Barnsley: Seaforth, 2013).

coverage, but in the context of this dissertation certain key themes can be highlighted. In particular, Marder argued that by the early 1900s the British naval authorities had identified the growing danger from Germany, particularly its naval building programme, supplanting in both the popular and official minds the menace posed from France and Russia. A consequence of this German threat was the redistribution of the Royal Navy's ships from overseas to home waters, the scrapping of obsolete warships and the need to establish east coast bases in the United Kingdom. Marder described the designing and building of the Dreadnought-type battleships, followed by the development of battle cruisers to counter the fast German commerce raiders. Post 1918, there was a popular perception that the Admiralty in particular, and the Royal Navy in general, had been conservative to the point of being hidebound, had been slow to adopt innovative technologies and had been led by senior Admirals with little foresight or imagination. Marder fostered this view by portraying Admiral Sir John Fisher as 'Radical Jack', intellectually superior to his colleagues and driven to introduce sweeping reforms. He cemented this idea by referring to this period of naval history as one marked by a 'Fisher Revolution.' Fisher was an early enthusiast for submarines, and although Marder does not ignore submarines, he has surprisingly little to say about them in *From Dreadnought to Scapa Flow* even in the context of Fisher's revolutionary ideas.

Marder's work was much acclaimed when published and went unquestioned for many years. Some documents referenced by Marder in his research were destroyed ('weeded') by the Admiralty in 1958 onwards, prior to the transfer of the departmental papers to the Public Record Office, now the National Archives. In 1976 Paul Kennedy published a seminal book evaluating the Navy's influence and domination of British history.⁴⁶ His review of the events leading up to 1914 supported Marder's conclusions. Marder and Kennedy based their work firmly on the surviving documents and are now referred to as the orthodox history.

2 Revisionist Historians

In 1973, Ruddock Mackay published a biography of Fisher in which he referred to his strong faith in technology, his preference for armoured cruisers over battleships and his desire to combine their capabilities with those of battleships into one class of capital ship. Although neither strictly an orthodox history nor a complete challenge to Marder's views, his work provided a new perspective on Fisher.⁴⁷ This would act as a springboard for an emerging revisionist school. Starting in the 1980s some historians, most notably Jon T. Sumida,

⁴⁶ P Kennedy, *The Rise and Fall of British Naval Mastery* (London: Penguin, 2017).

⁴⁷ R Mackay, *Fisher of Kilverstone* (Oxford: Clarendon, 1973).

Nicholas Lambert, and Charles H. Fairbanks, claimed that by superior scholarship they had deduced theories that undermined the accepted, orthodox history. In 1989 Sumida published *In Defence of Naval Supremacy* in which he argued that Marder's analysis had been wrong and that Fisher's concept for the real role of battle cruisers had been misunderstood completely. Sumida further claimed that the battle cruisers Fisher desired were intended to operate worldwide, not against a German threat to the British Isles, but against French and Russian armoured cruisers sent to destroy British commerce in a *guerre de course*.⁴⁸ According to Sumida, Fisher did not want a fleet based upon battleships as suggested by Marder, but of high-speed, heavily armed battle cruisers fitted with a new fire control system that would allow them to shoot accurately at very long range and use their speed advantage to keep out of range of enemy warships.⁴⁹ Although Sumida provided little hard evidence to support his interpretation of Fisher's views, his work was well received and others built upon it. In 1991, Fairbanks published an article very critical of Marder and strongly supportive of Sumida. In this article, he asserted that battle cruisers, which Marder treated as an afterthought, were at the very heart of Fisher's plans, even more, in fact, than Sumida had suggested. As part of his argument Fairbanks condescendingly and inaccurately excused Marder for his alleged mistake in failing to recognize this because in the 1930s he 'did not have access to the primary documents and did not have the mathematical and technical knowledge to understand them.'⁵⁰ Following on from the work of Fairbanks and Sumida, Nicholas Lambert claimed that an additional element in Fisher's plans for the defence of Britain against invasion was by what he termed 'flotilla defence'.⁵¹ According to Lambert, swarms of flotilla craft, consisting of many torpedo-armed destroyers and, of major importance to this dissertation, submarines, rather than acting as coast defence vessels, would infest the North Sea making it impassable for capital ships, a form of mutual sea denial. Lambert's theory of flotilla defence based upon torpedo armed destroyers and submarines, when combined with the other revisionist theories, became an integral part of a comprehensive revisionist reassessment of the Fisher era. By relying entirely on destroyers and submarines for home defence, it was argued, it would be possible to free the battle cruisers and cruisers to be used

⁴⁸ J T Sumida, *In Defence of Naval Supremacy, Finance, Technology and British Naval Policy 1889-1914* (Annapolis: NIP, 1993).

⁴⁹ J T Sumida, 'Sir John Fisher and the Dreadnought: The Sources of Naval Mythology' *The Journal of Military History*, October 1995, Vol. 59, (4), pp 619-637.

⁵⁰ C H Fairbanks Jr., 'The Origins of the Dreadnought Revolution: A Historiographical Essay' *The International History Review*, May 1991, Vol. XIII *2), pp.246-272.

⁵¹ N A Lambert, 'Admiral Sir John Fisher and the Concept of Flotilla Defence 1904-1909' *The Journal of Military History*, October 1995, Vol.39, pp.639-660.

world-wide in defence of British trade and of the Empire. Echoing Sumida, Lambert claimed that Fisher considered flotilla defence so secret and so sensitive that he did not tell anyone of his real plans. Lambert further asserted that Fisher could not get this plan accepted because of opposition from a conservative Admiralty, and although he had convinced Churchill of the merit of these supposed plans, the start of the war in 1914 precluded their being implemented. As Lambert states: 'one major reason why [orthodox] historians have so misunderstood Fisher's aims and motivations is that for most of his administration he felt compelled to mislead the nation's political executive as to the true direction of naval policy.'⁵² Despite the certainty with which Lambert propounds his views, there are, in fact, no documents to support Lambert's claims, but Lambert gets round this by asserting that any such documents were deliberately destroyed at the end of the war. In effect, he claims that the absence of evidence is proof of his thesis. However, the logic of his argument was that in Fisher's schema submarines were intended principally for sea denial operations in the mid North Sea. To provide sufficient submarines for this purpose, Lambert argues that the Admiralty proposed to build submarines in place of two battleships authorised under the 1915 naval estimates, a process termed 'substitution'.

By the 1990s, Sumida and Nicholas Lambert claimed that Marder's entire conceptual framework was so flawed that it should be discarded and replaced by the one that they had constructed around their research and analysis. Attempting to overcome the lack of documentary evidence, the revisionists resorted to undermining Marder's reputation by referring to his 'antiquated historical technique' his 'methodological backwardness' and referring him as a 'scissors-and-paste' historian.⁵³ By comparison, the revisionists asserted that they were the first to master all the primary sources. N Lambert's wife, Katherine Epstein claims that their work 'offers an undeniably better-researched and more sophisticated alternative to Marder's interpretation.'⁵⁴ Christopher Martin was also influenced by the revisionist theories in his interpretation of Fisher's motives.⁵⁵

⁵² N A Lambert, *Sir John Fisher's Naval Revolution* (South Carolina: Columbia, 1999) pp10.

⁵³ J T Sumida, 'Demythologizing the Fisher Era: The Role of Change in Historical Method', *Militär-geschichtliche Zeitschrift*, 2000, pp 171-181 referenced in M S Seligmann 'A Great American Scholar of the Royal Navy. The disputed Legacy of Arthur Marder Revisited', *The International History Review*, 2016, Vol.38 (5), pp.1040-1054.

⁵⁴ K C Epstein, 'Scholarship and the Ship of State' *International Affairs*, March 2015, Vol.91 (2), pp319-331.

⁵⁵ C Martin, 'The Complexity of Strategy: "Jackie" Fisher and the Trouble with Submarines', *Journal of Military History*, April 2011, Vol.75, pp441-470.

3 Post-Revisionist Historians

Although these revisionist theories initially created serious interest, many historians have since cast doubt on their validity by re-examining the documents on which they are based and by re-assessing the underlying assumptions on which they are grounded. The revisionist theories have been questioned systematically by historians including Christopher Bell, John Brooks, Christopher M Buckey, Richard Dunley, Shawn Grimes, David Morgan-Owen, Stephen McLaughlin and Matthew Seligmann. These historians can collectively be referred to as the new 'post-revisionist' school. As will be explained below, each of them has undermined aspects of the revisionist argument.

Seligmann, for example, by focusing on threat perception in the British Naval Intelligence Department has shown that the German danger was recognised much earlier than claimed by the revisionists and it was this rather than an illusory Franco-Russian menace that determined British naval policy.⁵⁶ He further argues that several key policies of the Fisher Admiralty, for example the building of battle cruisers, was driven by the need to combat German capabilities, in the case of the battle cruiser, the danger posed by armed liners. Developing this, Morgan-Owen also highlights that the growing threat from Germany was seen clearly in the early 1900s and that battleships, not battle cruisers or flotilla craft, formed the core of the developing Home Fleet which contributed the main line of defence of the British Isles.⁵⁷ This view was shared also by Buckey.⁵⁸ John Brooks has challenged Sumida's views regarding the development of the Royal Navy's gunnery fire control system and its role both in ship design and broader questions of defence policy.⁵⁹ In Brooks' analysis the fire control system developed by civilian inventor, Arthur Hungerford Pollen, not only did not provide a basis for Fisher's enthusiasm for the battle cruiser, as Sumida claims, but in fact never actually worked. Bell has likewise questioned Sumida's assertions about battlecruisers, pointing out that when the decisions were being taken, the fire control system was in its infancy and it is highly unlikely that Fisher, or anyone else, would have risked Britain's national defence on under-armoured capital ships with an unproven fire control system that might or might not enable them to hit a target at

⁵⁶ M S Seligmann, 'Switching Horses: The Admiralty's Recognition of the Threat from Germany 1900-1905' *The International History Review*, June 2008, Vol.39, pp.239-258.

⁵⁷ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics, and British War Planning 1880-1914* (Oxford: OUP, 2017).

⁵⁸ C M Buckley, 'Forging the Shaft of the Spear of Victory, The Creation and Evolution of the Home Fleet in the Pre-war Era 1900-1914' PhD Thesis, (University of Salford, 2013).

⁵⁹ J Brooks, *Dreadnought Gunnery and the Battle of Jutland, The Question of Fire Control* (Oxford: OUP, 2005).

longer ranges than their opponents.⁶⁰ Bell also refutes the revisionist claim that Fisher had persuaded Churchill to adopt a naval revolution based on the radical ideas that they attribute to him.⁶¹ Bell concludes that '[b]y subjecting the revisionist argument to scrutiny, it demonstrates that Churchill did not embrace either flotilla defence or the "Battlecruiser Concept", the two central components of Fisher's supposed radical agenda' and that, in striking contrast, Marder's interpretation remains compatible with the documentary record. Bell's research is particularly effective in undermining Nicholas Lambert's theories regarding 'substitution'. In 1912/13 and again in 1913/14, in the discussion surrounding the annual naval estimates, Churchill considered ordering new submarines in place of two of the scheduled battleships. Lambert portrays this proposed 'substitution' as proof that Churchill had adopted Fisher's revolutionary 'flotilla defence' plan. However, Bell argues otherwise. He demonstrates conclusively that it was simply because Britain had achieved such a superiority over Germany in battleships that it was possible to focus on other warship types. As more submarines were needed urgently to operate a close observational blockade off the German naval bases, it was they that would have been built if fewer dreadnoughts were needed. The outbreak of war occurred before this substitution could be implemented, but Bell's analysis confirms beyond doubt both Churchill's and the Admiralty's recognition of the need to provide a better balanced force between the battle fleet and auxiliary forces such as submarines.⁶²

As can be seen from the above, the broad debate about British naval policy before 1914 is wide-ranging and does not focus exclusively or even principally on submarines. Marder and Kennedy both noted the development of submarines but with little detail as to how they were to be employed other than the early submarines were classified as 'coastal' and the later classes were capable of operating 'overseas'. Revisionists fixate on submarines, but only in relation to the supposedly revolutionary theories that are untenable and now largely discredited. Post-revisionist historians have re-evaluated the sources and confirmed that there is no evidence either for flotilla defence or the battle cruiser concept or any other revisionist theories, but they do not offer a comprehensive alternative explanation for submarine development. This dissertation will do so thereby plugging an important gap in the literature.

⁶⁰ C M Bell, 'Contested Waters'.

⁶¹ C M Bell, 'The Myth of a Naval Revolution by Proxy: Lord Fisher's Influence on Winston Churchill's Naval Policy 1911-1914' *The Journal of Strategic Studies*, 2015, Vol.38 (7), pp.1024-1044.

⁶² Ibid

It is important to this dissertation to re-examine role of Admiral Jackie Fisher and his impact on the modernization of the Royal Navy, particularly on submarines. Between 1904 and 1910 he implemented several major reforms in the redistribution of fleets, scrapping obsolete warships, establishing a common entry for officers, the design and building of new warship types, and creating a warship reserve system. As noted, the historian Arthur Marder created an image of Fisher as being much superior intellectually and more progressive than his colleagues, and this became the norm of the orthodox histories. This image was developed further by the revisionist historians who portrayed Fisher as being a vindictive autocrat who made all the important decisions. Fisher's unwilling to establishing a formal naval staff permitted such interpretations. However, Fisher secured the developments in warship design, technology, and Royal Navy organisation by appointing and working with talented, progressive officers within the Admiralty, in naval shore establishments and in the fleets. Fisher created committees to examine issues to decide what was feasible, and then a further committee to implement their proposals. There were many other progressive officers such as Admirals W H May, G A Callaghan and J R Jellicoe who commanded extensive naval manoeuvres testing new warship capabilities and technologies, and their experience became the core of naval strategy and tactics. Admirals P Scott progressed long range gunnery, F C Dreyer developed accurate gunnery control systems, and H B Jackson was responsible for major advances in wireless telegraphy. Particularly relevant to this dissertation, Admiral R H S Bacon progressed submarine designs, their capabilities, and developed their future roles. There were also progressive civilians working with the Admiralty, for example E T d'Eyncourt and his colleagues developed innovative and effective warship designs, including submarines, while W and E Froude experimented and developed efficient underwater hull shapes for optimum warship hydrodynamics. The naval historian Sir J Corbett assisted in establishing senior office training where strategic issues were studied, and their conclusions published. The Admiralty worked also with leading shipbuilders, academics, engineers, and scientists. Fisher commissioned successive committees for war planning against Germany, often including Captain G A Ballard, M A Hankey, and Sir J Corbett, all experts in strategy.

Fisher was a great champion of submarines and supported Bacon in their rapid development. During his first period as First Sea Lord, many small coastal type submarines were built. As the experience was obtained and the technology progressed, the first of the larger overseas type were ordered. Fisher saw their importance in a war against Germany when these submarines would be needed for observation, early warning and be used offensively against a German fleet sortie.

In summary this dissertation first rejects the theory that Fisher had a secret flotilla defence plan either before the war, or when he returned to the Admiralty as First Sea Lord in 1914-1915. The development of submarines would have occurred regardless of Fisher, but his technical acumen and his ability to push through controversial decisions against entrenched bureaucracy led to their quicker adoption and integration into naval defence plans. The Fisher era is often described as 'revolutionary' but not all progress should be attributed personally to him. However, while there was no Fisher naval revolution, there was continuous development in submarine technology, and this had an incremental impact on Admiralty policy.

This dissertation rejects the popular perception that in the decade before the war, the Royal Navy and particularly the Admiralty was reactionary and against change. Unlike the War Office and the British Army, the Admiralty was both the command hub and administrative centre for the Royal Navy. Building on the environment created by Fisher and his colleagues, an important development was the 1911 appointment of Winston Churchill as First Lord with a brief from Prime Minister Asquith to establish a naval staff. Consequently, in 1912 a War Staff was created under a Chief of War Staff (COS) with separate Intelligence, Mobilisation and Operations Divisions, the latter growing from the earlier planning committees. A Trade section was established in 1913 that was to expand greatly during the war. The War Staff produced effective war plans, including the crucial economic blockade policy, and hence the supporting deployment to the Grand Fleet and the other naval modules-of-force. Admiral J R Jellicoe, appointed First Sea Lord in November 1916, implemented a rapid growth in the number of staff, their organisation, and responsibilities, including some key posts filled by officers with wartime experience at sea. As the war progressed, the Admiralty also became more involved in the economy, taking control of shipbuilding material supplies and creating new state-owned manufacturing facilities. In response to the 1917 unrestricted U Boat campaign, the implementation of ocean convoys and the direct control of merchant shipping necessitated further staff with specialist skills, including many civilians. In 1917 the new First Lord, Eric Geddes, re-organised the Admiralty to be more business orientated. The First Sea Lord became the Chief of Staff, and with two deputies with clear responsibilities, sharing operational decision-making creating a command hub. The other Sea Lords then concentrating on their respective administrative responsibilities of material, personnel, and financial issues.

This dissertation confirms that pre-war the Admiralty had a very good understanding of the capabilities of submarines and how they were integrated effectively into naval strategy. It also

shows how this led directly to specific employment of submarines in the First World War, a matter to which we will now turn.

The Historiography of British Submarine Operations in the First World War

Compared to the pre-war period, the historiography of British submarines in wartime operations is largely uncontested by historians, and by some, even many, the roles of submarines in the war, is almost entirely ignored. The starting point for understanding submarines in World War 1, is the official history. At the height of the war in 1916, the Admiralty commissioned Sir Julian Corbett to write the official history of the war at sea as they did not want the history to be dominated by the activities of the British Army, particularly actions on the Western Front. “*Naval Operations*” volumes one to three,⁶³ written by Corbett and published by 1922, cover the period from the commencement of the war to the Battle of Jutland in June 1916. Corbett died unexpectedly in 1922. Sir Henry Newbold, a well-known poet who had written propaganda for the Admiralty during the war including a book on submarine warfare, wrote volumes four and five, published by 1928.⁶⁴ *Naval Operations* is dominated by the big events, and sometimes controversial issues, including the Dardanelles campaign, the Battle of Jutland, and the unrestricted U Boat campaigns. In all of these, the focus was on the surface warships and very little was written about British-based submarines other than the disposition of coastal and overseas flotillas, with brief outlines of a few of their operations, and with little mention of submarines in Admiralty policies and war plans. This dissertation fills this gap. There is little written about the value of submarine observation patrols off the German naval bases, their reconnaissance off the coasts of Denmark and Norway and into the Kattegat. There is nothing written concerning their observational capabilities allowing the capabilities of other warship types to be exploited, particularly cruisers and destroyers, and likewise there is little about submarines being integrated with other warship types and forces.

In 1912, Churchill requested the War Staff to include a historical section, explaining it should, “be the means of sifting, developing and applying the results of history and experience, and of preserving them as a general stock of reasoned opinion available as an aid and guide for all who are called upon to determine, in peace or war, the naval policy of the country.”⁶⁵ During and after the war a large range of documents were collected and organised to facilitate the

⁶³ Sir J S Corbett, *Naval Operations, History of the Great War Based on Official Documents* Volume 2 & 3 [1921] (London: IWM, 2017).

⁶⁴ Sir H J Newbolt, *Naval Operations, History of the Great War Volumes 4 & 5* (London: IWM, 2017).

⁶⁵ ‘History of the Naval Historical Branch’, Ministry of Defence, FOI2014/07994/74204, 16 December 2014.

writing of the official history of the naval war. Regrettably, many potentially important documents known to exist were destroyed. The selected documents were organised by subject and most bound into over 4,800 volumes, now designated the ADM 137 series of documents. These documents were to be closed to public access for seventy-five years but were opened to public access from the early 1960s. These original documents form the basis for almost all subsequent historical research in the First World War naval warfare. The ADM 137 series of documents are now located within The National Archives, where they are open to access by historians and the public. Captain Alfred C Dewar joined the Naval Historical Branch in late 1918, becoming head between 1926 and 1948, and was responsible for preparing a series of monographs issued between 1926 and 1939.⁶⁶ Again, as with the Official History discussed above, the monographs concentrated on events and largely avoid comments on the actions and influences of the participants. In the same vein, British submarine operations are described in general terms but little on their integration with other forces.⁶⁷

Supplementing the official histories and Staff Monographs, many autobiographical books were published post war by naval officers. For example Admiral J.R. Jellicoe wrote on the creation and actions of the Grand Fleet while Commander-in-Chief from August 1914 to November 1916. He also wrote on the 1917 struggle against the German unrestricted U Boat campaign, during which time he had been First Sea Lord.⁶⁸ Neither says much about British submarines, their contribution to the war and their integration with other forces. Admiral Beatty's biographer Roskill hardly mentions British submarines.⁶⁹ Admiral E.M. Chatfield was Admiral Beatty's Flag Captain on HMS *Lion* from the beginning of the war until November 1916 when Flag Captain on *Iron Duke* and *Queen Elizabeth*, Beatty's Grand Fleet flagships.⁷⁰ These and other autobiographies concentrate on the actions and successes of the forces or units that the author commanded, with little mention of British submarines. Although First Sea Lord, Admiral Sir Arthur K. Wilson encouraged the development of submarines, his biographer Admiral Bradford almost entirely ignores this.⁷¹ In 1910 Admiral Wilson appointed Captain Keyes to be Inspecting Captain Submarines, commanding the submarine service. Previous Inspecting

⁶⁶ 'Naval Staff Monographs (Historical)' #1 to #19, 1924 to 1939, ADM 186, TNA.

⁶⁷ Ibid

⁶⁸ Adm. J R Jellicoe, *The Grand Fleet 1914-1916, Its Creation Development and Work* (London: Cassell, 1919); Adm. J R Jellicoe, *The Crisis in the Naval War* (London: Cassell, 1920).

⁶⁹ S Roskill, *Admiral of the Fleet Earl Beatty, The Last Naval Hero* (Barnsley: Seaforth, 2018).

⁷⁰ Adm. A E M Chatfield, *The Navy and Defence* (London, Heinemann, 1942).

⁷¹ Adm. E E Bradford, *Life of Admiral of the Fleet Sir Arthur Knyvet Wilson* (London: Forgotten. 2012).

Captains were experts in technical matters, particularly torpedoes, whereas Keyes considered himself a “sea horse”. Keyes was therefore surprised to be appointed, revealing in his autobiography that “Admiral Sir Arthur [Wilson] wanted a sea-going officer who had every prospect of being a young Admiral, and could be relied upon to bring the submarine service into close touch an collaboration with the fleet”.⁷² Such collaboration ensured the integration of submarines into the layered systems. Keyes appointed a committee whose members had the technical expertise to advise him on submarine development. His autobiography includes a section on submarines for this period, including the development of the service and his justification for introducing foreign designs.⁷³ When war began in 1914, he explains how he organised the overseas submarines for observational patrolling off the German North Sea naval bases, and patrols in the southern North Sea against potential raids by German surface warships. Keyes also describes the planning and the action of the Battle of Heligoland Bight on 28 August 1914, and of the submarines’ participation and role in the attempted air raids on Zeppelin sheds. Keyes autobiography does not comment explicitly on the integration of the different capabilities of the forces involved in the layered systems, or on submarines relieving cruisers and destroyers of observational patrols thus freeing them for their capabilities to be used in the Grand Fleet and in other commands. Aspinall-Oglander’s biography of Keyes has little on submarines but concentrates on Keyes’ relationship and dispute with Admiral Fisher over submarine development.⁷⁴ Commodore R.Y. Tyrwhitt was in command of the Harwich Force of light cruisers and destroyers throughout the war. His biographer, Temple Patterson mentions his force working with the Grand Fleet and the Dover Command but with little reference to British submarines.⁷⁵ This is surprising as his Force worked closely with the Harwich-based submarines including joint operations.

Unfortunately, two senior submarine service commanders, Sydney S. Hall, Commodore (S) from 1915 to the end of the war, and Admiral Arthur K. Waistell, who commanded Harwich-based submarines from 1914 to September 1917, neither wrote autobiographies nor left a collection of personal papers. A more analytical autobiography, written by Admiral Dreyer⁷⁶ covers naval warfare in both world wars. However, he also does not recognise the use of layered systems and the role of British submarines in the First World War. Many pre-war and

⁷² Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes, Volume 1* pp23-24.

⁷³ Ibid, pp29-34.

⁷⁴ C Aspinall-Oglander, *Roger Keyes Being the Biography of Admiral of the Fleet Lord Keyes of Zeebrugge and Dover* (London: Howgarth, 1951).

⁷⁵ A Temple Patterson, *Tyrwhitt of the Harwich Force* (London: MacDonald, 1973).

⁷⁶ Adm. F C Dreyer, *The Sea Heritage, A Study of Maritime Warfare* (London: Museum, 1954).

wartime politicians also wrote autobiographies, notably Winston Churchill⁷⁷ who wrote his history of the war. Churchill does not recognise layered systems and barely mentions British submarines, integration with surface forces, and ignores submarine observational patrols enabling surface warships to be used to their full capabilities. Inevitably, autobiographies by Admirals and politicians include degrees of self-justification to safeguard their reputations. One of the first autobiographies published after the war was by German Admiral Reinhard Scheer, who initially commanded a battle squadron and was then promoted to command the High Sea Fleet from 1916 to almost the end of the war.⁷⁸ Although justifying his actions and protecting his reputation, he refers to the constraints of German operations created by the British submarines patrolling off the German North Sea bases, particularly in observing and providing early warning of sorties of warships or the whole fleet. This important issue, obvious to the Germans, has been ignored in British autobiographies and biographies of senior officers.

It is probable that *Naval Operations*, the Admiralty's Monographs, and the documents now within ADM 137, have been major influences on subsequent historians and authors. The American academic Arthur Marder began researching the naval war in the mid-1950s.⁷⁹ He had privileged access to documents within the official records that were closed to other historians, and in the private papers of some surviving senior naval officers and politicians. His five volumes were published between 1961 to 1970, with the first concentrating on the political and strategic background pre-war, and the corresponding development of Admiralty policies. Volumes two to five deal with the war, concentrating on the major events and controversial issues. There are few details of British-based submarine operations, and as before, Marder does not recognise the layered systems provided by the different modules-of-force and the importance of submarines enabling this to occur.

At the start of the war, Henry Newbold, along with other leading British writers, joined the War Propaganda Bureau to promote Britain's interest during the war and maintain public opinion in favour of the war. In 1918 he was author of a book on the warfare of British submarines and German U Boats, in which he characterised the British as honourable heroes obeying international rules whereas the Germans were evil with no regard for civilisation.⁸⁰ The book has many stories but no reference to the strategic roles of British submarines. Today's reader

⁷⁷ W S Churchill, *The World Crises* (London: Penguin, 2008).

⁷⁸ Adm. R Scheer, *Germany's High Sea Fleet in the World War*.

⁷⁹ A J Marder, *From Dreadnought to Scapa Flow*.

⁸⁰ Sir H Newbolt, *Submarine and Anti-Submarine* (Kindle, 2018).

must remember that this is a propaganda book. Bower, an experienced wartime submarine commanding officer of E34 and K12, wrote a book in 1919 to tell the story of British submarines.⁸¹ In 1930, Carr who had served a submarine office during the war, also wrote a book on the many incidents involving British submarines.⁸² These books are based largely on anecdotes of events, with no mention of the strategic roles of the submarines. Other books have been published that claim to provide a history of submarines, but these books often concentrate on their technological development. One such book by Rear Admiral W. Jameson covers submarine development from 1578.⁸³ The chapters on World War One are almost exclusively on the activities of the German U Boats and the Royal Navy's responses, ignoring British submarine operations. A popular history book by Edwyn Gray, purporting to describe British submarine operations, concentrates on the exploits of submarines in the Sea of Marmara interrupting Turkish reinforcements to Gallipoli, British submarine operations in the Baltic, and the accidents to the K Class steam submarines.⁸⁴ A book by Compton-Hall, an ex-submariner, describes the design development of submarines and the various campaigns by British submarines and German U Boats.⁸⁵ A book by Lipscomb on British submarines is more on design development from the first to the start of nuclear power. In a summary of the First World War, the operations in the North Sea are almost ignored.⁸⁶ Although these books were written for the mass-market readership rather than for academic research, none explain the role and consequences of submarines operating a close, observational blockade off the German naval bases. Further, none recognise the roles of British submarine being integrated with other forces, their contribution to layered systems.

Vice Admiral Sir Arthur Hezlet's book on submarines in his series on Sea Power provides a more balanced and accurate description of British submarine and German U-Boat operations.⁸⁷ This book describes the disposition of British submarines and other forces, when there was a threat of a German bombardment of the east coast. Regarding naval intelligence, Beesly's books on the establishment and development of naval codebreaking and its integration into naval operations, has few mentions of submarine operations.⁸⁸ A recent book

⁸¹ J G Bower, *The Story of Our Submarines* (London: 1919).

⁸² W G Carr, *By Guess and By God* (London: Hutchinson, 1930).

⁸³ Adm. W Jameson, *The Most Formidable Thing, The Story of the Submarine from its earliest days to the end of World War1* (London: Hart-Davies, 1965).

⁸⁴ E Gray, *British Submarines at War 1914-1918* (Barnsley: Pen & Sword, 2001).

⁸⁵ R Compton-Hall, *Submarines and the War at Sea 1914-1918* (Penzance: Periscope, 2004).

⁸⁶ F W Lipscomb, *The British Submarine* (London: Conway, 1975).

⁸⁷ Vice Adm. A Hezlet, *The Submarine and Sea Power* (London: Davies, 1967).

⁸⁸ P Beesly *Room 40, British Naval Intelligence 1914-18*.

on naval intelligence by Boyd, does not mention British submarines and their roles in acquiring intelligence in reconnaissance, observational patrols, and gathering intelligence on minefields and German minesweeping activities, as a potential prelude to a fleet sortie.⁸⁹ Neither book links submarine operations to their roles in integrated layered systems nor as an enabling technology.

In 1972, Paul Halpern was editor of Admiral Keyes' papers and well aware of British submarine development immediately pre-war and in their early North Sea operations.⁹⁰ In 1994, Halpern published a book on the naval war, and in the Preface stated that he wanted to cover more than just the war in the North Sea. Thus, his chapters cover the naval war in overseas campaigns, in the Adriatic, the Baltic, the Black Sea, the Danube, the Mediterranean plus chapters on the U Boat campaigns.⁹¹ But crucially, there is little analysis of British submarines and their contribution to the naval war. In 2004 Robert Massie published a large, single-volume book on the naval side of the World War One, with chronological chapters on all the battles, warship raids and campaigns worldwide.⁹² There is a chapter on Admiral Fisher's role in the development of submarines, and their early operations while commanded by Commodore Keyes, but thereafter there are only occasional references to British submarines.

More recent authors of books on aspects of the naval war, for example Rear Admiral James Goldrick have little to say on British submarine operations or the composition and integration of modules-of-force providing a flexible layered system.⁹³ The prolific naval author Norman Friedman has written many books on the technical capabilities of different warship types, nationalities, and classes. His book on the naval war contains much information on the campaigns and warship capabilities in the text, in extensive photograph captions and in copious references. In the Introductory chapter, he reiterates the theories of how Fisher contemplated 'flotilla defence' and a sea-denial North Sea policy but he does not provide any documentary references to support this. However, in his chapter on the commencement of the war, he offers an accurate explanation for why flotilla defence could never have worked, providing an apology for those who allegedly advanced it as a strategy.

⁸⁹ A Boyd, *British Naval Intelligence through the Twentieth Century* (Barnsley: Seaforth, 2020).

⁹⁰ P G Halpern ed, *The Keyes Papers*, Volume 1, (London: NRS, 1972).

⁹¹ P G Halpern, *A Naval History of World War 1* (London: UCL, 1994).

⁹² R K Massie, *Castles of Steel, Britain, Germany and the Winning of the Great War at Sea* (London: Cape, 2004).

⁹³ Rear Adm. J Goldrick, *Before Jutland* (Annapolis: NIP, 2015); Rear Adm. J Goldrick, *After Jutland* (Barnsley: Seaforth, 2018).

The tactical objection was that submarines might find it difficult to find and engage fast capital ships. Unless they patrolled immediately outside the enemy's ports, they might well fail to find his ships and they were not so fast that they could contact ships detected at a distance (their detection range was limited, too). It is not clear how much these problems were appreciated before the war. However, once Fisher left office in January 1910, his successors were far less confident that torpedo craft could keep the enemy's fleet in harbour. Wartime experience shows that they were right. Fisher (and apparently everyone else) grossly down-played the difficulty submarines and other torpedo craft would find in actually finding an enemy's surface ships. That said, the Germans certainly took the threat of British submarines in the North Sea seriously.⁹⁴

The above is an accurate summary of the difficulties experienced by British submarines, but there is nothing written on how they freed-up surface warships of observational patrols and their subsequent involvement in creating the modules-of-forces in a layered system. Friedman's recent book on British submarines concentrates on their development, and therefore has little on their operations and contribution.⁹⁵

In 2022 Mark Harris published a detailed history of the overseas submarines in 1914, based upon their commanding officers' patrol reports and cross referenced by German records, and descriptions of operations are supplemented by charts.⁹⁶ The book provides well-researched information on specific operations and mentions when the submarines were used in support of the Harwich Force and the Grand Fleet in the Battle for the Heligoland Bight. However, he does not analyse their overall roles nor mention that submarines enabled the implementation of layered defence.

Historians prefer researching and writing about controversial issues and the characteristics of the decision makers and influencers, while book publishers need the content to be sufficiently interesting to sell multiple copies. It is not too surprising therefore that there are many books on major campaigns. Some books are outstanding, for example Christopher Bell's book on the roles of Churchill and Fisher in relation to the Dardanelles campaign.⁹⁷ The Battle of Jutland, and the many resulting disputes on the actions and inactions of the participants

⁹⁴ N Friedman, *Fighting the Great War at Sea, Strategy* (Barnsley: Seaforth, 2014), p28.

⁹⁵ N Friedman, *British Submarines in Two World Wars*.

⁹⁶ M Harris, *Harwich Submarines in the Great War, The First Submarine Campaign of the Royal Navy in 1914* (Warwick: Helion, 2021).

⁹⁷ C M Bell, *Churchill and the Dardanelles* (Oxford: OUP, 2017).

proves scope for many books, a recent example being by Nicholas Jellicoe⁹⁸ A further popular topic is the urgency to counter German U-Boat unrestricted warfare, and the controversy over implementing convoys, a recent example being by Steve Dunn.⁹⁹ When British submarines are mentioned, too much is concentrated on their important and courageous operations in the Sea of Marmara and in the Baltic. Too much is written on the accidents of the K Class steam submarines, to the point of trivialising why they were built, and not what they could have achieved if they had participated in another major fleet action. In effect, because submarines' roles in the North Sea involved many unspectacular but dangerous patrols, they have been largely ignored. The result is that when mentioned at all, the role and contribution of British submarines has been misinterpreted, and then ignoring they enabled the development and implementation of flexible layered systems to fight the naval war.

The research for this dissertation concentrated on Royal Navy submarine operations that were based in the British Isles, namely the North Sea and Heligoland Bight, off the coasts of Norway, Denmark, Sweden and Netherlands, in the south-western and north-western approaches of the Atlantic, and the English Channel. Central to the dissertation, the North Sea operations provides the clearest and most extensive examples of the different modules-of-force being integrated into layered systems. British submarines were involved in other campaigns including the Dardanelles, in the Aegean and in the Baltic. In the Dardanelles, the Allied surface warships failed to destroy sufficient Turkish forts and guns and were this unable to penetrate the Dardanelles, whereas submarines, albeit with heavy losses penetrated to the Sea of Marmara. There their exploits became famous in intercepting and delaying Turkish reinforcements and re-supply of their army on the Gallipoli peninsula. The relatively few submarines exerted an enormous effect on the land fighting, not achieved in any other theatre during the war. Operating alone and with limited naval intelligence support, they were the forward module-of-force in the Gallipoli campaign.

Within the Mediterranean, British submarines operated in the Aegean and its entrance, the Straits of Otranto. The first submarines were five obsolete B Class that were based in Venice patrolled off the principal Austro-Hungarian naval base of Pula. Later H Class submarines operated from Italian east coast bases, patrolled off the coast of Austrian controlled Yugoslavia. They were the forward module-of-force of the combined Italian, French and

⁹⁸ N Jellicoe, *Jutland, The Unfinished Battle* (Barnsley: Seaforth, 2016).

⁹⁹ S R Dunn, *Bayly's War, The Battle for the Western Approaches in the First World War* (Barnsley: Seaforth, 2018).

British surface warships against sweeps in the Aegean by the Austro-Hungarian surface warships. British submarines patrolled also off the major German U Boat base at Cattaro, now called Kotar, in Montenegro. British submarines integrated with surface warships patrolled the Straits of Otranto, where an anti-U Boat barrage of nets and minefields was established, comparable to the Straits of Dover barrage.

In late 1914, the first British submarines to penetrate The Sound between Denmark and Sweden to enter the Baltic, where they were expected to patrol off the German naval base at Kiel, and then return to England. However, they were integrated into Russian naval plans in the defence of the Gulf of Finland and the approaches to St. Peterburg. The Russian navy had been partially rebuilt after the 1904-05 war with Japan, and in the Baltic consisted of surface warships, a few obsolete submarines, and minelayers that laid extensive minefields in the Baltic. The British submarines were used offensively against the trade of ore from northern Sweden to Germany. Abiding by international law, they sank merchant ships and disrupted this trade. Russian insistence to keep these submarines for defensive purposes meant that opportunities were missed for further attacks on this essential trade. Submarine operations were also interrupted by the ice conditions during the Baltic winters, and logistic problems creating numerous maintenance difficulties. When Russia surrendered in 1917, the remaining worn-out submarines were scuttled as it was not considered worth returning them to England at risk to their crews.

This dissertation is divided into chapters to define how the layered systems evolved pre-war and developed during the war. The first chapter is concerned with the pre-war development of submarines, the perceptions of the naval officers and civilians involved, the fleet manoeuvres and how these changed Admiralty policies and war plans, and the expectation of the role of submarine in wartime. The second chapter deals with submarines from the start of the war to 1916. Wartime experience quickly confirmed that the Admiralty had essentially got it right as the coastal submarine were incapable of stopping a German bombardment or amphibious landing, whereas the overseas submarines fulfilled their expectations in close observational patrols off the German North Sea bases. British submarines were integrated in layered defence systems, and they solved the Admiralty's "North Sea Problem" by relieving cruisers and destroyers of their previous high-risk need to provide a close or mid-North Sea patrols. These cruisers and destroyers then available to use their capabilities being mostly integrated into the Grand Fleet and Harwich Force. Submarines were therefore an enabling technology. The third chapter is concerned with the rapid development of submarine

technology in overall design, machinery, equipment and weapon systems. As the war progressed, it was clear that the pre-war overseas submarines had design constraints, so based upon experience, superior overseas-patrol submarines were designed. Requirement for specialist submarines were identified and these were designed and built, albeit with varying degrees of success. At tactical levels submarines acted alone, but at a strategic level, submarines were integrated into layered defence systems. The fourth chapter covers the war from mid-1916 to the armistice, particularly the availability of fleet submarines being integrated directly into the Grand Fleet. Fleet submarines and the patrol submarines had their roles defined should a further fleet action occur, a highly developed layered system, using the capabilities. The fifth chapter concentrates on the German unrestricted U Boat campaign from February 1917 to the armistice. British submarines were not ideal for anti-U Boat warfare, and although they sank a few U-Boats, they were integrated into layered defence systems. For example, their suspected presence forced U Boats to dive into deep laid minefields. Submarines patrolling in defence layers with surface anti-U Boat vessels, forced U Boats to submerge while on passage thus delaying their operational time on station. Hydrophone equipment was developed and installed in British submarines to detect submerged U Boats, and deck guns were fitted to engage surface U Boats. Trials were made of fitting depth charges. Specialist anti-U Boat submarines were developed, and a few were operational before the war ended. The final chapter analyses the successes and limitations of British submarines, based particularly on the post war investigative committee and their analysis. Germany had surrendered the surviving U Boats and they were gathered in Harwich where they were examined by British submariners and designers. In a 1920 technical discussion in London on the relative merits of British submarines and German U Boats, somewhat unsurprisingly concluded that apart from superior German diesel engines, the British designs were better.¹⁰⁰

¹⁰⁰ A W Johns, 'German Submarines' *The Institution of Naval Architects* (Transactions London 1920).

Chapter 1: Pre-War Naval Policy, War Plans, the Evolution of Layered Defence and Submarine Development

Positioning My Argument

This chapter demonstrates how in the pre-war period the Admiralty initiated and managed the rapid technical development of submarines plus their weapon systems and communication equipment to further their integration with other warship types and systems for the evolution of a naval layered defence. It argues that Admiralty pre-war plans were consciously shaped by the rapidly developing warship technologies, for example, developments in armament, gunnery control, machinery, wireless telegraphy that provided new and enhanced capabilities. Especially important were submarines and aircraft. These were completely new weapon platforms offering completely new capabilities.¹⁰¹ All of these were tested and evaluated in exercises and the Admiralty War Plans were modified and enhanced to include these new capabilities. The Royal Navy also conducted major fleet manoeuvres to test and evaluate different scenarios involving these new platforms.

It is obviously most important for this dissertation to examine how the Admiralty perceived the capabilities of submarines and how their perceptions of these craft developed throughout the period 1900 to 1914.¹⁰² In the early 1900s the first Royal Navy submarines were used for trials and evaluation.¹⁰³ Once they were considered capable of operational roles, they were included in exercises and fleet manoeuvres, where much experience was gained.¹⁰⁴ There was very rapid growth in submarine technologies, in their design, of their weapons, propulsion and communication equipment.¹⁰⁵ This chapter identifies the senior personnel responsible for this rapid progress and the decision-making process by examining the critical documents that exist from this period. Warship design, including submarine design, is determined first by British foreign policy and the resulting naval policy. Within the naval policy, the Admiralty identified specific roles for new types of submarines. Drawing on experience from previous designs and new technologies, the capabilities of a new submarine were defined. A design was then made, built around the weapon system to be used. Equally new submarine technologies also influenced naval policies and war plans. This chapter argues that the

¹⁰¹ R Compton-Hall, *Submarine Boats, The beginning of undersea warfare* (London: Conway, 1983).

¹⁰² 'The Development of HM Submarines', BR 3043.

¹⁰³ 'Reports on Tactical and Other Exercises of Submarine Boats up to 31 December 1903', R H Bacon, Inspecting Captain of Submarine Boats, ADM 1/7725, TNA.

¹⁰⁴ 'Umpire's Report on Manoeuvres between the Home Fleet and Submarines', March 1904, ADM 1/7795, TNA

¹⁰⁵ 'The Development of HM Submarines', BR 3043.

Admiralty was very pro-active in the rapid development of submarines, recognising their potential value and the possibilities for their integration into the war planning process in collaboration with other elements of the fleet. This is confirmed by the precis and agenda for an Admiralty conference, attended by senior officers, that was scheduled for late July 1914, but was cancelled when the fleet was deployed for war.¹⁰⁶

Holland Class, 1901/1902 Naval Estimates.

Until the early 1900s France, possibly in an alliance with Russia, was considered the most likely potential adversary.¹⁰⁷ France was developing submarines and the Admiralty monitored their progress. The Admiralty did not encourage the use or adoption of submarines as they were perceived as a potential threat to the Royal Navy's supremacy in battleships. Submarines were considered a weapon for a weaker navy that could not afford a large surface fleet. By the 1890s France led the way in submarine development, and as a potential enemy, the British Admiralty became progressively concerned by this threat. The Royal Navy being considerable larger than the French Marine Nationale, the Admiralty War Plan followed the traditional pattern of earlier centuries with the battle fleets operating a close blockade off the French naval bases in the Channel and the Mediterranean, albeit this was more difficult to maintain in the age of steam as steam ships needed regular refuelling.¹⁰⁸ In 1899 Captain Henry Jackson, the naval attaché in Paris, and a radio pioneer and future First Sea Lord, reported on the successful trial of France's latest submarine the *Gustave-Zédé*, during which she hit the old barbette ship *Magenta* with a torpedo.¹⁰⁹ French submarines located within their naval bases were deemed to pose a threat to a British blockading surface fleet, so a means of attacking and destroying submarines was sought. This highlighted the need for the Royal Navy to acquire submarines, initially to explore potential counter measures, and to defend British ports should the French Marine Nationale gain a blockading situation. In a minute, the Senior Naval Lord stated:

¹⁰⁶ M S Seligman, *A Service Ready for Total War? The State of the Royal Navy in July 1914* (Oxford: OUP, 2018).

¹⁰⁷ A J Marder, *The Anatomy of British Sea Power, A History of British Naval Policy in the Pre-dreadnought era 1880-1905* (London: Cass, 1972) pp 65-118.

¹⁰⁸ F T Jane Ed., *All the World's Fighting Ships* (London: Marston, 1898).

¹⁰⁹ 'Attachment to a report from Sir Edmund Monson, the British Ambassador in Paris, to the Marquis of Salisbury, the Prime Minister', 22 January 1899, ADM1/7422A, TNA.

The success of the French submarines appears to be sufficiently assured to make it necessary to consider how to meet them. There are two points to consider, how to find them, and how to destroy them.¹¹⁰

In 1900 a report by Captain Charles Ottley, the naval attaché in Washington DC, dealt with submarine developments in the United States.¹¹¹ Together with a report by the Naval Intelligence Division, these were used by Admiral Lord Walter Kerr, the Senior Naval Lord, to advise that the Royal Navy should obtain a submarine for tests and evaluation purposes.¹¹² In parallel HMS *Vulcan*, the Royal Navy's Torpedo and Electrical School at the Nore, now commanded by Captain Henry Jackson, was investigating the use of mines against submarines.¹¹³ By 1900 separate technologies came together to make a viable submarine, namely: the ability to submerge and to surface; an internal combustion engine for use while on the surface and a battery powered motor for use while submerged with the ability to recharge the batteries while on the surface; the ability to control the submarine while underwater; and the development of torpedoes.¹¹⁴ Combining these provided a potent weapons system. The Admiralty recognised that it would be quicker to buy a developed submarine or submarine design from abroad rather than take the time needed to develop one in Britain. It was unlikely that France would co-operate, so the Admiralty turned to the United States. In July 1900 the Admiralty received a letter putting them in contact with Isaac L Rice, President of the Electric Boat Company.¹¹⁵ Electric Boat had acquired the patents and rights for the Holland Submarine Torpedo Boat Co. and thus owned the submarine designs of John Holland. In discussions of October 1900, it was agreed that Messrs Vickers, Sons and Maxim at Barrow-in-Furness would become the sole European licensee of the patents of the Holland Submarine Torpedo Boat Co.¹¹⁶

The need to test submarine capabilities was highlighted by the growing realisation that the threat of destroyers and submarines, both armed with torpedoes, meant that a close blockade

¹¹⁰ 'Attached Minute by Admiral W Kerr, Senior Naval Lord', dated 4 May 1900, 'Discussions on the Use of Contact Mines for Defence Against Submarines', ADM 256/39, TNA.

¹¹¹ 'US Submarine Boat Holland', enclosed in FO 3 January 1900, ADM 1/7471, TNA.

¹¹² 'Submarine Boats', NID 577, ADM 1/7461B, TNA,

¹¹³ 'Report by Captain Henry Jackson, Captain of HMS *Vulcan*', dated 5 February 1900, 'Discussions on the Use of Contact Mines for Defence Against Submarines', ADM 256/39, TNA.

¹¹⁴ R Compton-Hall, *Submarine Boats, The beginning of undersea warfare*.

¹¹⁵ 'August Belmont & Co., New York to N.M. Rothschild and Sons, London', 13 July 1900, ADM 1/7515, TNA.

¹¹⁶ 'Attached Minute by DNC', 19 October 1900, ADM 1/7515, TNA.

by a battle fleet could not be sustained in the future. January 1901 the Controller, Rear Admiral Sir Arthur K Wilson, issued a memorandum to the Board in which he stated:

“As far as one can see at present the principal use of the submarine boat will be to attack ships blockading a port, although efforts are being taken to extend their action.

To which the Senior Naval Lord added a minute:

Submarine boats were introduced by France in the first instance as a means of defence and protection to their harbours, by keeping off an attack of ships on them and to prevent a close Blockade of their Ports.¹¹⁷

In January 1901, the 1901-1902 Navy Estimates were presented to the Defence Committee of the Cabinet, and regarding submarines:

In respect of these boats the French claim to have passed beyond the experimental stage. They claim to have perfected a type which will be capable of steering along the surface of the water for a distance at least sufficient to cross the Channel, and then to submerge itself and acting as a submarine boat. Experience can only show whether the danger from this invention is as great as it appears to be. It is quite certain that all that is claimed for it should turn out to be true, there is no defence yet known against a submerged boat except to steam away.

The submarine boat has also been perfected in the United States by Mr. Holland and adopted already by the United States Navy. My predecessor felt, in common with the whole board, that it was no longer safe to remain in complete ignorance of the real value of this new invention to which the French are attributing so much importance and from which they expect such great results. Five of these boats have been accordingly ordered from Mr. Holland, the first of which it is hoped will be delivered not later than 1 November 1901.

We shall then begin to know something of a subject on which we at present know nothing and I do not think the Cabinet will consider that the step has been taken too soon.¹¹⁸

The Admiralty wanted to expedite the building and evaluation of submarines. In April 1901 Rear Admiral Sir Henry Jackson was appointed Controller and Third Sea Lord and he appointed Captain Reginald Hugh Spencer Bacon as Inspecting Captain of Submarines. Bacon had established his reputation for technical expertise being involved in the torpedo

¹¹⁷ Memorandum and Minute by Controller “Submarine Boats”, 21 January 1901, ADM 1/7515, TNA.

¹¹⁸ ‘Navy Estimates 1901-1902, Memorandum on Shipbuilding, Submarine Boats’, 17 January 1901, CAB 37/56/8, TNA. p11.

branch in the 1890s and being on the staff of the navy's torpedo school. Bacon was responsible for all aspects of submarines including overseeing their design and building at Vickers, their trials and the selection and training of their crews. Submarines were to be based in Portsmouth for trials and evaluation. Bacon obtained the old cruiser *Latona* as a depot ship to provide accommodation for the crews and specialist maintenance facilities and the torpedo gunboat *Hazard* as a support ship.¹¹⁹

Vickers laid down the first Holland Class submarine in February 1901, launched in October 1901 and sea trial began in April 1902. These were known simply as No.1, No.2, No.3, No.4 and No.5.¹²⁰ They were the single hull type whereby the ballast tanks for submerging were located inside this hull. They had a surface displacement of 104 tons, 63.75 feet long and armed with a single 18-inch diameter torpedo tube in the bow. Surface propulsion was by a 160 horse-power petrol engine giving a speed of 8 knots, submerged propulsion by a battery powered 74 horse-power electric motor giving a speed of 5 knots. They had a reported range of 250 nautical miles, albeit such historic figures quoted for 'range' and/or 'endurance' are very unreliable and were dependent on the speed at which the submarine operated. There were very limited facilities on board for the crew of seven. No periscope was fitted although a vertical telescope was devised. There was no conning tower (or fin) fitted and while operating on the surface there was very little freeboard.¹²¹ In waves they provided no protection to the crew on deck and the hatch had to be shut to avoid flooding. When the first submarines were ready in 1902, they left Barrow and proceeded to Portsmouth from where they participated in trials and exercises off Portsmouth and demonstrated their threat to a blockading surface fleet. By May 1903 Bacon was able to report to the C-in-C Portsmouth, Admiral Sir Charles Hotham, and to the Admiralty on the experience gained from exercises:

Sufficient experience has been obtained with these boats to assign to them a definite role in the armaments of the Navy, and to make the question of the number of boats required, and their disposition, one that may now be considered. At present the boats have been always worked from a permanent base and have shown that when employed in this manner they limit the operations of ships in two ways.

1. That it is almost impossible for a ship to remain near that base.

¹¹⁹ 'Bacon to Rear Admiral May, Hulk for Crews of Submarine Boats', 16 August 1902, ADM 1/7605, TNA.

¹²⁰ F T Jane Ed., *All the World's Fighting Ships* (London: Marston, 1902).

¹²¹ Ship's Cover Holland, A, B and C Classes, ADM/SC/290, Brass Foundry, NMM.

2. That it is very hazardous for ships to pass within a distance of about 25 miles.¹²² Bacon recommended that if a submarine were sighted before an attack, the best option for the ship's captain was to sail directly away. An alternate was to sail straight at the submarine to disconcert her captain, however this could be a dangerous as other, unseen submarines could be nearby. Controlled minefields had been used along with shore-based guns as the main defence of a navy base against a blockading fleet. Captain Bacon recommended that submarines be substituted for the existing minefields at Portsmouth, Devonport and Sheerness. The Royal Engineering Mining Establishments, an Army unit, would be handed over to the Admiralty and used as depots for the submarines. Bacon recognised the value of the defensive guns particularly in weather conditions when the submarines could not operate with certainty, and continued:

Submarines boats are daylight craft only. At night-time owing to the loss of light, their one great attribute "invisibility due to submersion" vanishes; the necessity for diving vanishes, and the more efficient destroyer under the protective cloak of darkness takes their place. This is the keynote in the use of submarine boats.

Submarines by day, Destroyers by night

These two craft, the destroyer and submarine, should be considered complementary to each other.¹²³

This is an early example of submarines being integrated with surface warships. Bacon recommended that submarines could be used overseas particularly at Gibraltar, Malta and Alexandria. They would be useful for local defence in the absence of the Mediterranean Fleet. He recommended further that submarines could be developed to block the English Channel and the passage between Scotland and Norway thus closing the North Sea.¹²⁴

In retrospect the Admiralty policy of purchasing a working American design paid-off as it is doubtful a home-grown design could have been built quicker.

A Class 1902/1903 Naval Estimates

The Admiralty quickly saw the potential of submarines for harbour defence. While the Holland Class was still being used for trials and exercises, the Admiralty authorised the next class which addressed some of the obvious issues with the Hollands. The Admiralty enthusiasm for submarines led them to adopt a regular submarine programme and money was included

¹²² Report "Submarine Boats" by Captain R Bacon, ICS to C-in-C Portsmouth and Admiralty, 31 May 1903, ADM 1/7725, TNA.

¹²³ Ibid

¹²⁴ Ibid

in the 1902/03 estimates for four new A Class submarines with the first delivered in 1904. The 1903/04 estimates included a further nine and they were delivered by 1905 being named A.1 to A.13.¹²⁵ Larger than the Holland Class, their general particulars were a surface displacement of 165 tons, 100 feet long and surface propulsion by a 500 horse-power petrol engine giving a speed of 11 knots, submerged propulsion by a battery powered 150 horse-power electric motor giving a speed of 7 knots, a planned range of about 400 nautical miles. A.1 had a single and all later A Class two 18-inch diameter torpedo tube in the bow. The crew of fourteen could remain at sea for two days, albeit there was no accommodation provided onboard. They were fitted with a small conning tower which was a great advantage in surface navigation, ship handling and increased visibility while surfaced.¹²⁶

In November 1903 Admiral Sir Jackie Fisher, then C-in-C Portsmouth, wrote a Memorandum entitled *Invasion and Submarines* in which he stated:

The primary object of enclosed remarks is to make clear that the Submarine Boat has made Invasion impracticable. . . These remarks can only be fully appreciated by those who have witnessed the Flotilla of Submarine Boats now in Portsmouth practising out in the open sea . . . As regards the Navy it must revolutionise Naval Tactics for this simple reason – that the present battle formation of ships in a single line presents a target of such a length that the chances are altogether in favour of the Whitehead torpedo hitting some ship in the line even when projected from a distance of two miles. . . . Now, as regards Invasion. . . No rational Commander would rely on landing on an open beach. Hence some sort of harbour must be used. All such suitable places on the Coasts of the United Kingdom can be counted on the fingers of one hand, and if provided with three submarine boats such would absolutely intimidate any transports from using them.¹²⁷

There is so much wrong with this as to wonder if Fisher believed it. It is typical of Fisher's writing, and his motive was undoubtedly to ensure ongoing funding for submarines.

B Class 1903/1904 Naval Estimates

Between 1903 and 1905 there were a series of debates on the assertions of the War Office on the feasibility of an invasion.¹²⁸ The Admiralty gave assurance to the Committee for

¹²⁵ 'The Development of HM Submarines', BR 3043, p 3.3.

¹²⁶ Ship's Cover, Holland, A, B & C Classes, ADM/SC/290, Brass Foundry, NMM.

¹²⁷ Memorandum by Admiral Sir John Fisher, November 1903, ADM 116/942, TNA.

¹²⁸ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics and British War Planning 1880-1914*, pp 93-98.

Imperial Defence (CID) that such an invasion could be countered by torpedo flotillas of submarines and destroyers.¹²⁹ This plan was used by the Admiralty only as a device in its disputes with the War Office about funding for anti-invasion measures, but Revisionist historians have used this to justify their theory of flotilla defence¹³⁰. Examination of the background to the supposed flotilla defence theory shows that the documents on which the Revisionists base their theories, were for political and not military purposes.¹³¹ When Fisher was appointed First Sea Lord in October 1904, he was under great pressure to make defence savings, so he endeavoured to make defence saving elsewhere, namely the War Office, by frustrating their Army Estimates for home defence. Torpedo armed vessels were considered capable of attacking an invasion force at night, but only under the protection of battleships. Submarines and destroyers were a part of the Navy's defence plans and would be used against any invasion or raid. The Admiralty intention was stated as 'it will be their duty to endeavour to torpedo ships carrying troops'. If the transports were protected by enemy battleships, they were to avoid engaging capital ships unless under the most favourable circumstances, but to harass the expedition until the arrival of the Fleet'.¹³² The real Admiralty defence plans were based squarely upon a superior battle fleet whose battleships would also give protection to locally based forces of cruisers and torpedo-armed submarine and destroyer flotillas. Prince Louis of Battenberg wrote a series of naval policy documents that clearly show the primary role of the flotillas to be masking the enemy's torpedo vessels off their bases and to protect the fleet against a torpedo attack.¹³³ Older battleships and cruisers were given the role of providing a backstop against enemy action off the British coast.

The Admiralty therefore needed a submarine that could continue be used for harbour defence, and also for coastal defence against invasion or military raid, so a larger submarine with better seakeeping capability was required. The first B Class submarine was included in the 1903/04 estimates and delivered in 1905.¹³⁴ This policy enabled a prototype to be evaluated before ordering ten more included in the 1904/05 estimates, being named B.1 to B.11. Their general

¹²⁹ Ibid, p 141.

¹³⁰ N Lambert, *The Submarine Service 1900-1918*.

¹³¹ R Dunley, 'Invasion, raids and army reform: the political context of flotilla defence, 1903-5', *Institute of Historic Research*, August 2017, Vol.90 (249), pp.613-635.

¹³² 'Admiralty, Memorandum to Commander-in-Chief Channel Fleet and Home Ports and Admiralty (D)', May 1905, ADM 116/900B, TNA.

¹³³ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics, and British War Planning 1880-1914*, pp 95-96, citing Battenburg, 'Memorandum on the Possibilities of Invasion During Temporary Loss of Command of the Sea in Home Waters' 31 March 1903, CAB 3/1/11, TNA, pp 61-66.

¹³⁴ 'The Development of HM Submarines', BR 3043, p3.3; 'Navy Estimates 1903-1904' CAB 37/63/142, TNA.

particulars were a surface displacement of 280 tons, 135 feet long and surface propulsion by a 600 horse-power petrol engine giving a speed of 13 knots, submerged propulsion by a battery powered 750 horse-power electric motor giving a speed of 8 knots with a theoretical range of 1000 nautical miles. There was a crew sixteen, but there was still no accommodation, greatly limiting their endurance for coastal defence. There were two 18-inch diameter torpedo tubes in the bow, and they were the first Royal Navy submarines fitted with forward hydroplanes, thus providing better submerged control.¹³⁵

In 1903 Captain Bacon wrote that submarine surface speed was considered as entirely strategic, providing the ability to get quickly to any threatened location. Submerged speed was considered tactical as only of use when in contact with the enemy. High submerged speed was difficult to attain, usually at the expense of range as the battery was quickly discharged.¹³⁶ In December 1903 Captain Bacon also raised the subject that Vickers was solely responsible for realising design requirements and that the Admiralty should have submarine design expertise. With the agreement of the Engineer-in-Chief, the Controller recommended that:

. . . a Constructor and an Engineering Inspector should therefore be told off entirely to work in connection with submarines.

In March 1904, H.G. Williams was appointed along with a senior Engineering Lieutenant RN to work on new designs in close association with Captain Bacon.¹³⁷

In 1904 there were manoeuvres off Portsmouth between the Home Fleet and Submarines. Captain Robert Arbuthnot, the umpire reported:

In conclusion, we consider that the submarine, used as either an offensive or defensive weapon, has achieved a state of completion and perfection which must render it in naval warfare a continual danger and menace to an enemy in enclosed waters, or in any position within its radius of action.¹³⁸

In January 1905 Admiral Fisher sent Balfour two papers. Referring to Submarines used defensively:

¹³⁵ 'Ship's Cover, Holland, A, B & C Classes', ADM/SC/290, Brass Foundry NMM.

¹³⁶ 'Memorandum by the Inspecting Captain of Submarines on New B class', November 1903, ADM/SC/185, NMM.

¹³⁷ 'Memorandum Captain Bacon and correspondence relating to a Naval Constructor', December 1903, ADM 1/7745, TNA.

¹³⁸ 'Umpire's Report on Manoeuvres between the Home Fleet and Submarines', March 1904, ADM 1/7795, TNA.

A submarine boat therefore is a daylight torpedo boat of medium speed but considerable radius of action. . . The destroyer by night, and the submarine by day, should render it practical impossible for transports to remain in a locality sufficiently long to discharge troops. As a check therefore to destructive raids on any of our territories where such aggression might be conceived, these boats should be a valuable adjunct.

Referring to Submarines used offensively:

Offensive action must be held to include the circumscription of the free movements of the enemy. . . Closing the Straits of Dover is of great importance . . . and the Straits of Gibraltar.¹³⁹

C Class 1906/1907 Naval Estimates

In 1905 a Submarine Boat Design Committee was established with Captain Henry Jackson, Controller, Philip Watts, Director of Naval Construction, Admiral Sir A.J. Durston, Engineer-in-Chief, Captain Reginald Bacon, now Naval Assistant to the First Sea Lord, and Captain Edgar Lees, Inspecting Captain of Submarines.¹⁴⁰ This committee, with their wide range of technical experience, advised on the future submarine developments. The committee considered both a progressively better coastal submarine, the C Class, and the development of the large experimental D Class. The 1906-1907 navy estimates included seven C Class submarines. All submarines so far had been built by Vickers, but two from this programme were built by Chatham Naval Dockyard. The first C Class submarine was delivered in 1906 with a total of thirty-eight built and named C.1 to C.38.¹⁴¹ It has been suggested that the continued building of small coastal submarines supports the revisionist theory of Fisher's secret plan of flotilla defence, but the reality was that experience and extensive testing were necessary before building the larger D Class. The general particulars of the C Class were a surface displacement of 290 tons, 135 feet long and surface propulsion by a 600 horse-power petrol engine giving a speed of 13 knots, submerged propulsion by a battery powered 200 horse-power electric motor giving a speed of 8 knots, a theoretical range of 1500 nautical miles, two 18-inch diameter torpedo tube in the bow and a crew of sixteen.¹⁴² The C Class had limited range making them only capable of coastal patrols, seldom more than three days endurance. There were differences in the detail design within each class as experience was gained. The

¹³⁹ Fisher to Balfour, January 1906, MSS 49710.

¹⁴⁰ 'Meeting of the Submarine Design Committee, 23 June 1905', Ship's Cover Holland, A, B & C Classes', ADM/SC/290, Brass Foundry, NMM.

¹⁴¹ F J Dittmar & J J Colledge, *British Warships 1914-1919* (Shepperton: Ian Allan, 1972).

¹⁴² 'The Development of HM Submarines', BR 3043, Section 3.

same spindle hull form of the Holland Class was used in the A, B and C Classes albeit they were progressively larger. Many improvements were made between B.1 and C.38, particularly added superstructure to improve surface running and seakeeping although there was little improvement in crew habitability. The Holland, A, B, C and D Classes did not have internal watertight bulkheads.¹⁴³ The dangers of explosions from a petrol engine were obvious, and it was decided in future designs to replace these with diesel engines, so A.13 was refitted with a diesel for trial purposes.¹⁴⁴

The A, B and C Class submarines were designed by Vickers, based upon specifications defined by Captain R. Bacon, Inspecting Captain of Submarines 1900-1906, with the support of Admiral Fisher. No American patents were used, and the Electric Boat Company had no further involvement with these submarines. By 1914 the A and B Classes were obsolete with the former being paid-off and the latter relegated to the eastern Mediterranean and Adriatic.¹⁴⁵ The C Class were more successful with thirty-eight built, showing the Admiralty's faith in submarines. The first few years of the submarine service were concerned with trials and exercises, and these showed apparent success against surface warships, particularly torpedoing slow-moving, blockading battleships. These exercises, however, gave a false picture as typically the submarine had only to show its periscope close to the attacked ship to claim a torpedo hit. For safety, the escorting ships were not allowed to attack a submarine, and some captains of the surface warships took little avoiding actions. As more submarines were commissioned, the older submarines were stationed at the major Royal Navy bases for harbour defence and for training.

German Threat & D Class 1906/1907 Naval Estimates

From the early-1900s there was growing awareness that Germany was a more likely future adversary than France or Russia.¹⁴⁶ Admiral Fisher recognised the vulnerability of the east coast of England and the potential for an invasion or raids continued to cause concern in deciding the location of the Home Fleet. Plymouth and Scapa Flow were too far away from the threatened east coast. Rosyth was better placed but the naval dockyard being constructed there was not ready. In 1907 Fisher positioned the best battleships and flotilla craft at the

¹⁴³ Ibid, p 3.7.

¹⁴⁴ 'The Development of HM Submarines', BR 3043, p 3.34.

¹⁴⁵ P Kemp & P Jung, 'Five Broken Down B Boats, British Submarine Operations in the Northern Adriatic 1915-1917', *Warship International*, No.1 1989 pp 11-29.

¹⁴⁶ M S Seligman, 'Switching Horses: The Admiralty's Recognition of the Threat from Germany, 1900-1905', *The International History Review*, June 2008, Vol. 30 (2), pp 239-258.

Nore. The Nore Division comprised six battleships including the new HMS *Dreadnought*, eight of the latest armoured cruisers, forty-eight destroyers and twenty submarines.¹⁴⁷ The Nore Division was thus a homogeneous force integrating the capabilities of the different types of warships, enabling the development of a layered defence system. In the event of a German invasion or raid, the submarines albeit C Class coastal type, would have provided a forward defence layer in the southern North Sea. Fisher referred to the Nore Division as a “permanent Home Guard” with the role as a deterrent until the arrival of the main Home Fleet.¹⁴⁸ Fisher continued to build up the number of armoured warships and submarines in home waters, and to improve their fighting efficiency to ensure superiority over Germany. The experience gained initially with the Nore Division, and the subsequent naval manoeuvres, established the naval plans, the dispositions of naval resources particularly the Grand Fleet, and the layered defence system implemented in 1914.

The vulnerability of Britain’s East Coast to a German surprise attack necessitated that early warning be received to allow all defences to be in position and enable the capital ships of the Home Fleet to intercept the German High Seas Fleet or invasion troopships. An observational blockade / early warning system was therefore a major concern that dominated the Admiralty’s war planning. The opening of the Kaiser Wilhelm Canal in 1895 enabled the German fleet to enter the North Sea from two routes, namely the German Heligoland Bight and the Skagerrak, placing additional demands on the Navy’s scouting warships.¹⁴⁹ The initial war plan for war against Germany was for the Royal Navy’s battle fleet to operate a close blockade off their North Sea naval bases.¹⁵⁰ It quickly became apparent that a battle fleet off the German North Sea navy bases would be very exposed to attack by torpedo craft at night or during poor visibility. Throughout the 1900s there were various plans for destroyers and light cruisers to operate a close, observational blockade off these bases, but they too would be vulnerable to a surprise attack from superior enemy forces. Shawn Grimes has examined the War Plans against Germany in the context of the situation in which they were written, particularly in parallel with British Foreign Office activities of Scandinavian neutrality and ensuring diplomatic access to the Baltic.¹⁵¹ Grimes concludes that the development and evolution of these plans

¹⁴⁷ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics, and British War Planning, 1990-1914*, p 162.

¹⁴⁸ Ibid, p 163

¹⁴⁹ Ibid, p 141

¹⁵⁰ P Kennedy, *The Rise and Fall of British Naval Mastery*.

¹⁵¹ S T Grimes, *Strategy and War Planning in the British Navy, 1887-1918*.

supports the Orthodox and Post Revisionist historians and undermines the Revisionists' theories. This is the context in which the deployment of submarines was taken.

There was a pressing need to operate a close, observational patrol off the north German coast.

The Admiralty appreciated that surface warships in this task were too vulnerable, and the C Class coastal-type submarines were too small with insufficient endurance. Consequently, the 1906/07 naval estimates included a larger prototype submarine, double the size of the C Class, fitted with twin diesels and wireless telegraphy equipment to transmit and receive messages. This became the D Class and with its endurance to patrol off the German coast, was the first to be referred to as an "overseas" submarine, thus providing the crucial, forward defence layer upon which the other layers depended. The coast types had internal ballast tanks, whereas the D Class was the first to have external port and starboard ballast tanks. These so-called saddle tanks provided a great reserve of surfaced buoyancy, being safer and with better seakeeping properties. The additional internal space enabled better habitability, albeit still stark, and an enhanced internal layout for additional equipment. The diesel propulsion replaced the explosive risk of the previous petrol engine submarines and provided the requisite endurance and speed for operations off the enemy's coast. The D Class were fitted with two bow and one stern torpedo tubes, and a gun installed in most of the class. Known as 'overseas' type, these were the first submarines capable of prolonged offensive operations off the enemy's coast and set the standard for subsequent classes of overseas-type submarines.¹⁵² The prototype, first-of-class D.1 was ordered in the 1906-07 Navy Estimates,¹⁵³ and D.2 was ordered in the 1908-09 Navy Estimates.¹⁵⁴ With confidence in the design, D.3 to D.8 were ordered in the 1909-1910 navy estimates.¹⁵⁵

In 1907 Admiral Fisher established a committee to re-examine the war plans for offensive operations off the German North Sea coast. The committee was under Captain Ballard, recently Assistant Director of Naval Intelligence and the most experienced naval planner. Captain M.P.A. Hankey RMA, the War Division's expert on coastal defence and amphibious operations and the future CID Secretary was also a member.¹⁵⁶ (Ballard and Hankey had been on the 1905 Owen Committee reviewing the defences of the principal naval bases at

¹⁵² 'Ship's Cover D Class', ADM/SC212, Brass Foundry, NMM.

¹⁵³ Report of the Navy Estimate Committee 1906-07, CAB 37/81/173, TNA.

¹⁵⁴ Navy Estimates 1908-09, CAB 37/90/112, TNA.

¹⁵⁵ Navy Estimates 1909-10, CAB 37/96/164, TNA.

¹⁵⁶ S T Grimes, *Strategy and War Planning in the British Navy, 1887-1918*, pp 86-101.

home and overseas.¹⁵⁷) The Committee's membership also included Captain E. Slade, President of the Naval War College in Portsmouth, and Julian Corbett, a lecturer on the War Course, underscoring the link between the existing link between Naval Intelligence and the War Course in strategic planning. The Committee met at the Admiralty and at the Naval War College where Captain Slade organised war games to test the feasibility of the plans.¹⁵⁸ The resulting 1907-1908 plans considered a war against Germany with Britain alone, and in alliance with France. Four potential offensive operations were considered, namely:

1. Seizure of the Island of Sylt.
2. Blocking the Weser River.
3. Blocking the Mouth of the Rive Elbe.
4. Forcing the Defences of Cuxhaven.
5. Military Expedition to Zeeland in Support of the Danes against German Invasion

Each of the cases were considered in terms of (1) A direct attack on the German fleet, (2) An attack on the German line of passage and communications, (3) A diversionary raid, and (4) An eccentric attack.¹⁵⁹ The plans also considered the diplomatic reactions of the Scandinavian countries, including them laying minefield in The Belts and The Sound. The various possibilities are described by Grimes.¹⁶⁰ Germany was aware of the possible British actions and conducted naval manoeuvres to simulate these. In 1908, Captain P.W. Dumas the British Naval Attaché in Berlin, speculated that with the expected widening of the Kaiser Wilhelm Canal, and the extensive development of the Wilhelmshaven naval dockyard, an Anglo-German war might occur in 1913.¹⁶¹

These War Plans reflect the situation in 1907 and specified the main resources, that is the layers, that were to be combine for each potential operation. The plans included the disposition of the Royal Naval warships in time of peace and on mobilization, in effect the layers available for defensive and for offensive operations.¹⁶²

¹⁵⁷ S W Roskill, *Hankey Man of Secrets*, Vol.1 1877-1918 (Collins London 1970), pp 65-78.

¹⁵⁸ 'History of War Plans: Remarks on the Framing of Certain Plans for War with Germany now at the Admiralty' G A Ballard, 3 May 1909, ADM 1/8997, TNA.

¹⁵⁹ 'War Plans 1907-1908', CASE 0073, ADM 116/1043B, TNA.

¹⁶⁰ S T Grimes, *Strategy and War Planning in the British Navy, 1887-1918*, pp 100-104.

¹⁶¹ M S Seligman, *Spies in Uniform, British Military and Naval Intelligence on the Eve of the First World War* (Oxford: OUP, 2006).

¹⁶² 'War Plans 1907-1908', CASE 0073, ADM 116/1043B, TNA.

E Class 1910/11 Naval Estimates

The first E Class ordered under the 1910/11 estimates was developed from the D Class, being considerably larger and armed with one bow, two beam and one stern torpedo tube.¹⁶³ Exercises had shown that upon sighting a target, the captain had to manoeuvre the submarine into a time-consuming, end-on torpedo attacking position, potentially losing the opportunity to fire.¹⁶⁴ The beam torpedo tubes thus provided greater flexibility in manoeuvring to attack, albeit with only a single torpedo. The E Class were a very successful design, and fifty-one were built for the Royal Navy and two for the Royal Australian Navy.¹⁶⁵ Larger than the D Class they had more internal space for the latest equipment to be installed. Their design figures were surface speed 15.25 knots and submerged speed 10.25 knots.¹⁶⁶ These capabilities allowed these submarines to transit to and from their patrol areas and to remain on patrol for around three to five days.¹⁶⁷ Depending on the operational objectives and the weather, they maintained surfaced or underwater patrols during the day. They could submerge quickly and then had sufficient submerged endurance to escape from danger. At night they operated on the surface to recharge their batteries. The E Class was designed to have a reasonable factor of safety at a depth of one hundred feet, beyond which it was considered a submarine would never descend voluntarily. Events during the war proved this to be wrong and there was often a need to go deeper, such as diving under a minefield.¹⁶⁸ The designers at the time stated that with the strengthening of the hull from earlier designs they considered the boats capable of diving to two hundred feet. Off the north German coast, the Heligoland Bight is sufficiently shallow that it allowed submarines to lie on the seabed at night, saving battery power and providing the opportunity for the crew to rest.¹⁶⁹ By any standard, the habitability for the officers and crew was spartan, but much better than in the A, B and C Classes. The habitability was just adequate for typical patrols, but when in port, the crew lived on board the submarine flotilla's depot ship.¹⁷⁰ Many improvements were made including more powerful Wireless Telegraphy (W/T), sky searcher on periscopes, sounding machines and underwater signalling

¹⁶³ 'The Development of HM Submarines', BR 3043, Section 4.

¹⁶⁴ Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes, Volume 1*, p 27; Ship's Cover E Class, ADM/SC/291, Brass Foundry, NMM.

¹⁶⁵ F J Dittmar & J J Colledge, *British Warships 1914-1919*.

¹⁶⁶ E.T. d'Eyncourt, 'Submarine papers', DEY/31, Caird Library NMM.

¹⁶⁷ 'The Development of HM Submarines', BR 3043, p 4.14.

¹⁶⁸ Note diving depth calculations were inaccurate in First World War era: D K Brown, 'Submarine Pressure Hull Design and Diving Depths Between the Wars', *Warship International*, 1987 No.3, pp 279-286.

¹⁶⁹ 'Commodore (S) War Records Volume 1 Submarine Patrol Reports', ADM 137/2067, TNA.

¹⁷⁰ 'Ship's Cover E Class', ADM/SC/291, Brass Foundry NMM.

equipment. The endurance of these submarines was highlighted by the two Australian submarines, namely AE.1 and AE.2, proceeding from Portsmouth England to Sydney Australia under their own power. The journey was divided into successive portions between ports, each around one thousand miles. Accomplished between 2 March and 24 May 1914, the submarines were available for service.¹⁷¹ Subsequent chapters will describe the wide range of operations and how these submarines and surface warships were integrated.

F, S, V and W Classes plus Nautilus & Swordfish

All submarine officers and crews were volunteers who needed to become skilled in the technology of submarines. Compared to surface warships, conditions on board were dirty and dangerous, and submarine officers considered themselves to be an elite group. The inevitable gulf between general service and the submarine service resulted in the latter being referred to rather condescendingly as “The Trade”.¹⁷² Submarine officers were expected to serve for a five-year period after which to qualify for further promotion, they would revert to general service on board a surface warship for at least two years. This also allowed the subface warship officers to obtain a better understanding of the capabilities and limitations of submarines. The first Inspecting Captains of Submarines, namely Bacon, Lees and Hall, were appointed due to their technical expertise, but in November 1910 Admiral Sir A.K. Wilson, First Sea Lord, unexpectedly appointed Captain Roger J.B. Keyes as Inspecting Captain of Submarines. Keyes had a track record of leadership and by his own admission was poor on technical issues, but “could be relied upon to bring the submarine service into close touch and co-operation with the fleet”.¹⁷³ Wilson’s appointment of Keyes and the remit for improvement in co-operation became the foundation for submarines being integrated into the developing defensive layers.

Keyes did not have a technical background so quickly established a committee of submarine experts, including Commander Percival Addison, Lieutenants Martin Nasmith, Noel Laurence, and Charles Craven, and worked closely with Arthur Johns the chief submarine designer of the Royal Corp of Naval Constructors.¹⁷⁴ This 1910 committee played a major role in preparing the specifications for submarines by considering the operations they would

¹⁷¹ ‘HMA Submarines AE.1 and AE.2’, MP472/1, 16/14/4771, National Archives of Australia.

¹⁷² D Redford, *The Submarine, A Cultural History from the Great War to Nuclear Combat* (London: Tauris, 2015) p 73.

¹⁷³ Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes,, The Narrow Seas to the Dardanelles 1910-1915, Volume 1*, p 25.

¹⁷⁴ P G Halpern, *The Keyes Papers 1914-1918, Volume 1*.

undertake in the event of war, both coastal and overseas types. As the coastal name implies, their primary layer was to be onsite immediately for port and coastal defence while awaiting the arrival of enemy surface forces. The committee concluded that coastal types should be an economical vessel of small displacement with good seagoing and habitability capabilities to operate in the winter months. Overseas submarines need to operate at considerable distances from their base, providing an observational blockade and a forward offensive layer also with layer(s) of superior surface forces further offshore. These therefore required a large radius of action, able to keep to sea in all weathers and have good habitability for the crew to live on-board in reasonable comfort for lengthy periods.¹⁷⁵

At this time there was a widespread opinion that although the Royal Navy designs were good, the double hulled type of submarines being used by France and Italy, were superior to the British single, spindle hull and the saddle tank designs. The double hull's ballast tank arrangement provided a greater range of buoyancy than could be obtained for a single hulled submarine.¹⁷⁶ This resulted in three S Class built by Scotts to an Italian Fiat design¹⁷⁷, four W Class built by Armstrong to a French Laubeuf design¹⁷⁸, four V Class built by Vickers to their own design¹⁷⁹ and three F Class built to an Admiralty design¹⁸⁰. All were coastal types but by 1914 were considered too small and of limited use. When completed, the S and W Class submarines were ceded quickly to Italy where there was a need for more resources in the Adriatic to counter the Austro-Hungarian fleet. The F Class were used successfully for training. The V Class were capable of limited patrols in the North Sea and were used in this layer to support the larger overseas submarines.¹⁸¹

The D and E Classes were considered suitable for patrols off the German North Sea coast, but their endurance was limited. Circa 1910 there was a perception that for submarines, to be effective needed to be accompanied by a surface warship for scouting duties plus command and control. For example, the coastal submarines on patrol were expected to have surface warships further offshore to provide early warning of an enemy invasion or raid.

¹⁷⁵ 'Memorandum on the Function of Submarines', Commodore Keyes, 15 August 1913, E.T. d'Eyncourt papers DEY 31, Caird Library, NMM.,

¹⁷⁶ D K Brown, 'The Technology of Submarine Design, A Historical Survey', *Interdisciplinary Science Review*, 1990, Vol.15 (3), pp 235-251.

¹⁷⁷ 'Ship's Cover S Class', ADM/SC/289A, Brass Foundry, NMM.

¹⁷⁸ 'Ship's Cover W Class', ADM/SC/307, Brass Foundry, NMM.

¹⁷⁹ 'Ship's Cover V Class', ADM/SC/289, Brass Foundry, NMM.

¹⁸⁰ 'Ship's Cover F Class', ADM/SC/354, Brass Foundry, NMM.

¹⁸¹ Commodore (S) War Records Volume 4, Submarine Patrol Reports' ADM 137/2070, TNA

. . . to get full value out of the submarines it is absolutely essential that they should dive before they are sighted by an enemy. In clear fine weather, provided a good lookout is kept, they should always be able to do so, and under such conditions, it is preferable that submarines should be accompanied by surface craft while lying waiting for an enemy, or proceed to attack some object. . . [In hazy] weather conditions, or when making a long passage when there is the possibility of falling in with an enemy, they should be accompanied by fast surface craft to scout for them.¹⁸²

Such surface warship support was clearly impracticable for overseas submarines off an enemy's coast. A larger overseas submarine was considered necessary to provide the added endurance, operate in all weather conditions and with a higher speed to do its own scouting, and to work directly with the fleet. Consequentially the Submarine Committee meeting of 29 February 1912 included a proposal for a larger overseas submarine.¹⁸³ The outline specification included: The vessel to have a large reserve of buoyancy; Surface displacement of about 1,000 tons; Double hull (complete or partial); Sub-division of hull; Surface speed should be about 20 knots; Submerged speed should be high for a short distance; Large surface and submerged endurance at economical speeds; Capable of submerging in three minutes; Good accommodation for officers and men; Armament two right ahead, two beam tubes each side, and stern tubes. Consideration was given to a foreign design from Labeuf, FIAT, Krupp and Electric Boat.¹⁸⁴ All their designs had improvements in habitability as they recognised the importance of the health and the endurance of the crews. It was also recognised that to obtain the 20 knot surface speed, the horsepower of the current heavy oil engines would need to be increased. Vickers endeavoured to design a submarine to the committee's recommendations but found that the displacement had to be increased for more engine space before they could guarantee a speed of even 17 knots with combustion engines. Scotts were tasked to design a submarine with steam turbine propulsion as it appeared that steam was the only way to provide the requisite power for great speed.¹⁸⁵ In 1913 an order was placed for one submarine, HMS *Nautilus*, with Vickers, but not completed until 1917, as the Admiralty instructed that work was to be stopped due to delays with the engines and permit work on more urgent submarine construction. Considered somewhat as an experimental submarine,

¹⁸² Memorandum by Inspecting Captain of Submarines to Admiralty, 3 June 1911, Keyes Mss 4/13, British Library.

¹⁸³ 'Report of the Submarine Committee on Future Material', 29 February 1912, ADM 1/8374/93, TNA.

¹⁸⁴ Ibid

¹⁸⁵ 'Memorandum by Commodore Roger Keyes on the Function of Submarines', 15 August 1913, E T d'Eyncourt Papers, DEY 31, Caird Library, NMM.

Nautilus did not become operational. The Scotts steam powered submarine, HMS *Swordfish*, was completed in 1916, but was found to be unsuccessful and in 1917 was converted into a surface patrol vessel. However, the experience gained was useful in the later fleet-type K Class steam powered submarines.¹⁸⁶

Vickers' contract with the Admiralty gave it a monopoly to build submarines for the Royal Navy including those designed by the Admiralty. When it became clear that Vickers could not meet all future requirements, on 31 March 1911 the Admiralty gave them the two years notice to terminate this contract. An agreement was reached that in the interim, submarines could be built in HM Dockyards and hence orders for ten submarines were awarded to Chatham Dockyard. When the exclusive Vickers contract terminated in 1913, submarines could be built in other Admiralty dockyards and in commercial shipyards.¹⁸⁷

By 1911 the disposition of the operational submarines consisted of twelve C Class at Dundee, twelve C Class at Harwich, and ten C Class and five B Class at Portsmouth that in wartime would transfer to Dover. Eight new D Class in Portsmouth but in wartime moving to Harwich. The C Class submarines at Dundee and Harwich were allocated for East Coast defence. They were not to be on continuous patrol but be stationed at various strategic points on the coast, in one or more groups of three submarines with a parent ship, ready to proceed at short notice to an enemy raid location. The Dover-based submarines would work with a destroyer flotilla to assist in blocking the Dover Straits. The D Class submarines were available to operate off the German North Sea coast.¹⁸⁸ In 1911 Keyes assumed wrongly that the Royal Navy would be operating an inshore surface ship blockade, and should they be attacked by German ships, these submarines would be further to seaward in support.¹⁸⁹

Fleet Manoeuvres, Design Developments and Changing Naval War Plans

In the 1880s, the threat of the large number of French small, torpedo-armed warships led to the development of the Torpedo Boat Destroyer, designed initially to operate in the English Channel.¹⁹⁰ By the 1900s Germany was building torpedo boat warships with their primary weapon being torpedoes. The Admiralty responded by building ever larger destroyers with better seakeeping and endurance capable of operating in the North Sea. In the mid-1900s

¹⁸⁶ M P Cocker, *Royal Naval Submarines 1901-1982* (London: Warne, 1982).

¹⁸⁷ Adm. R B Keyes, *Naval Memoires, The Narrow Seas to the Dardanelles 1910-1915, Volume 1*, p 28.

¹⁸⁸ 'Memorandum by Inspecting Captain of Submarines' 3 Jun 1911, Keyes MSS 4/13, British Library.

¹⁸⁹ Note signed by Keyes, attached to 'Memorandum by Inspecting Captain of Submarines', 3 June 1911, Keyes MSS 4/13, British Library.

¹⁹⁰ D Lyon, *The First Destroyers* (London: Chatham 1996).

destroyers were organised into divisions and based under the Commander-in-Chief of each naval base, but with the threat of war, some divisions would join the fleet, some with cruisers to operate in an observational role off the German naval bases, and the older, smaller destroyers to maintain local, coastal patrols.¹⁹¹ By 1912 it was clear that the Royal Navy could not operate a close blockade off the German coast using surface warships. It was planned therefore that cruisers and destroyers would maintain a North Sea intermediate observational blockade, stationed in an arc between Horn's Reef off Denmark and Terschelling Island off the Netherlands.¹⁹² However the manoeuvres showed that these could be evaded at night or in poor visibility. They would also be very vulnerable to a surprise attack by fast, powerful German Battle Cruisers. The Admiralty had assumed that they would prevent any German amphibious landings on the East Coast, but the Navy's extensive manoeuvres in 1912 and in 1913 highlighted that this was possible. Within the Admiralty it became known as the "North Sea Problem".¹⁹³ In the 1912 manoeuvres the Red Fleet, representing the German navy, had evaded the Blue Fleet, representing the Royal Navy.¹⁹⁴ The Blue coast was the whole of the British Isles, except with the Red coast between Yarmouth and Dungeness, with Harwich representing the Ems, Dover and the Downs the Jade and Heligoland Bight. The Blue Fleet was located initially near Scapa Flow. Before any of the Red Fleet could mount a raid, they had to proceed first into the North Sea the equivalent of having left a German base, and then turn towards the East Coast. The Red Fleet evaded the Blue Fleet and successfully landed troops on the Yorkshire coast and also on the North-East coast between Sunderland and Blyth to simulate a raid to destroy the nearby large shipbuilding and armaments industries. The Red Fleet also executed a successful raid into the Humber where they simulated a bombardment of Hull. The similar 1913 manoeuvres were curtailed by concern that a further landing planned could have alerted the Germans to such wartime opportunity.¹⁹⁵

To fulfil their role as an integral part of the fleet, British destroyers were designed with a heavier gun armament and high speed, but at the expense of fewer torpedoes. Destroyers were organised into flotillas led by a light cruiser to accommodate the flotilla commander and staff and to provide protection against attacks by German light cruisers. Larger heavily gun-armed, high-speed destroyers were built, and defined as destroyer-leaders, to also provide the flotilla

¹⁹¹ 'War Plans 1907-1908', ADM 116/1043B/1, TNA.

¹⁹² D G Morgan-Owen, 'An Intermediate Blockade', *War in History*, 2015. Vol.22 (4), pp.478-502.

¹⁹³ Ibid, p 212.

¹⁹⁴ 'Reports, Naval Manoeuvres 1912', ADM 116/1169, TNA.

¹⁹⁵ 'Reports, Naval Manoeuvres 1913, ADM 116/1214, TNA.

command roles.¹⁹⁶ These destroyer flotillas were thus crucial capabilities in the Grand Fleet in both defensive and offensive roles in layered defence. Throughout the war, additional destroyers were in demand by all commands, and there were always shortages.¹⁹⁷ It will be seen in later chapters that the importance of destroyers in the anti-U Boat campaign necessitated destroyers being taken from the Grand Fleet, that in turn inhibited plans for a major fleet action.¹⁹⁸

The Admiralty incorporated both the overseas and the earlier coastal types into the 1913 naval manoeuvres to evaluate and verify their potential roles. As in 1912, the Blue Fleet represented the British fleet whilst the Red Fleet represented the German fleet. Different scenarios were included with submarines and destroyers in layered defence roles, for example:

- The Red Fleet's raid on Immingham, Grimsby and Haisborough included the 8TH Submarine Flotilla of overseas types, was on a patrol line from Flamborough Head to 30 miles offshore. The 4TH Submarine Flotilla of coastal types covered the Red Fleet retreating eastward by attack from the pursuing Blue Fleet battleships.
- The Red Fleet's raid on Blyth and Sunderland included the 4TH Submarine Flotilla on a line from the Coquet Island at right angles to coast and a similar line 10 miles south of Sunderland. These would attack Blue Fleet ships coming from the north and south respectively.
- Blue Fleet C Class coastal submarines were located at major ports to attack the Red Fleet.¹⁹⁹

Submarines and destroyers integrated with the fleets demonstrated that they could provide very significant enhancements to the layered defence systems. However, despite the enthusiasm of the submarine service and progressive senior officers, the coastal submarines failed to meet expectations as they did not prevent an enemy fleet entering the Humber and bombarding Hull, nor did they prevent the enemy landing troops on the North-East coast.²⁰⁰ Overseas submarines were credited with some success against a fleet in the North Sea although they were pre-positioned on its track and did not need to search for it. The analysis of submarine attacks was somewhat artificial as they did not fire practice torpedoes but merely

¹⁹⁶ E J March, *British Destroyers* (London: Seeley, 1966).

¹⁹⁷ For example: 'Grand Fleet Ships, Allocation of Destroyers, 15 September 1914', ADM 137/995, pp 43-100, TNA: 'Discussion at Admiralty on Occasion of Visit of Commander-in-Chief, Grand Fleet, 2nd – 3rd January 1918', Geddes Papers, ADM 116/1806, TNA.

¹⁹⁸ S Roskill, *Admiral of the Fleet Earl Beatty* [1980] (Barnsley: Pen & Sword, 2018), p 250.

¹⁹⁹ 'Reports, Naval Manoeuvres 1913, ADM 116/1214, TNA.

²⁰⁰ Ibid

had to raise their periscope close to a target to claim a torpedo hit. The target's escorting destroyers were not allowed to operate close to the positions of submarines as there was too great a risk of an accidental ramming with the sinking of the submarine and loss of the crew.²⁰¹ The slow speed of submarines and their poor range of visibility, particularly through their periscopes when submerged, revealed that they had to be in right position before the enemy arrived. Churchill, First Lord, drew the conclusion that coastal patrol flotillas "did not achieve any tactical purpose".²⁰² The analysis of the manoeuvres showed that the Red Fleet, representing the German High Seas Fleet, could cross the North Sea and arrive off any East Coast port with little or no warning. Blue Fleet submarines were credited with torpedoing some Red surface warships and transports, particularly those at anchor or proceeding slowly. Red Fleet submarines were also credited with torpedoing Blue Fleet surface warships as they retreated eastwards.²⁰³ Admiral Sir William May, who was chief umpire for these manoeuvres, reported that submarines alone did not provide security for the British Isles, as they needed to be part of larger defence force with other warship types - a layered defence system:

The experience gained from the raids on the Humber, Sunderland and Blyth is that provided the attack is a surprise they may be partially successful especially in misty weather. The coastal patrol, although a good protection, with proper look-out vessels and experience is not sufficient; it therefore appears necessary to have fixed defences at the principal seaports in the United Kingdom and of sufficient strength to be able to check a determined raid for some hours until a battle fleet can be concentrated on the spot and at the same time give opportunities for the submarines to act.²⁰⁴

The manoeuvres revealed the difficulties of providing early warning of an enemy attack. In the North Sea, daytime visibility is often very poor and with insufficient patrol vessels available, there was no guarantee that an enemy force would be sighted and reported, prior to a bombardment or amphibious landing. By night, sighting and enemy force was even harder. The conclusion drawn was that east-coast ports needed land-based defences, probably artillery and supporting troops. The British fleet, stationed in Scotland, needed approximately a day to arrive off an east-coast port. Therefore, to achieve the maximum warning that a

²⁰¹ Ibid

²⁰² Report by W.S. Churchill, 'Notes on Manoeuvres: Prepared for the Prime Minister by the First Lord', ADM 116/3381, TNA.

²⁰³ 'Manoeuvres 1912, Flag Officer's Remarks', ADM 1/8269 Case 1493, TNA; 'Naval Manoeuvres 1913', ADM, 116/1214, TNA.

²⁰⁴ 'Report on the 1913 Manoeuvres by Admiral of the Fleet Sir William May', 18 August 1913, ADM 116/3381, TNA.

German force was at sea, it was imperative that it be sighted and reported as it left one of their North Sea naval bases.

1913: A Turning Point.

It was clear to the Admiralty that a battle fleet or light forces could not operate an observational or an intermediate blockade in the North Sea. In late 1912 the Admiralty decided to operate a distant (economic) blockade, codified in Plan A/A1 (1907).²⁰⁵ The battle fleet would be stationed at Scapa Flow in the Orkney Islands and control the exit to the North Sea between the Shetland Islands and Norway. The cost would be that the Germans could mount a raid or even an invasion of the British East coast and it would take time for the British fleet to come south in defence. Against this, the blockade or rather a contraband control system would stifle German trade.²⁰⁶ Although the effect on German industry and population would be slow, this became a key element in British Naval Policy. In the longer term as submarines developed, it was considered that it would be increasingly difficult for either country to obtain command of the North Sea in the accepted sense of the term. However, the problem of obtaining early warning of a German raid or invasion, “the North Sea problem” still existed. Consideration was given to achieving early warning of German fleet movements by composite squadrons of battle cruisers and light cruisers, all capable of high speed, making regular sweeps in the southern North Sea.²⁰⁷ This plan was also unsatisfactory as it would have been possible for the German High Seas Fleet and invasion or raiding transport ships to be unobserved or to evade these Royal Navy sweeps.

In July and August 1913 there were four papers from the War Staff, from Ballard, from Churchill and from Keyes that propose solving the North Sea Problem by means of submarines used in a layered defence system. The centrality to the argument justifies quoting them at length.

First: War Staff minute on submarines, 18 July 1913:

The operations carried out in last year's manoeuvres demonstrated practically that the submarine has progressed beyond the stage of a local defence craft and that the larger classes which we now possess are capable of more offensive action in war at a distance from their bases than was anticipated a few years ago; in fact great potentialities appear to lie in this direction and the policy of further development in a

²⁰⁵ S T Grimes, *Strategy and War Planning in the British Navy 1887-1918*, p 159.

²⁰⁶ J Ferris, 'Pragmatic hegemony and British economic warfare 1900–1918,' in G Kennedy (ed) *The War they thought and the war they fought* (Westport: Praeger, 2016).

²⁰⁷ D G Morgan-Owen, *The Fear of Invasion, Strategy, Politics, and British War Planning, 1880-1914*, p 223.

design to meet war requirements is fully concurred in by the War Staff, and although the new designs appear to have been prepared before considering the actual details of the movements and operations for which they will be required, it is very possible they may be found, if not absolutely suitable, a forward step in the right direction towards obtaining the ideal.

. . . further advantage can then be taken of their power of evasive diving, to carry out, or endeavour to carry out, our most difficult problem in war with a near enemy, viz.: that of close observation and offensive action off and perhaps in our enemy's naval bases, if not mined, and may enable us to revive the strategy of close blockade. It is problematical, but worth trying for, and would require practical exercises in peace manoeuvres to prove its value before being adopted as part of our war plans. . . Good wireless to report the enemy's movements to supporting vessels up to 60 miles or so would be essential. The supporting vessels might be fast cruisers, destroyers, or even large submergible vessels, of which, it is understood, designs are being prepared.

. . . the War Staff would not advocate the construction of small coastal defence submarines of special design so long as others [Ds and Es] are available to fall back into this category. Should such, however, be required surface speed should be one of the first considerations, to enable them to reach the threatened spot as quickly as possible.

. . . It is a matter of consideration whether these new types [overseas] of submarines projected should have some distinguishing official appellation, such as "submersible Blockader".

. . . The question of the above watercraft to act in conjunction with the open sea type [fleet] is one which the opinion of Commodore (S) should be obtained. The destroyers working with the patrol [overseas] submarine flotillas appear satisfactory, but for the open sea at long distances from their bases more powerful ships with high speed in rough weather will probably be demanded, so that they could seek safety in temporary flight, returning to the sphere of operations of the submarines subsequently.²⁰⁸

Second: In July 1913, Captain George Ballard, Director of Operations Division, Naval War Staff, in a pivotal paper, *War Staff: General Policy of Submarine Development*, established the basis for the development of submarines and their use in wartime:

. . . Very great potential appears to lie in this direction.

²⁰⁸ 'War Staff Minute on Submarines', 18 July 1913, E T d'Eyncourt papers, DEY/31, Caird Library, NMM.

It is not considered, however, that, as a matter of general policy, money should be diverted from building battleships and other surface types of ocean-going vessels towards increasing the submarine programme. The defence of the Empire as a whole requires that the present high standard of ocean-going vessels should be maintained. Submarines of any type are a special case in so far as their more immediate development seems probable. They are suitable only for special conditions, and, although there seems to be good reason for anticipating that before very long they will be supreme within their own sphere, that sphere is limited, and they cannot be regarded as fair substitutes for battleships or cruisers in a general review of our position. . . .

There appears to be three special spheres of activity for submarines, each to a certain extent demanding special qualifications to obtain the best results:

The most important of these spheres would consist in a watch of the enemy's harbours, reviving the strategy of a close blockade. . . Dive in safety in 6 fathoms, good radius of action on the surface and submerged and habitability would be required but not a high surface speed. . . .

The second sphere is of duty for submarines would be in open water on watch for hostile squadrons known to be at sea. Vessels designed for this purpose would to some extent take the place of light cruisers and might be much larger than the blockade type. Their principal requirements would be a high surface speed. . .

A coastal patroller would require neither a great radius of action nor habitability for long periods. Her prime qualification should be a very high surface speed to enable her to reach a threatened point. . .²⁰⁹

Third: Churchill, First Lord, added to these, 20 July 1913:

There are three distinct types, of which the dominant requirements are respectively:

- 1 For Coastals – Numbers.
- 2 For Overseas – Endurance.
- 3 For Ocean – Speed.

The Coastal Submarine is a partial substitute for the Shore battery and the Mine fields,
The Overseas Submarine takes the place of Torpedo Boat Destroyers and the inshore

²⁰⁹ 'Memorandum by Captain George Ballard, Director of Operation Division, Naval War Staff', 14 July 1913, ADM 1/8331, TNA.

squadron. The Ocean Submarine is a decisive weapon of battle as such must count in partial substitution of battleship strength.

. . . Overseas boats are for blockade. The Ds and Es belong to this class through a great improvement is required. They must be able to dive quickly and in 6 or 7 fathoms – less if possible. They must be able to keep to sea continuously for 7 days . . . Overseas submarines proceeding on blockade service, so as to arrive fresh, should be convoyed by destroyers and cruisers and travel behind an effective screen of fast vessels until they approach the blockade area. Then their escorts stand off and they go on alone. It is a matter of individual preference whether they should take a destroyer with each group for lookout work or not. The pros and cons are evenly balanced. Some officers would like it, others prefer to work alone.

. . . No class of submarine requires guns except against aircraft.

. . . Forty-eight Overseas boats are required to maintain a continuous blockade of the German rivers. . . This force could be created largely at the expense of the destroyers.

. . . Ocean submarines should be organised in “Submarine flotillas” as follows: Three or four Ocean submarines of 24 knots surface speed. Two Light Cruisers of 30-31 knots, one of each as a small seagoing depot ship, and the other carries 3 sea planes. Four submarine squadrons might be created for general service and stationed in the North Sea and Mediterranean. It is important to choose their ports so that the water is deep enough for the submerged cruiser to leave harbour and go to sea if necessary submerged: Cromarty, Gibraltar and Malta fulfil this condition.²¹⁰

Fourth: Commodore (S), Commodore R. Keyes minute, 15 August 1913 in response to the War Staff and to Churchill’s minutes:

A Committee of Submarine officers in February 1912 recommended the construction of two types of submarines, after careful considering the operations they would be called upon to perform in time of war:

The Coastal. . . should carry out duties efficiently in the winter months, seagoing qualities and habitability were considered essential.

The Overseas. . . The “E” Class may be considered as the first of the “overseas” type proper. It was decided to build a large overseas vessel for experimental purposes. . . capable of accompanying a modern fleet to sea. A Vickers design for the latter would not guarantee a speed of even 17 knots which was disappointing as it was hoped to

²¹⁰ W S Churchill, ‘Notes on Submarines’, 20 July 1913, E.T. d’Eyncourt papers, DEY/31, Caird Library, NMM.

obtain 20 knots. Scotts were then asked to prepare a design for a steam turbine submarine as it appears that steam is the only method of obtaining the higher power required for greater speed.

. . . The E Class are considered very suitable to the inshore squadron working off the Elbe. Vickers have designed a double-hulled E boat of about the same displacement that is faster and work in all-weather but is considerably more expensive.²¹¹

These documents from July and August 1913, clearly demonstrate the integration of submarines with surface warships into a layered system way-of-warfare. The War Staff minute states clearly that the overseas submarines are to be used for observation and offensive action off and perhaps in our enemy's naval bases reviving the strategy of a close blockade. These submarines needed good W/T to communicate with their supporting fast cruisers and destroyers. The minute also states that no coastal types are needed as the current overseas submarines will be used if necessary against any coastal raids or amphibious landing. Churchill's minute, written two days later, agrees with the War Staff and adds the requirement for composite "submarine flotillas" consisting of fast ocean submarines and light cruisers. One light cruiser to be a seagoing depot ship and the other to operate aircraft, note: submarines, light cruisers and aircraft operating together in a combined unit would have been a very ambitious layered system. Commodore (S)'s minute refers to the decisions made at a conference of submarine officer in February 1912. Although he agrees with the War Staff and Churchill minutes, he also endeavours to justify the additional coastal and the two large fast submarines then under construction, and their contribution to other layers. He mentions also the improved overseas double hull design being developed by Vickers which became the G Class.

At the end of 1913, intelligence reports indicated that Germany was spending their submarine budget on overseas-type of double hull construction, approximately the size of the E Class. On 9 December 1913 at a conference in the First Lord's room, the Admiralty decided to prepare a design of an overseas type of partial double hull construction, also similar in size to the E Class.²¹² The initial armament was single 21-inch torpedo tubes forward and aft and two 18-inch beam tubes. This design became the G Class, and in July 1914 fourteen were ordered from Chatham Dockyard. Their double hull design allowed the outer hull to be

²¹¹ 'Commodore (S) Minute on Submarines', 15 August 1913, E T d'Eyncourt papers, DEY/31, Caird Library, NMM.

²¹² 'Minutes of Admiralty Conference on Submarine Policy' 9 December 1913, Keyes papers, British Library.

designed for surface performance thus enabling higher surfaced speed and better seakeeping performance. The first were available in late 1915, albeit construction of some was delayed. They were considered successful and throughout the war operated alongside the more numerous E Class.²¹³

Although nominally retired, Admiral Fisher was still very active in the immediate pre-war period, and published two inciteful memoranda on the effect that submarines would have on naval warfare. The first was "The Oil Engine and the Submarine", and subtitled "Some Reflections on impending vast Changes in Sea Fighting".²¹⁴ The second was "The Submarine", and subtitled "A Contribution to the Consideration of Future Sea Fighting".²¹⁵

Submarine Policy Investigated by Naval War College

The importance that the Admiralty placed on the use of submarines in layered defence is reflected in the pre-war work of the Naval War College, in today's parlance, a think tank where different scenarios were examined, and potential solutions developed. War games were conducted to evaluate strategic problems facing the Admiralty, and the results from these influenced Admiralty war plans. The course participants were obliged to write essays on specified issues and these essays were circulated and further influenced naval thinking at the Admiralty. During this period, the essays on the role of submarines reflected their on-going development and their operational capabilities.

Such essays included:

- Autumn 1912: In the event of war with Germany discuss the relative merits of a line of patrol compared with a periodical 'sweep' of the area of operations and including use of submarines in an observational blockade of German North Sea ports.
- Autumn 1912: The feasibility or otherwise of carrying out a close blockade of German Ports with the latest type of Submarine and what would be the best way of employing them in war time?
- Spring 1914: What effect will the increased offensive power of submarines have in the position in the North Sea in the event of a war between England and Germany?²¹⁶

These and other essays indicate Admiralty progressive thinking, their endeavours to acquire fresh ideas and how to implement their developing war plans. The courses provided training

²¹³ 'Ship's Cover G Class', ADM/SC/330, Brass Foundry, NMM.

²¹⁴ 'The Oil Engine and the Submarine', c1914, Fisher papers FISR 5/18, Churchill Archive Centre, Cambridge.

²¹⁵ 'The Submarine', c1914, Fisher papers FISR 5/22, Churchill Archive Centre, Cambridge.

²¹⁶ 'Royal Naval War College Portsmouth and Naval Staff College Greenwich', ADM 203/100, TNA.

for officers enabling them to appreciate the capabilities and planned use of submarines. At the end of each course, the participants were graded thus determining their likely appointments within the navy.

Substitution of Submarines for Battleships

The Admiralty was very aware of their shortage of overseas submarines to implement their layered defence plans. In 1914 a further four super dreadnought battleships were scheduled to be ordered, and with those already under construction, the Royal Navy would have a large superiority of dreadnought battleships over the German navy. Churchill therefore considered replacing two of these four battleships with additional destroyers and submarines, but he had to be careful of both Parliamentary and Public opinion which favoured battleships and did not see the requirements for smaller vessels. He also had to consider the effect on shipyard and ordnance factory work should he cancel these scheduled battleships. The Sea Lords developed this plan by investigating the continuance of the Royal Navy's 60% margin in capital ships over the German navy, and if possible, the substitution of submarines for battleships.²¹⁷ This confirms further Churchill's and the Admiralty's recognition of the urgent need for more overseas submarines and their importance in how they planned to fight the naval war.

The 1914 Naval Conference - The Eve of War

Rather than have further, expensive fleet manoeuvres in 1914, the Admiralty decided to hold a major conference immediately after the Fleet Review in July.²¹⁸ Seligman has correctly highlighted that the issues to be discussed in the conference destroy the erroneous perceptions that the Admiralty was backward in the application of modern technologies, and then implementing these in the optimum strategies and tactics.²¹⁹ All senior officers from Commodore and above were to attend and were invited to suggest issues to be discussed, albeit the final issues and agenda were decided by Churchill.²²⁰ The naval conference did not occur due to the rapidly deteriorating diplomatic failures to avert the war. However, the preparation of the introductory précis for each issue, and the agenda are good guides as to the concerns of senior officers, and as to how the Admiralty intended to fight the naval war.

²¹⁷ C M Bell, *Churchill & Sea Power* (Oxford: OUP, 2013), pp 26-27.

²¹⁸ 'Precis and Agenda, Flag Officers' Conference papers', 24/25 July 1914, ADM 1/8387/219, TNA.

²¹⁹ M S Seligman, 'A Service Ready for Total War? The State of the Royal Navy in July 1914', *The English History Review*, 2018, Vol.133 (560), pp 98-122.

²²⁰ 'Precis and Agenda, Flag Officers' Conference papers', 24/25 July 1914, ADM 1/8387/219, TNA.

One of the more significant issues to this dissertation was suggested in a letter by Rear Admiral C.E. Madden, then in command of the 2ND Cruiser Squadron, and dealt with the proposed composite squadrons of combining battle cruisers and light cruisers.

“It is perhaps, the Light Cruiser’s lot on war to be detached and take part in operations with a greater number of different types of ships than any other class, for circumstances will probably arise when they will be called upon to act with:

1. Submarines, to locate the enemy.
2. Destroyers, to support in an offensive movement.
3. Cruisers, as an advanced line of lookouts watching a channel, shadowing, etc.
4. Battle Cruisers, as the advanced lookouts to a fleet pursuing an offensive policy.
5. Battle Fleet, to cover its flanks from torpedo attack during a fleet action and to attack with torpedoes the enemy’s line and torpedo craft”.²²¹

Although Madden’s comments dealt specifically with the wartime roles of Light Cruisers, they illustrate his very inciteful thinking on the core layered defence system. Each of the five points listed utilise the capabilities and strengths of each type of warship, and succinctly defines their integrated roles. The significance of this is that shortly afterwards, Madden became Chief-of-Staff to Admiral Jellicoe, Commander-in-Chief of the Grand Fleet, and as such had a major contribution on strategy and tactics, with these five points became the standard for fighting the naval war. Historians have largely ignored Madden’s important influence on the naval war.

In July 1914, submarines had not been used previously in naval warfare. The submarine service had been viewed from its inception and development as somewhat of a separate entity within the Royal Navy. During the annual War Course, submarines roles were explored and evaluated extensively in different scenarios, but not all senior offices had participated in the more recent war courses.²²² The conference therefore provided an opportunity to re-iterate Admiralty thinking and plans on submarine capabilities and planned roles. All attending were provided with the technical details of the larger / overseas submarines then under construction, namely *Nautilus*, *Swordfish*, Later E Class, and Admiralty Improved E Class (shortly to be redesignate G Class). The submarine issues to be discussed during the conference were:

- a) What is the value of a submarine, and how can they capable of influencing the results of a war with Germany?

²²¹ ‘Letter from Rear Adm. C E Madden to C-in-C’, 11 June 1914, ADM 137/1939, TNA.

²²² ‘Royal Naval War College Portsmouth and Naval Staff College Greenwich’ ADM 203/100, TNA.

- b) What measures are best to protect heavy ships against them (i) at sea, (ii) when leaving or returning to port?²²³

A very full agenda limited the time for issue (a) to twenty-minutes for presentation and discussion. Issue (a) is essentially about the roles for Royal Navy submarines, whereas issue (b) is concerned with anti-U Boat warfare. The War Orders specified already that overseas submarines, all based in Harwich, were to implement a close, observational blockade off the German North Sea naval bases, to report and to attack any sortie, and to gather intelligence. This issue provided the Admiralty the opportunity to emphasize these orders and emphasize that submarines were in the front line of the major layered defence system, including initially the Harwich Force, Channel Fleet, Grand Fleet and the economic blockading squadrons. This is completely compatible with Madden's strategy. Issue (b) was allocated only ten-minutes that was barely enough to inform this attending of the latest anti-U Boat technology and ship manoeuvring when sighting a U Boat.

After the fleet review but before the conference could commence, all Royal Navy warships were deployed to their war stations. In home waters these included the Grand Fleet to Scapa Flow, a Battle Cruiser Force to the Humber, a force of light cruisers and destroyers to Harwich, the Channel Fleet, cruisers to economic blockade positions, and all overseas submarines to Harwich.²²⁴ The enormous support organisation was also activated to keep these fighting forces supplied, maintained, and trained. The defensive priorities were essentially protection against potential amphibious invasion or military raid, and the safe transportation of the British Expeditionary Force to France.²²⁵ The offensive priority was to establish the economic distant blockade.²²⁶ There was also the expectation of an early, major fleet action. The flexibility of the dispositions and the command structures allowed these forces to switch between defensive and offensive layered defence systems, as and when priorities changed and when opportunities arose. The issues that were to be discussed at the conference confirmed how these forces provided the vital inter-dependent elements in the Admiralty's flexible layered defence systems.

²²³ 'Precis and Agenda, Flag Officers' Conference papers', 24/25 July 1914, ADM 1/8387/219, TNA.

²²⁴ W S Churchill, *The World Crisis 1911-1918* [1031] (Penguin London 2007) pp 111-122.

²²⁵ Ibid, pp 123-140.

²²⁶ Papers of Adm. D de Chair, Documents 7865, Imperial War Museum.

Chapter 2: Naval Policy, Layered Defence and Submarines, 1914-1916

This chapter argues that histories concerning submarine operations in the First World War do not provide an accurate account of their contribution to naval warfare. Many histories on the naval war concentrate on separate battles and campaigns such as the Battle of Jutland, the German unrestricted U-boat campaigns, and the Dardanelles.²²⁷ Many academic histories analyse the actions of the principal participants, the organisation and role of the Admiralty and political influences.²²⁸ These histories, in so far as they mention submarines at all, create the image that the submarine service was almost a separate organisation within the Royal Navy with the result that submarines were not well integrated into Admiralty plans either at the strategic or operational level. Even histories dealing specifically with British submarines emphasise famous events, for example the operations in the Sea of Marmora, and the mishaps of the K Class steam powered submarines, rather than considering overall policy.²²⁹ The existing histories describe the use of submarines in the events of the war, but do not give sufficient emphasis that submarines were integrated with surface warships in both defensive and offensive operations. Sophisticated plans were implemented that enabled the attributes of the different weapon systems and weapon platforms with their various tactical capabilities to be integrated, whereby they complemented each other to achieve the strategic objectives. The previous chapter described how an integrated, naval layered defence evolved, with submarines being the key element. This chapter deals with how this was implemented at the start of the war and in its first year, in both defensive and offensive operations and the process of newer, advanced submarines being developed to meet the challenges of the war. To be fair, submarines had only been serving in the Royal Navy for fourteen years so there were no senior officers in relevant command positions who had served in them while junior officers. Despite this, concrete plans for their deployment did exist. The first phase of the maritime war from August 1914 to January 1915 was particularly eventful in the North Sea, and submarines were involved in most operations and actions. In most cases it was a result of deliberate policy and prior planning, albeit occasionally this was inadvertent. The July 1914 War Plan recognised that surface warships could not operate safely or effectively undertake

²²⁷ R K Massie, *Castles of Steel Britain, Germany and the Winning of the Great War at Sea* (London: Cape, 2004); N Friedman, *Fighting the Great War at Sea, Strategy, Tactics and Technology*.

²²⁸ S Roskill, *Admiral of the Fleet Earl Beatty, The Last Naval Hero* (Barnsley: Seaforth, 2018); S T Grimes, *Strategy and War Planning 1887-1918*.

²²⁹ E Gray, *British Submarines at War 1914-1918* (London: 1971); R. Comptom-Hall, *Submarines at War 1914-1918* (Penzance: Periscope, 2004).

a close or intermediate blockade off the German North Sea coast.²³⁰ The plan defined that the Grand Fleet covered the northern exit of the North Sea, the Harwich Force patrolled the southern North Sea, and the Channel Fleet covered the English Channel. The economic “blockade” between the Shetland Islands and Norway, was the primary weapon against Germany. The 10TH Cruiser Squadron was to intercept merchant ships trading with contraband goods for Germany and consisted initially of old cruisers being replaced quickly with armed merchant cruisers, better suited to the conditions.²³¹ An early example of inter-dependent layers was that protection for these against superior German warships, was provided by the Grand Fleet, acknowledged by the first command Rear Admiral Le Chair.²³² Royal Navy submarines were the only type of warship able to operate off the German coast in a close, observational blockade. This dissertation argues that in doing so, these submarines provided an important enabling technology that allowed the surface warships to achieve their full potential. They freed-up many cruisers and destroyers that would otherwise have been required for a close or an intermediate blockade, and they were thus available to operate directly with the Grand Fleet. The armoured cruisers were organised in squadrons to operate as a screen usually stationed ahead of the Grand Fleet’s battle squadrons. The high-speed light cruiser squadrons provided reconnaissance capabilities to report the position, course, and speed of the German First Scouting Group and the High Seas Fleet. The modern destroyers were organised in flotillas to protect the Grand Fleet against torpedo attacks by enemy torpedo craft, and when the opportunity arose, to make torpedo attacks against German warships. They also provided anti-U Boat protection without which it was very dangerous for the battle squadrons to operate.²³³ This dissertation also argues that the submarine-based close, observational blockade of the German North Sea coast also freed the British battle cruisers from North Sea sweeps. It had been intended such sweeps would be made by mixed squadrons of cruiser plus two battle cruisers.²³⁴ The submarine observational patrols removed the need for these sweeps, allowing the formation of the powerful, homogeneous Battle Cruiser Force, later rename the Battle Cruiser Fleet. After the initial phase of the war, the battle cruisers operated almost exclusively in the North Sea, which is

²³⁰ ‘War Plans (War with Germany)’ July 1914, ADM 116/3096, TNA; ‘War Orders 1914, Home Fleets and Detached Squadrons’, ADM 137/818, TNA.

²³¹ J D Grainger, *The Maritime Blockade of Germany in the Great War: The Northern Patrol, 1914-1918*.

²³² Papers of Adm. D de Chair, Documents 7865, DEC/2 & DEC/3, Imperial War Museum.

²³³ D K Brown, *The Grand Fleet, Warship Design and Development 1906-1922*, p 68-73.

²³⁴ M S Seligmann, ‘A Service Ready for Total War? The State of the Royal Navy in July 1914’, *The English History Review*, 2018, Vol.133 (560), pp 98-122.

completely the reverse of the revisionists' claims that they were designed and built to operate worldwide for trade protection. These capabilities, freed from blockade duties by submarines, greatly strengthened the Grand Fleet in its primary role to destroy or at least to contain the High Seas Fleet. Admiral Jellicoe's battle plans defined the integrated roles for all class of warships within the Grand Fleet.²³⁵ By enabling the different surface warships to achieve their designed potential, submarines were a force multiplier.

Southern North Sea and East Coast threat of invasion operations.

To examine how the integrated, layered defence policies were implemented, the first geographic area to consider is the British littoral, namely the East Coast of England and Scotland, and the southern North Sea with the eastern approach to the English Channel. When war was declared on the evening of 4 August 1914, the 8TH Submarine Flotilla, with all the available overseas submarines, had arrived at its war station at Harwich. Upon the declaration of war, a priority for the Royal Navy was to protect the transportation of the British Expeditionary Force across the Channel from attacks by German warships. It was necessary to obtain advanced warning of an attack to enable transport ships to remain in port and for warships to attack the German raiding warships. On 2 August, prior to the declaration of war, submarines, together with scouting destroyers, were stationed in the southern North Sea.²³⁶ Sweeps further north by the Harwich Force destroyer flotillas were to detect any approaching German warships. When available a Cruiser Squadron of armoured cruisers was deployed in the Broad Fourteens off the Dutch coast providing heavier support. From 12 September the submarines were stationed further south at the entrance to the Dover Straits to increase the opportunity of sighting and attacking any German warships that might penetrate that far.²³⁷ This was an example of layered defence integrating the capabilities of destroyers, cruisers, and submarines. If the destroyers sighted German warships in daylight, they were to fall back upon the supporting armoured cruisers. The submarines, warned of the approaching German warships, would be in position to torpedo the enemy warships, preferably before they entered the English Channel. A German raid did not occur, and the British Expeditionary Force was transported to France without loss or hindrance. It was realized that the armoured cruisers were inadequate for their task and vulnerable while patrolling the Broad Fourteens, but before

²³⁵ 'Grand Fleet Battle Orders 1914-1918', ADM 137/4049, TNA.

²³⁶ 'War Orders for Submarines E.4, E.9, D.3 and D.5', 2 August 1914, ADM 137/2067, TNA.

²³⁷ 'Commodore (S) to Chief of War Staff, Admiralty', 12 August 1914, ADM 137/2067, TNA.

they were recalled, HMS *Aboukir*, *Cressy* and *Hogue* were torpedoed and sunk by U.9 on 22 September.²³⁸

Before and during the war, there were recurring British concerns about the possibility of a German invasion of Britain's east coast, and of naval or military raids against coastal cities. The recent 1912 and 1913 naval manoeuvres had shown that these were possible. The Grand Fleet was responsible for defence against an invasion but could not guarantee against a raid or a military landing on the east coast.²³⁹ In 1912 an East Coast defence force was established to report and attack enemy transports endeavouring to land troops.²⁴⁰ In 1914 Rear Admiral G.A. Ballard was appointed Admiral of Patrols commanding a force of old and coastal destroyers, coastal submarines, auxiliary patrol craft and minesweepers.²⁴¹ Ballard had served previously as deputy Director of Naval Intelligence under Admiral Fisher at the Admiralty, and in 1906/7 he headed a committee to prepare war plans for a war with Germany. In 1913 Ballard also wrote a paper on how submarines would operate in wartime.²⁴² If Fisher had intended to implement any secret flotilla defence war plans, as discussed in chapter one, then Ballard would have been aware of these. Throughout the war, even when Fisher returned to the Admiralty in 1914-1915, there was no attempt by Ballard, or his successors, to implement any form of flotilla defence. The warship allocated to the East Coast were incapable of repelling an escorted troop convoy and could do little other than report its sighting.²⁴³ However, the East Coast warships evolved quickly into important littoral layers for minesweeping and anti-U Boat warfare.

Bombardment of Yarmouth and Scarborough-Hartlepool, 1914

Germany realised that the Grand Fleet was stationed far to the north and decided to implement naval raids on the east coast of England with the hope of catching and destroying detached Grand Fleet battle squadrons. On 4 November 1914, the German First Scouting Group, consisting of the battle cruisers *Seydlitz*, *Moltke*, and *Von der Tann* and the armoured cruiser *Blücher*, bombarded Yarmouth while four light cruisers *Kolberg*, *Graudens*, *Strassburg* and

²³⁸ 'Loss of H.M.'s Ships *Aboukir*, *Cressy*, *Hogue*, 22 September 1914' ADM 137/47, TNA.

²³⁹ D G Morgan-Owen, *The Fear of Invasion, Strategy, Policies, and British War Planning 1880-1914*.

²⁴⁰ A J Marder, *From Dreadnought to Scapa Flow*, Volume 2, p 5

²⁴¹ 'Patrol Flotillas' 4 September 1914, Adm. of Patrols G A Ballard, Churchill papers, CHAR 13/13/31, Churchill Archive Centre, Cambridge

²⁴² 'Memorandum by Captain George Ballard, Director of Operations Division, Naval War Staff', 14 July 1913', ADM 1/8331, TNA.

²⁴³ 'East Coast patrol warships' Churchill papers, Report c1914, CHAR 13/6B/395-400, Churchill Archive Centre, Cambridge.

Stralsund, laid mines nearby.²⁴⁴ The German warships were sighted and reported by HMS *Halcyon*, a mine sweeping gunboat, just prior to the attack. Off Yarmouth were six old British destroyers but they were too weak to attack successfully or to prevent the bombardment. Three overseas submarines of the 8th Flotilla in Yarmouth were immediately ordered to the Heligoland Bight to intercept the returning German warships, an example of coordinated action.²⁴⁵ One submarine was lost to mines and the others were unable to get there in time. There were no British coastal submarines close enough to take any part in operations to defend Yarmouth. Early on the morning of 16 December, the battle cruisers of the German First Scouting Group bombarded Scarborough, Whitby, and Hartlepool, while their light cruisers laid mines nearby.²⁴⁶ Scarborough and Whitby were undefended, and a coastal submarine and two old cruisers were stationed at Hartlepool. The only British forces to sight the Germans off the coast were four old destroyers but due to the heavy German fire, they were unable to get into an attacking position. The submarine and a cruiser were ordered to proceed to sea but on leaving harbour the submarine was forced to submerge due to heavy German fire and ran aground on a sandbank. It took time for her to get free by which time the Germans had gone. In anticipation of a raid, the Admiralty had positioned eight submarines, accompanied by Keyes in the destroyer *Lurcher*, in a patrol line off Terschelling.²⁴⁷ Realising that these were in the wrong place, they were ordered to proceed to be off the German naval bases to intercept the returning warships the following morning. It was not possible to contact the submarines while they were submerged. When they surfaced Keyes was able to locate only four submarines and dispatched them to the Heligoland Bight, but once again the German warships had returned unobserved to the Elbe the evening before. Despite these interception failures, due to the submarines' slow speed and communication difficulties, it confirms that submarines were planned to operate offensively within the Heligoland Bight together with the surface warships operating further north, rather than a flotilla defence, sea denial strategy.

The bombardments of Yarmouth and Scarborough-Hartlepool occurred without warning and with the German warships operating at high speed. The coastal submarines that were supposed to defend against this could not do so as they would have needed to be on station prior to a raid and then be in the optimum positions to launch a successful torpedo attack. It

²⁴⁴ A J Marder, *From Dreadnought to Scapa Flow, Volume II*, p 130.

²⁴⁵ 'The German Raid on Yarmouth', Naval Staff Monograph Volume XII, Home Waters Part 3, p 1-17.

²⁴⁶ A J Marder, *From Dreadnought to Scapa Flow, Volume II*, pp134-149.

²⁴⁷ R B Keyes, *The Naval Memoires of Admiral of the Fleet Sir Roger Keyes*, Volume 1, p 142-152.

was also apparent that should the Germans execute a surprise military amphibious landing on an east coast beach, the submarines would need to be on station at that location in advance. The initial period of the war showed that the anticipated use of submarines in a coastal defence role was flawed. In November Keyes reported to the Admiralty the limitations of the coastal submarines to prevent the disembarkation of a German military expedition, to defend the ports and to prevent a sortie through the Straits of Dover.²⁴⁸ Keyes stated that from the experience obtained by submarine wartime patrols, the wrong conclusions had been drawn from the pre-war manoeuvres. Their slow speed and vulnerability to attack from escorting German destroyers would have made it very difficult for them to achieve a viable position from which to torpedo the troopships. There were also too few coastal submarines to cover the entire east coast. In the event of a German military invasion or raid, their supposed need to capture a port to land artillery and stores led to the decision to position the C Class coastal submarines in East Coast ports for their defence rather than for general coastal defence.²⁴⁹ Consequently the C Class coastal submarine were redeployed with six allocated to each of the Firth of Forth, the Tyne, the Humber, the Thames and fourteen to Dover.²⁵⁰ Communications with the overseas submarines was also a serious problem. For example, to redirect the submarines in the Heligoland Bight, the Admiralty had to contact Keyes onboard *Lurcher*, but the destroyer's wireless telegraphy equipment's reception and transmission were problematic due to the range. The destroyer *Firedrake* was positioned back towards Harwich to provide a signal relay with their depot ship *Adamant* which was in telephone communication with the Admiralty.²⁵¹ This was clearly inadequate and unreliable requiring an urgent solution. It is understandable that early submarine operations did not work as anticipated because the submarines and their technology were new, and there was no previous experience of submarines in war. Expectations had been raised by the enthusiasm of Admiral Fisher and the officers within the submarine service, whereas there were no senior serving officers with personal submarine experience. The Admiralty was very quick to learn, for example the re-deployment of the coastal type submarines purportedly for the protection of ports. The

²⁴⁸ 'Employment of submarines against attempted raids' Keyes to Chief of the War Staff Admiralty, 1 November 1914, ADM 137/2067, TNA.

²⁴⁹ 'Employment of Submarines against an attempted raid', 1 November 1914, ADM 137/2067, TNA.

²⁵⁰ 'Disposition of British Submarines', Keyes to Chief of the War Staff Admiralty, 5 November 1914, ADM 137/1926, TNA.

²⁵¹ 'The State of the Flotilla' 10 October 1914, Comm. R Keyes, C-in-C Secret Pack XLVI, ADM 137/1926, TNA, f 20; Keyes, *The Naval Memoires of Admiral of the Fleet Sir Roger Keyes*, Volume 1, p 143.

Admiralty also began a rapid programme of development of the design of better submarines and their weapons and equipment.

German North Sea Littoral and First Battle of Heligoland Bight, 1914

The second geographic area to consider includes the Heligoland Bight with the German North Sea littoral, the North Sea and the coasts of the Netherlands, Denmark, Norway and Sweden and the Kattegat and the Baltic. The German North Sea naval bases were located within the Heligoland Bight at:

- Wilhelmshaven, within Jade Bay, the principal North Sea dockyard of the High Seas Fleet with the entrance channel known as Schillig Roads.
- Cuxhaven at the entrance of the River Elbe.
- Heligoland where a heavily defended harbour accommodated submarines, torpedo boat destroyers and patrol craft.
- Emden on the River Ems.
- Brunsbüttel at entrance to the Kaiser Wilhelm Canal on the River Elbe.

The Frisian Islands off the German coast, between the Rivers Ems and Jade, were heavily protected by gun emplacements. The sea around the islands and towards the mainland was shallow with many sandbanks that extended further east along the coast. The D and E Classes of overseas submarines were designed with the capability to conduct offensive patrols in the Heligoland Bight and off the German North Sea naval bases providing the crucial observation layer in the layered defence plans. Pre-war orders were issued that upon receipt of the signal 'Take up war Stations', submarines would proceed to patrol in the Heligoland Bight. As planned, the first patrols commenced when two submarines left Harwich on 5 August and proceeded to positions off the river Ems.²⁵² The submarines could attack German warships, and subject to wireless-telegraphy range limitations, report sorties of German warships. As had been planned pre-war, maintaining this layer was the major focus of submarine North Sea operations for the first two years of the war.

These initial and subsequent submarine patrols observed the German defensive operations that were to warn of any British warships and minelayers approaching the Bight and to deter submarines. These observations provided useful intelligence on the operational pattern of German destroyers, torpedo boats, U-boats, and light cruisers plus the beginning of operations

²⁵² 'War Orders for Submarines E.6 and E.8', 31 July 1914, ADM 137/2067, TNA; Papers of C P Talbot, *Diary 5 to 8 August 1914*, IWM.

by Zeppelin airships and seaplanes. British submarines had few opportunities of attacking German warships during this period due largely to the scarcity of targets as very few major German warships left their bases.²⁵³ On 13 September submarine E.9 torpedoed and sank the old German light cruiser *Hele*.²⁵⁴ However, German torpedo boats and destroyers were fast, small targets and zig-zagged to make them very difficult to hit with a torpedo.²⁵⁵ The only success was the German destroyer T.116 torpedoed and sunk by E.9 off the mouth of the Ems on 6 October.²⁵⁶ There were many trawlers in the Heligoland Bight, and it was difficult for a submarine to identify if a trawler was fishing or was a German naval auxiliary warship. Germany converted merchant ships to naval minelayers, and these were also difficult to identify from those on merchant trade.²⁵⁷ Hospital ships were sighted and were immune from attack under international law, albeit there was suspicion that these were used also for intelligence gathering on British naval operations. British submarines patrolled along the west coast of Denmark and reported on the lack of maritime trade between Esbjerg and Hamburg. Zeppelins were observed patrolling off the Jutland coast. Submarines sighted merchant ships regularly off the Dutch coast which was patrolled extensively by Dutch warships to maintain neutrality and preclude unlawful incursions by belligerent warships into Dutch territorial waters. British submarines and surface warships would not attack or try to stop any merchant ship within neutral territorial waters.

At the beginning of the war, the 8th Flotilla did not have enough submarines for contiguous patrols within the Heligoland Bight, but the German Navy could not always be sure when they were on or off station. By October, the 8th flotilla had nineteen overseas submarines in commission, but for operations this was reduced by transit times, the need for refits and to repair damage, and give the crews rest. To keep five or six submarines on patrol in the Heligoland Bight, required twelve to fifteen to be available.²⁵⁸ As intended pre-war, when more overseas submarines were completed in late-1915 further patrols were made in the Heligoland Bight and off the Danish and Dutch coasts. The overseas submarines were designed and

²⁵³ 'Home Waters Part 1, From the Outbreak of War to 27 August 1914', Naval Staff Monograph Volume X, 1925, ADM 186/619, TNA.

²⁵⁴ 'Report of Proceedings between 13 and 14 September 1914', Lt. M.K. Horton E.9, ADM 137/2067, TNA.

²⁵⁵ 'Conduct of the Enemy Destroyers when Encountering our Submarines', Commodore R. Keyes, 20 August 1914, ADM 137/2067, TNA.

²⁵⁶ 'Report of Proceedings of E.9', 7 October 1914, ADM 137/1922, TNA.

²⁵⁷ 'Submarines' Reports of Proceedings' Commodore (S) War Records Vol. 1, ADM 137/2067, TNA.

²⁵⁸ 'The State of the Flotilla', 10 October 1914, Comm. R Keyes, C-in-C Secret Pack XLVI, ADM 137/1926, TNA.

built pre-war to torpedo German warships and with the important function of acquiring intelligence of German operations and of neutral shipping activities. The Admiralty, and particularly Churchill, had recognised the urgent need for more submarines thus explaining their plans to substitute two battleships in the 1914 programme and building destroyers and submarines.²⁵⁹ This intelligence was very important to on-going British naval planning, to the modifications to the implementations of the blockade policy and to diplomatic relations and negotiations with neutral countries. Thus, the use made of the intelligence gathered was arguably more important than sinking the occasional German warship, a fact also largely overlooked by naval historians.

The reluctance of the German High Seas Fleet to leave its North Sea bases led the British Admiralty to consider aggressive action. Intelligence from the early submarine operations identified that German light cruisers and destroyers patrolled the outer Heligoland Bight to protect their minesweepers, and this provided an opportunity to attack these warships. Commodores Keyes and Tyrwhitt developed a plan to surprise and attack these by the Harwich Force's two destroyer flotillas with their accompanying light cruisers. The formal orders were "to cut off any outlying or detached small vessels or minelayers of the enemy in that area".²⁶⁰ In an integrated operation, eight overseas submarines were positioned closer inshore to attack any German major warships coming to the aid of their light forces. Keyes was on-board the destroyer *Lurcher* to co-ordinate the submarines. Unknown to Keyes and Tyrwhitt, Admiral Jellicoe ordered Vice Admiral Beatty with five battle cruisers and a light cruiser squadron, to be in support, which could and should have been integrated further. The Harwich Force achieved surprise, but Tyrwhitt's new flagship was seriously damaged. The sudden and unexpected appearance of British battle cruisers and light cruisers took the pressure off the Harwich Force and led to the sinking of the German light cruisers *Mainz*, *Köln*, and *Ariadne*. The bad visibility in the Bight and the confusion caused by a lack of co-ordinated staff work, nearly led to a disaster. There was no way of alerting the submerged submarines of the presence of the battle cruisers and light cruisers so there was a real concern that they would endeavour to torpedo these British warships.²⁶¹ The bad visibility, faulty planning and the non-appearance of any German major warships led also to disappointing results for the

²⁵⁹ C M Bell, *Churchill & Sea Power* (Oxford: OUP, 2013), pp 46-47.

²⁶⁰ 'Operation Orders', 28 August 1914, Heligoland Bight 28 August 1918, ADM 137/551, TNA.

²⁶¹ 'Heligoland Bight 28 August 1914', Commodore Keyes to Chief of the War Staff to Admiralty, 29 August 1914, ADM 137/551, TNA.

British submarines.²⁶² A similar operation was carried out on 10 September with the Harwich Force sweeping through the Heligoland Bight together with submarines deployed off the German naval bases, but the German patrols had not taken up their positions, so nothing was achieved. Despite the poor staff work, the operations of 28 August and 10 September demonstrate layered defence with submarines being integrated with the light cruisers and destroyers of the Harwich Force. Rear Admiral Madden, Chief-of-Staff Grand Fleet, wrote in his diary for 29 August 1914:

Report of work of our submarines off Heligoland Bight is a record of very fine work indeed and promises well for the future.²⁶³

Operations in Southern North Sea

British Army units were landed at Zeebrugge in early October to support the Belgium Army. The Belgium Army and the supporting British Royal Naval Brigade were forced to retreat from defending Antwerp which was occupied by the Germans on 9 October.²⁶⁴ Submarine patrols off the Ems had detected a build-up of German naval vessels creating the suspicion that they would be used to raid the British transports off the Belgium coast.²⁶⁵ There was concern also that German warships would use the facilities in Antwerp's shipyards to establish a naval base from which to carry out raids in the southern North Sea. The submarine patrols off the Ems were to provide warning and attack any sortie by German warships. Cruisers and destroyers were stationed off the Dutch coast to intercept and to attack these warships proceeding south. Further submarines were stationed off the Scheldt estuary to attack any German warships that escaped the surface action and were then proceeding to Antwerp.²⁶⁶ The primary role of the submarines off the Ems was to provide warning of a sortie, whereas the submarines off the Scheldt to torpedo enemy warships. This is a further example of a layered defence with submarines being integrated with surface warships, and also the submarine versatile capabilities defined and designed into the per-war overseas submarines. No raid took place and Germany did not use the Scheldt estuary to reach Antwerp, the entrance to which is in Dutch territorial water.

²⁶² 'Heligoland Bight 28 August 1914', Keyes to Rear Adm. Christian, 28 August 1914, ADM 137/551, TNA.

²⁶³ Adm. C Madden, 'Diary 29 August 1914', MAD-1, Caird Library, NMM.

²⁶⁴ W S Churchill *The World Crisis 1911-1918* [1931] (London: Penguin, 2007), pp 188-210.

²⁶⁵ 'Commodore (S) to Admiralty', 10 October 1914, ADM 137/2067, TNA.

²⁶⁶ 'Reports and Operational Orders', ADM 137/2067, TNA.

Kattegat and Baltic operations, 1914

As designed pre-war, British overseas submarines were the only warships capable of secret and clandestine reconnaissance operations. The three Scandinavian countries of Denmark, Norway, and Sweden had declared their neutrality, but Britain became increasingly concerned about the extent of their trading with Germany.²⁶⁷ They were increasing exports of war material and food to Germany, and it was feared they might be providing anchorages or even bases for German warships. On 24 September two overseas submarines proceeded to the Kattegat to reconnoitre the Danish, Norwegian and Swedish coasts.²⁶⁸ Their patrols were extended southward to reconnoitre the entrances to the Great Belt, Little Belt and The Sound, the three passages which led to the Baltic. The submarines did not observe any German warships other than suspicious trawlers. German merchant ships were sighted but they kept within neutral territorial waters, thus making it impossible for them to be stopped or attacked under International Law. Many merchant vessels were observed flying neutral Danish, Norwegian and Swedish ensigns and there was the suspicion that some of these were German vessels. In these initial Kattegat patrols, the submarines operated in what today is referred to as stealth mode, with Germany and the neutral countries being unaware of their reconnaissance. During some later patrols, the submarines allowed themselves to be sighted to force the merchant ships to keep within territorial water thus extend the time taken for them to reach Germany.

Submarines were the only type of British warship that could enter and be effective in the Baltic. The Royal Navy had long-standing ambitions to operate in the Baltic to aid Russia and to interdict German trade of essential war materials from Sweden.²⁶⁹ The Russian Navy was weak as most of their warships had been lost a decade earlier in the Far East during the Russo-Japanese war. Complicating matters was that the Russian Baltic Fleet reported to the army and its primary objective was the defence of the Gulf of Finland and the approaches to St. Petersburg. The Commander-in-Chief of the Russian Navy had wanted to take offensive actions at sea or against coastal areas, but it was vetoed by the Army Headquarters to whom he was subordinate.²⁷⁰ A conference on board HMS *Iron Duke* on 17 September decided that the only practical way to project British sea power into this important theatre was by

²⁶⁷ 'Reports on Sweden, Denmark and Norway', Staff Papers Various 1914-1917, ADM 137/500, TNA.

²⁶⁸ 'Orders for submarine operation in Kattegat', 15 September 1914, ADM 137/2067, TNA.

²⁶⁹ S T Grimes *Strategy and War Planning in the British Navy, 1887-1918*.

²⁷⁰ M Wilson *Baltic Assignment, British Submarines in Russia 1914-1919* (London: Cooper, 1985), p 61.

submarines.²⁷¹ Two overseas submarines entered the Baltic through The Sound on the nights of 17 and 18 October, respectively. An immediate, unsuccessful torpedo attack on the cruiser *Viktoria Louise* south of The Sound, alerted the German to the presence of British submarines. This action forced Germany immediately to withdraw their major warships into Kiel, thus interrupting further their operations, training, gunnery practice and exercises.²⁷² Future German naval activities needed anti-submarine escorts thus drawing away escort resources from the North Sea. Although outside the scope of this dissertation, it should be noted that British submarines in the Baltic forced Germany to provide strong anti-submarine escorts for its offensive naval operations. Despite these, the British submarines sank and damaged several major German warships. Russia had limited capability to attack or interrupt the important summer trade route of iron ore from northern Sweden to Germany. The submarines were able to attack this trade route and sank merchant ships while they were in international waters. The Russian extensive and effective minelaying off the north German coast and in the Gulf of Finland, the British submarines operating in the central Baltic, and from the Russian Baltic Fleet at Kronstadt created a layered defence. The Russian C-in-C's preference was to use the British submarines in coastal defensive roles, but the British command pushed successfully for them to be used in offensive operations.²⁷³ It was the presence of the British submarines that achieved integrated, layered operations.

Air raid on Zeppelin sheds, December 1914

The ability of German Zeppelins to provide long-range aerial reconnaissance for the High Seas Fleet operations was a major concern of the Royal Navy, particularly to Admiral Jellicoe. Three British passenger ferries, *Engadine*, *Riviera* and *Empress*, were converted into Royal Navy seaplane carriers and were attached to the Harwich Force to support the light cruisers and destroyers operating in the southern North Sea. An aerial attack was planned on the German Zeppelin sheds near Cuxhaven.²⁷⁴ Admiralty planners hoped that when Germany was aware of the British ships operating close to their bases, the High Seas Fleet would come out to attack them. The aerial attack would be secondary to the Grand Fleet and the Battle Cruiser Force being further offshore to engage the enemy High Seas Fleet in battle. Submarines were positioned to attack German forces as they emerged from their bases and

²⁷¹ 'Conference on board Iron Duke' 17 September 1914, ADM 137/1939, TNA.

²⁷² 'Proceeding of E.1, 2 November 1914, Baltic Sea, 1914-1915', ADM 137/271, TNA.

²⁷³ M Wilson *Baltic Assignment, British Submariners in Russia 1914-1919*.

²⁷⁴ 'Air Raid on Cuxhaven', Naval Staff Monograph Volume XII, Home Waters Part III, ADM 186/621, TNA, ff 133-142.

to recover the crews of returning seaplanes. Early on 25 December seven seaplanes got airborne from north-east of Heligoland but fog over the land prevented any finding the Zeppelin base. The seaplane recovery position was north of the island of Norderney, and a submarine, stationed closer inshore, rescued the crews of three seaplanes and the seaplanes were then destroyed.²⁷⁵ Submarines being used as plane-guards to rescue airmen, anticipated this practice used extensively in the Second World War. German surface ships failed to leave their bases despite knowing that the Harwich Force warships were in the Heligoland Bight and therefore a major battle did not occur.²⁷⁶ On 20 January 1915 the Harwich Force made a further sweep from Borkum to the northeast at Horn's Reef to sink German patrols that were believed to operate along this line.²⁷⁷ Submarines were again part of the operation being positioned off Heligoland and the Ems to report and attack German warship sorties. Battle cruisers were positioned north of the Bight until the Harwich Force withdrew safely. In bad visibility no German surface warships were encountered although German submarines, seaplanes and a Zeppelin were sighted by British forces. These operations integrated most layers of the Royal Navy including the Grand Fleet, Battle Cruiser Force, Harwich Force together with the Royal Navy Air Service seaplanes and the overseas submarines, all operating in different roles.

Battle of Dogger Bank. January 1915

In January 1915, naval intelligence based upon wireless-telegraphy intercepts, indicated a further raid by German warships. The Germans planned an operation to lay mines off the Firth of Forth and to attack British patrols believed to operate off the Dogger Bank. Hipper and the First Scouting Group sailed on 23 January while the British Battle Cruiser Force and the Harwich Force rendezvoused off the Dogger Bank. These movements led to the battle of Dogger Bank in which the British sank the German armoured cruiser *Blücher*.²⁷⁸ Eight submarines were ordered to proceed to be off the Jade and other channels to the German

²⁷⁵ 'Submarine Reports of Proceedings' Comm. (S) War Records Volume 1 1914. ADM 137/2067, TNA, ff 531-560; M Harris *Harwich Submarines in the Great War 1914* (Warwick: Helion, 2021), pp 297-308.

²⁷⁶ D Hobbs, *The Royal Navy's Air Service in the Great War*, pp 80-92.

²⁷⁷ 'Raid on the Bight Patrol', Naval Staff Monograph Volume XII, Home Waters Part III, ADM 186/621, TNA, ff 169-172.

²⁷⁸ J S Corbett, *Naval Operations, History of the Great War Based on Official Documents* Volume 2, [1921] (London: IWM). pp 82-102.

naval bases, but they did not arrive on station until 25 January by when the German warships had returned.²⁷⁹

Submarine operations, February – December 1915

Following the Battle of Dogger Bank and the loss of the armoured cruiser *Blücher*, in Germany it was felt that the Commander-in-Chief of the High Seas Fleet, Admiral von Ingenold, had been responsible for not having had battleship support available. The Admiralstab's review of the naval war to date concluded that he had not provided sufficient battleship support for the earlier battle cruiser raids and consequently, he was replaced in command by Admiral von Pohl. There was little change in policy as the Kaiser insisted that any operational plan had to be submitted to him in advance, as the fleet had to be preserved as a political instrument for future peace negotiations.²⁸⁰ In early 1915 the High Seas Fleet was less well prepared for action as the battle cruisers *Seydlitz* and *Derfflinger* were repairing battle damage and the 3RD Squadron was exercising in Kiel Bay, albeit under threat from the Baltic-based British submarines. British policy agreed between Admiral Jellicoe, C-in-C Grand Fleet, and the Admiralty did not want to expose the Grand Fleet to U-Boat torpedo attacks or from running into minefields. The Grand Fleet would proceed south from its northern bases only if there was the opportunity to meet the High Seas Fleet. These two policies therefore minimised the prospect of a major fleet battle.

North Sea submarine operations in 1915 were dominated by the number of overseas types available.²⁸¹ Upon the outbreak of war, there were only seventeen overseas submarines in commission, that were insufficient to maintain contiguous operational patrols off the German North Sea naval bases.. Between August 1914 and January 1915, two E Class submarines entered the Baltic where they would remain, four overseas submarines were lost in North Sea operations. in the same period, six new overseas submarines were completed, so by January 1915 the number of overseas submarines for North Sea operations remained at seventeen. Counting new submarines completing and deducting those lost and others sent to the Mediterranean and Baltic, by July 1915 there were fifteen and by December 1915 there were eighteen. The actual numbers available were less as some would be having maintenance and newly commissioned submarines needed a working-up prior before going on patrol. The

²⁷⁹ Rear Adm. J Goldrick, *Before Jutland, The Naval War in Northern European Waters August 1914 – February 1915*, pp 258.

²⁸⁰ P G Halpern, *A Naval History of World War 1*, p 47.

²⁸¹ 'Histories of RN Submarines 1914-1918', J J Colledge papers, World Ship Society Archive, Chatham.

situation was exacerbated as the submarines sent abroad had the most experienced commanding officers and crews. It is probable that the Admiralty, and particularly Churchill, believed that these submarines would make a greater contribution in the Baltic and at the Dardanelles. The Admiralty may well have taken a calculated risk of receiving warning of a German sortie from wireless telegraphy intercepts, and the diminishing likelihood of a German invasion or military raid. The accelerated building programme of submarines ordered in 1914 and 1915 began to deliver increasing numbers of submarine at the end of 1915 and beyond.

Despite the lack of overseas submarines, there were many patrols into the Heligoland Bight, off the Dutch and Danish coasts and into the Skagerrak and Kattegat. Many patrols were in response to intelligence on anticipated movements of German surface warships and multiple submarines would proceed to adjacent positions. When it appeared that the High Seas Fleet or major units might proceed beyond the Heligoland Bight, Grand Fleet and Harwich Force warships proceeded to interception positions. If submarines sighted the German warships, they were ordered to attack first and then to report the contact, their course and speed.²⁸² This was based on an integrated layered defence.

The German 1911 exercises in the North Sea off the Jutland coast, included the Grand Fleet being lured over a U-Boat trap. This had been reported to British Naval Intelligence by the Danish Navy.²⁸³ Admiral Jellicoe was based in the Admiralty at that time and would have been very aware of the German plan. By 1915 Jellicoe believed that U-Boats would operate as an integral part of the High Seas Fleet and would be located to ambush the Grand Fleet particularly when chasing a retreating High Seas Fleet.²⁸⁴ It was assumed erroneously that a class of U-Boats was capable of high surface speed and an integral unit of the High Seas Fleet. Jellicoe wanted the same capability but knew that the current overseas submarines were too slow to operate with the Grand Fleet. In the event of an anticipated fleet action, he wanted overseas submarines to rendezvous with the Grand Fleet in positions in which he determined they would intercept the High Seas Fleet before or after the fleet action, and on 24 July 1915 wrote to the Admiralty.

Be pleased to inform the Lords Commissioners of the Admiralty that, in my opinion, great advantage would result from the presence of submarines with the Grand Fleet during a fleet action.

²⁸² Naval Staff Monographs, Home Waters, Parts 1 to 9', ADM 186, TNA.

²⁸³ 'Naval Intelligence notes on German Submarine Construction, Report of German Fleet exercises', 30 May 1912, ADM 137/3905, TNA.

²⁸⁴ 'Jellicoe to Admiralty', 30 October 1914, *The Jellicoe Papers*, Volume 1 (London: NRS, 1966).

Under existing circumstances, and with the present distribution of our overseas submarine flotillas, it is very improbable that this would be the case, although it is recognised that they might intercept any surviving enemy's ships on their return to German waters.

The E Class are not capable of cruising with the Fleet owing to the low speed. It is improbable that any submarine of sufficient speed for the purpose of will be completed during the current year and, pending the provision of such vessels, I submit that a few submarines, with one destroyer for each group of three submarines as escort, should be stationed in the Tyne as soon as numbers permit and that they should be under the direct orders of the Commander-in-Chief, Home Fleets, and available to meet the Fleet at any desired rendezvous. . . .

Three units, each consisting of one destroyer and three submarines, would greatly increase the offensive power of the Grand Fleet²⁸⁵

This is clear evidence of Jellicoe wanting an enhanced, integrated layered defence. Jellicoe expected that any fleet action would take place in the northern North Sea, and it was thus unlikely that the overseas submarines based in Harwich could proceed to the battle position in time to participate. The best that they could hope to achieve was to proceed to be off the German North Sea naval bases to intercept surviving warships returning after the fleet action. In mid-1915, the Admiralty was unable to agree to Jellicoe's request due to the lack of overseas submarines in home waters.²⁸⁶ Jellicoe persisted in his request to have overseas submarines under his direct control to provide an integrated layer within the Grand Fleet. Throughout the remained of 1915 more overseas submarines were commissioned and on 17 November 1915 the Admiralty replied:

With reference to your letter of the 8 November, I am commanded by My Lords Commissioners of the Admiralty to acquaint you that the Eleventh Flotilla of "E" and "G" Class submarines to be stationed at Blyth will be an Overseas Flotilla and will carry out similar duties to the Eighth Flotilla at Harwich but in a different area. It was always intended that the Eleventh Flotilla should co-operate with the Grand Fleet, although the vessels comprising it are too slow to work in company with the Grand Fleet.

The Eleventh Flotilla will be placed under your orders.

In detailing Boats for cruises, you are to note that they should not be sent to the southward of a line joining Flamborough Head and a position in Latitude 56°N

²⁸⁵ 'Jellicoe to Admiralty, 24 July 1915', ADM 137/1926, TNA, ff 40-42.

²⁸⁶ Ibid, f 43.

Longitude 8°E, without special arrangements being made with the Admiralty. The Admiralty will give orders that the Eighth Flotilla Boats are never to cruise north of the above line. This will obviate the liability of boats of different Flotillas being acquainted with each other by mistake.

The Eleventh Flotilla will also have to co-operate in defensive measures in case of a raid or invasion North of Flamborough Head, and the Captain (S) Blyth will have to keep the Rear Admiral Commanding, East Coast of England informed of the movements of his vessels and the times when boats are expected back for cruises, and the Captain (S) Blyth and the Rear Admiral should concert measures to avoid mistakes occurring between their respective vessels.²⁸⁷

Unrestricted U Boat warfare, 1915

The German's first period of unrestricted U-Boat warfare began in February 1915, and there was a severe shortage of specialised anti-U Boat warships. The few overseas submarines were of limited value because on the rare occasions of sighting a U-Boat, its relatively small size and tendency to submerge immediately, limited the opportunities for a successful torpedo attack. Overseas submarines lacked a suitable gun armament to attack a surfaced U-Boat and there was no submarine weapon to attack a submerged U Boat. However, forcing a U-Boat to submerge for a prolonged period meant it could not travel as fast as on the surface, and therefore delayed it getting to its patrol location. The coastal C Class submarines had a more successful role when being towed submerged by a trawler in a U-Boat trap.²⁸⁸ When a surfaced U Boat stopped the trawler, the submarine slipped the towline and attempted to torpedo the stopped U Boat, an idea that Admiral Beatty attributed to his Secretary, Commander F.T. Spickernell.²⁸⁹ After some successful sinking Germany became aware of such traps, and they ceased to be so effective.

Experience of British submarine operations, August 1914 to January 1915, and effect on German naval policy.

When the war began, the British submarines were untried weapon systems and during the first period of war, much experience was gained, and lessons were learnt. This section considers the effectiveness of submarines during this period and analyses their tactical and technology capabilities. As noted earlier, the coastal submarines were found to be unable to

²⁸⁷ 'Admiralty to Jellicoe, 17 November 1915', ADM 137/1926, TNA, ff 51-52.

²⁸⁸ E Gray, *British Submarines at War 1914-1918* [1971] (Barnsley: Pen & Sword, 2016), pp179-180.

²⁸⁹ S Roskill, *Admiral of the Fleet Earl Beatty, The Last Naval Hero*, p 250.

achieve their expected role of deterring or attacking a bombardment force off the east coast. The obsolete coastal A and B Classes were withdrawn from operational service. The coastal C Class were re-deployed for the defence of east coast harbours and the Dover Straits, for which with their short endurance, they were equally unsuited.

The British overseas submarine patrols had a major and immediate impact on the activities of the German High Seas Fleet. It is probable that this was not realised fully at the time, and this has not been recognised fully by naval historians. Admiral Scheer, commander of the 3RD Battle Squadron of the High Seas Fleet from 1914-1916, wrote that the presence of British submarines imposed serious constraints on operations and on training.²⁹⁰ The Kaiser who had the authority to veto warship operations, did not want to risk losing any of his precious warships as he foresaw their potential value during future peace negotiations. Rather than risk the threat posed by the submarines in the Heligoland Bight, these warships were transferred to Kiel in the Baltic for training, gunnery practice and exercises. It was considered too dangerous to send them around Denmark, so they were transferred to the Baltic via the Kaiser Wilhelm Canal. The High Seas Fleet was thus often below strength with their warships at Kiel not being readily available for North Sea operations. Reduced training, gunnery practice and exercises reduced efficiency, and long periods in the dockyard undermined crew morale.

The overseas submarines' apparent lack of success in attacking and sinking German warships was due largely to a lack of targets as major warships of the High Seas Fleet were seldom allowed to leave their bases and then only for short duration in the Heligoland Bight. The ability to torpedo a warship was also found to be more difficult than on peace-time exercises. When viewed through a periscope, it was difficult to estimate an enemy warship's speed and course, particularly if the target ship was fast and zig zagging. Five hundred yards was considered the optimum range to ensure a hit. The early E Class submarines had single torpedo tubes in their bow and stern plus port and starboard beam tubes and it was necessary to manoeuvre the submarine to be in the correct orientation to the target while avoiding any escorting warships. Small warships such as torpedo boat destroyers were very difficult to hit due to their high speed and shallow draught and naval trawlers were hardly worth a torpedo. In action it was possible to fire only a single torpedo thus reducing the probability of hitting the target. Later E Class submarines had two bow tubes that allowed a salvo of two torpedoes to be fired with a greater probability of a hit. Identification of targets through the periscope was

²⁹⁰ Scheer, *Germany's High Seas Fleet in the World War*.

also a problem, for example the risk of torpedoing British cruisers during the Battle of the Heligoland Bight. A further example was the sighting of a submarine north of the entrance to The Sound that appeared to have the pendant U3 painted on her conning tower. A torpedo fired at her missed and it transpired that she was J3, the Danish submarine *Havmanden*, which resulted in many diplomatic exchanges between Britain and Denmark.²⁹¹

There was also a lack of enemy merchant ship traffic. British submarines were not allowed to stop and search any merchant ships within territorial waters and only to stop and search those in international waters. British submarines observed International Law whereby a merchant ship could not be sunk until the safety of the merchant crew was assured. The submarines found it difficult to stop and search ships as they had no gun to force them to stop, and then needed the merchant ship to send a boat to transport a submarine officer on board to make an inspection. If contraband cargo for Germany was found, the submarine needed a prize crew to ensure the merchant ship sailed to the UK. There was also a great risk to the submarine when stopped on the surface if an unseen German U-boat was nearby. British submarines had also to be very careful to avoid an incident when they encountered warships from neutral Holland, Denmark, Norway and Sweden. These warships were patrolling their territorial waters ensuring there was no interference with merchant ships. German hospital ships and relief ships taking supplies to the Belgium population were also to be avoided.

A typical patrol from Harwich to the Heligoland Bight consisted of a transit day to arrive on station, four or five days on-station and then a transit day to return. While on the surface in daylight, the low height of their conning tower above sea level restricted the ability to sight targets at best to a few miles, and while submerged the visible range through their periscope was approximately a thousand yards. These ranges were less in typical North Sea poor visibility, bad weather and at night. Accurate navigation was also difficult with the inability to obtain star sights thus relying on dead reckoning, a very difficult task in the shallow Heligoland Bight with its strong tides and currents.²⁹² Rough weather with the cold and lack of sleep undermined the crew's performance. Rough weather also caused damage to the submarines, particularly the vulnerability of the non-retracting forward hydroplanes of the D and E Classes.

²⁹¹ 'Report of Proceedings of E.11', 24 September 1914, ADM 137/2067, TNA.

²⁹² W G Carr, *By Guess and By God, the Story of British Submarines in the War* (London: Hutchinson, 1930).

Continued slamming in waves caused their control shafts to crack or become jammed, necessitating the submarine to return for repair, thus being unavailable for service.²⁹³

The submarine operations against German surface warship sorties highlighted that the tactical command and control of submarines were ineffective. Keyes tried to exercise control from on board a destroyer but could not communicate with the submarines once they submerged and then had difficulty finding them when they surfaced. The destroyer was also vulnerable when operating off the German coast. Communications with submarines, particularly wireless telegraphy (W/T) and their operating procedures, needed to improve. Submarines endeavouring to warn of sightings of the High Seas Fleet and individual warship were severely limited by their low-powered W/T equipment.²⁹⁴ The submarine had first to surface clear of German warships and then rig masts to support their aerial. Their Type 11 sets had a transmission range of approximately thirty miles although they could receive messages from the UK. An initial solution was to position a surface warship off the Dutch coast which could receive the message from the submarine and re-transmit it to Harwich from where it was telephoned to the Admiralty in London. Submarines also carried homing pigeons which could be released with a message from the Heligoland Bight, and subject to the weather and wind direction, arrive in Harwich within ten hours, from where their message was telephoned to the Admiralty. Both systems were unreliable. It became clear that the slow speed of the existing submarines made it very difficult to include them in a fast-changing, often confused surface action. The submarines had to be in to correct position in advance to intercept German warships. Better staff planning was needed with clear orders for the submarines to act independently within the scope of the plan. Commodore Keyes' attempts to control the submarine flotilla while on board a destroyer was clearly flawed.²⁹⁵

Operations showed that overseas submarines were ideal for reconnaissance. From their first patrols in the Heligoland Bight, their observations deduced the German warship, U-Boat and Zeppelin patrol patterns and procedures, the activities of German minesweepers, and the location of navigation buoys. They observed the reduction in merchant ships using the port of Esbjerg and the lack of traffic along the Danish and German coasts between Esbjerg and the Elbe. Submarine patrols in the Skagerrak and Kattegat discovered that German and neutral merchant ships were keeping within Norwegian and Swedish territorial waters.

²⁹³ 'Reports of Proceedings', ADM 137/2067, TNA.

²⁹⁴ Vice Adm. A Hezlet, *The Electron and Sea Power*, p 97.

²⁹⁵ 'Commodore (S) War Records' Volume 1 1914, ADM 137/2067, TNA.

Germany realised the threat from submarines and quickly took action to develop an anti-submarine capability. In addition to surface warships and U Boats, Zeppelins and later seaplanes and aircraft were fitted with bombs. Early British submarines were not fitted with an anti-aircraft gun and could not risk the chance of a bomb hit, so were obliged to submerge thus reducing her effectiveness. The German Navy laid defensive minefield in the shallow waters of the Heligoland Bight, the channels between the Frisian Islands and in their river estuaries. British submarines had the very dangerous task of observing the German minelayers to identify and to plot the minefields and mine-free channels. The Royal Navy began to lay offensive minefields in January 1915 with the first field laid off the Amrum Bank to block the passage between Denmark's west coast and Germany. The German defensive and the British offensive minefields within the Heligoland Bight further constrained the German warships' exercise areas. The German increasing anti-submarine measures took up their valuable resources and manpower that could have been useful elsewhere.

When war began, the Royal Navy's Submarine Service had been in existence for only thirteen years, so the 1914 to 1915 period was the first occasion when actual operational experience could be gained. Germany had expected the Grand Fleet to operate a close blockade where it would be vulnerable to attritional attacks, whereas Britain had expected to encounter the High Seas Fleet in the central North Sea resulting in a decisive fleet action. The observational patrols of British submarines thus became critical to provide warning of German naval activity. Planned prewar to operate as a tactical layer, these patrols became a key strategic layer. The German bombardments of English East Coast ports were conducted by their battle cruisers and cruisers whose high speed made them very difficult targets for submarine torpedoes and suicidal for the poorly armed patrol warships. There was no attempt to operate any form of a "flotilla defence" policy. The versatility of submarines became apparent and led to many technological developments in specialist designs, weapons, equipment, and particularly detection. The Admiralty was quick to recognise their potential and their design teams, many supporting organisations and the industrial base, all contributed to their rapid development. These together with the Admiralty integrating them effectively into layered defence systems, are described in this dissertation's subsequent chapters.

Chapter 3: Wartime Submarine Technology Developments

This chapter deals with the development of submarine technology to position submarines within the layered defence systems, and of the key personnel involved. The experience gained from the start of the war shaped the technology of British submarines, including overall design, weapon systems, communication systems, sensors, machinery, habitability, and equipment. All advanced throughout the war, and the urgency of the anti-U Boat campaign set new priorities and expedited developments. Throughout the war, Submarine Committees were established to advise the Admiralty on the submarine design and equipment technology for the further integration of submarines with the other naval assets within different scenarios. Submarine design and equipment technology had advanced rapidly enabling submarines with unique capabilities to be designed and built for different roles within layered defence systems. This confirms the argument that submarines were key to implementing layered defence and were a force multiplier, enabling surface warships to be used to their designed capabilities. In parallel with technology developments, the training of Commanding Officers and Crews was developed so they could use and maintain the increasingly complex onboard equipment.

The naval disasters at the beginning of the war expedited a press campaign for the resignation of Admiral Prince Louis of Battenberg and Fisher had returned as First Sea Lord on 30 October 1914.²⁹⁶ Commodore Keyes had been in command of the submarine service from October 1910.²⁹⁷ A month before the war Admiral Fisher, while out of office, visited the headquarters of the Submarine Service and had a verbal row with Keyes. Fisher criticized Keyes for his running of the submarine service since his appointment, complaining that Keyes had wasted time and resources on a proliferation of experimental submarine types and had too few of the overseas E Class.²⁹⁸ Keyes blamed Fisher due to his earlier agreement of a Vickers monopoly of submarine building and his concentration on building the C Class coastal submarines, necessitating the need to look abroad for new submarine designs. The tension between Fisher and Keyes is detailed in an undated letter from Keyes to Churchill.²⁹⁹ Fisher assured Keyes of his on-going support, but their relationship deteriorated and in February 1915 Keyes

²⁹⁶ A J Marder, *From Dreadnought to Scapa Flow* Volume 2, pp 89-93.

²⁹⁷ Adm. R B Keyes, *The Naval Memoires of Admiral of the Fleet Sir Roger Keyes*, Volume 1, pp 25-169.

²⁹⁸ R F Mackay, *Fisher of Kilverstone* (Oxford: Clarendon, 1973), pp 454-455; C. Aspinall-Oglander. *Roger Keyes* (London: Howgarth, 1951), pp103-104.

²⁹⁹ 'Letter, c 1920, Keyes to Churchill', CHAR 8/41, Churchill Archive Centre, Cambridge.

was transferred to become Chief of Staff to Admiral Carden for the forthcoming Dardanelles campaign.

Captain Sydney S Hall, a protégé of Fisher who had held the post before Keyes, was re-appointed as Commodore (S) of the submarine service. Whereas Keyes used every opportunity to go on operations to control the 8th Flotilla's overseas submarines, Hall concentrated on the necessary administrative work, as had been intended originally, for the rapid expansion of the service. The command and operations of the 8th Flotilla reverted to its Captain (S), Captain A.K. Waistell.³⁰⁰ Churchill realised that there were insufficient overseas submarines available to meet all their commitments, particularly the observational patrols in the Heligoland Bight, plus the sending submarines to the Baltic and to support the Dardanelles operations. All vital in their respective layered defence systems. The day following Fisher's return, Churchill asked him to order more submarines:

I shall be much obliged if you will give this matter your personal attention and issue the necessary orders to obtain 20 submarines additional to those now ordered in the shortest possible time. Keep me informed of your progress and proposals. But there must be no delays. Let me have your proposals for accelerating to the utmost those now in hand.³⁰¹

Fisher responded with his usual vigour and chaired a conference of all interested companies at the Admiralty. On 5 November he replied to Churchill:

The situation was explained at the conference on November 3rd, at which all those interested were present, and my colleagues on the Board also attended.

I think, so far as I could gather, no difficulties are likely to arise.

The first boat ought to be completed ready for trials in eight months, and the whole in eleven months.

. . . Supply of identical parts will with advantage be ordered by the Admiralty and supplied to the builders complete. Preliminary steps have already been taken regarding batteries, main motors, periscopes, torpedo tubes and similar parts, will be ordered within a fortnight. . . The building of E type hulls, instead of G type will reduce time of construction

. . . Heads of Departments are not to write minutes but come to me personally if difficulties are met with, however trivial – so that there will be no excuse wherever

³⁰⁰ J S Corbett, *Naval Operations, History of the Great War* Volume 2, p 141.

³⁰¹ 'Additional Orders for Submarine Boats', 11 November 1914, ADM 1/8402/419, TNA.

hereafter for delays. As the First Lord says in his minute: "THERE MUST BE NO DELAYS".³⁰²

Admiral Fisher, together with Churchill, were involved deeply in the ordering of twenty H Class submarines from the United States.³⁰³ The order was agreed with C.M. Schwab of Bethlehem Steel Corporation in London on 3 November 1914. To avoid problems with United States neutrality laws, the prefabricated parts, machinery, and equipment were sent to Canadian Vickers in Montreal where the submarines were built. They had the benefit of four torpedo tubes mounted in their bow so could fire a salvo of torpedoes with the great probability of obtaining a hit. The first twenty, of which six were ceded to Chile, had 18-inch tubes.³⁰⁴ Later improved H Class submarines, built in the United Kingdom, had four 21-inch torpedo tubes. The H Class submarines had the requisite endurance to proceed from Canada to the United Kingdom under their own power.

Although nominally a coastal type, their range and endurance enabled them to be used extensively in the observational defence layer of North Sea patrols, particularly on the western edge of the Heligoland Bight minefields. The first to be completed in late 1915 were deployed to the Mediterranean to operate from southern Italy against the threat of Austro-Hungarian surface warships. This was important as the submarines enabled a local layered defence system to be established, particularly as the Admiralty were reluctant to deploy British dreadnought-type battleships to the region. They were deployed also in the layered defence against U Boats operating from Pola and Cattaro (now renamed Kotor in Montenegro) as the German unrestricted U Boat campaign commencing in 1917, was successful against the poorly escorted British and Allied merchant vessels. Considered a successful design, a few British-built H Class survived to be used in operations in the North Sea at the beginning of the Second World War.³⁰⁵

S.S. Hall, Commodore (S) and E.H.T. d'Eyncourt, Director of Naval Construction, had the major influence on submarine designs.³⁰⁶ Hall worked in the Admiralty ensuring that the Submarine Service had the submarines, weapons, equipment and crews needed for efficient and effective operations. Hall and d'Eyncourt were supported by Vice Admiral F.C.T. Tudor the Third Sea Lord and Controller of the Navy from 1914 to 1917, responsible for procuring all

³⁰² Ibid

³⁰³ E C Fisher, 'The Subterfuge Submarines', *Warship International*, 1977 (3).

³⁰⁴ 'Ship's Cover H Class', ADM/SC/368, Brass Foundry, NMM.

³⁰⁵ E Young, *One of Our Submarines* (London: Penguin, 1954), pp 31-45.

³⁰⁶ 'Submarine Designs' d'Eyncourt papers DEY-31, Caird Library, NMM; D K Brown *A Century of Naval Construct.*

new warships. Tudor ensured that the resources were available to build the submarines. The First Sea Lord and the Admiralty Board authorised the ordering of the submarines by their inclusion in the Navy Estimates and obtaining the necessary funding from the Treasury.

By mid-1915, after Fisher's resignation, further consideration was given to the roles that submarines would fulfil as the war progressed. In August 1915 Hall sent a memorandum to the Chief of Staff, the Director of Naval Construction, and the Third Sea Lord in which he argued that submarines with different capabilities were needed for the different layers:

Hitherto the development of Submarines has proceeded along well-defined lines to enable them to torpedo surface vessels though their powers of doing this have enormously increased with size, speed, and endurance, their functions have remained the same. It is evident that this straight path of progress will now diverge into several branches, each of which will have to undergo a similar course of development.

Hall proposed the preparation of designs for:

Fast Submarine Minelayers, suitable for laying connected mines.

Submarine Minelayers suitable for laying single or connected mines in shallow or confined waters.

Submarine Monitors with various kinds of guns, single or more, for bombardment purposes.

Submarine Patrol vessels, capable of long endurance, with long distance Wireless, but not requiring speed either on surface or submerged.³⁰⁷

Rear Admiral H.F. Oliver, the Chief-of-Staff, concurred with the above and added:

A great need is to develop a large habitable submarine for use all over the world on foreign stations. The first nation to develop these and build 20 or 30 of them will have command of the seas.³⁰⁸

The Director of Naval Construction, E T d'Eyncourt replied that he concurred with Commodore (S) and the C.O.S. as regards the extreme importance of the development of submarine designs for the various purposes identified from wartime experience, adding:

Our later designs of the J and K Classes have marked great strides in submarine construction and to some extent meet the requirements named by C.O.S., they are the outcome of designs proposed by me some time ago and gradually improved and developed in conjunction with Commodore (S). The study and experience gained with

³⁰⁷ 'Memorandum', 13 August 1915, Commodore (S), Policy Various Matters July-Dec. 1915, ADM 137/1098, TNA, ff 314-315.

³⁰⁸ Ibid, f 315.

these types placed us in a very good position to advance still further, and I now have initial stages designs of still larger vessels with heavier armament or other good qualities, which can be developed with one feature or another specially improved, to meet new requirements.

A modified "E" Class boat adapted for minelaying has already been submitted.

It must be borne in mind that the real determining factor in submarine design is the speed and radius of action required for under-water work. If the under-water speed can be kept low with a moderate radius of action, the battery and motor power required may be kept within reasonable limits; but as the speed or radius under water increases in a large vessel, the weight involved soon begins to mount up to an unwieldy figure. This point, therefore, requires special careful consideration when enumerating the requirements of a submarine vessel.³⁰⁹

Rear Admiral Fredrick Tudor, Third Sea Lord, proceeded to establish this Committee:

It is the utmost importance to formulate a Programme for future Submarine Construction, but before that is done, we must know our limitations and I propose a 'Submarine Development Committee' to be formed of the following over which I shall preside.³¹⁰

The committee was formed and consisted of the Director of Naval Ordnance and Torpedoes, the Naval Assistant to First Sea Lord, Commodore (S), the Director of Naval Construction, and the Engineer-in-Chief. Minutes of this committee have not survived but the findings are included in the Technical History.³¹¹ The first meeting was on 8 September 1915 and six, distinct types were specified, confirming the different capabilities that submarines required for the diverse tasks in the different layered defence systems:

1. Coastal
2. Patrol (previously called Overseas)
3. Fleet
4. Cruiser
5. Minelayers
6. Monitor

These will be considered in turn.

³⁰⁹ 'Memorandum', 19 August 1915', d'Eyncourt papers, ff 316-317.

³¹⁰ 'Some Considerations on Submarine Development', 22 August 1915, Rear Adm. Tudor, ff 312-313.

³¹¹ 'The Technical History & Index, Submarine', TH1, ADM 275/19, TNA.

One: Coastal submarines

By the outbreak of war, the remaining A and B Classes were obsolete, possessed little fighting value, and were limited to training roles. Thirty-seven C Class were in available but with their small size, petrol engine for surface propulsion, slow speed, and poor endurance, they were of limited fighting value. As noted in the previous chapter, in 1915 they were allocated a role in defence of ports against an enemy bombardment. In theory if there was an invasion or amphibious landing, these submarines were to provide a defence layer until the arrival of superior surface force. By 1915 a German invasion or amphibious raid was a diminishing possibility, however, the bombardment of an East Coast port was still considered a threat. In reality, the concept of these submarines in a coastal defence layer was a façade as the fast-moving German bombardment raids of 1914 proved that they were incapable of providing such defence. Had flotilla defence been real, Great Britain would have been in trouble. However, they were disposed to East Coast ports as a last layer in the naval defensive system, albeit more for political motives. However, as the war progressed, it will be seen that they were used effectively in specific anti-U Boat roles and for training new submariners.

The small, experimental classes, based upon foreign designs were completing, and although much superior to the C Class, the Admiralty recognised their limitations. Consequently, the three F Class submarines were allocated for training, and the three S Class and four W Class submarines were ceded to Italy.³¹² The four V Class submarines were capable of operational patrols in shorter-range operations and were deployed in the southern and central North Sea. By mid-1915 the Submarine Committee and the Admiralty considered that a German invasion or military raid was so unlikely that no further coastal types were needed. The more capable H Class submarines building in Canada were to commission in mid-1915, and should the need arise, these were more capable for coastal protection layer.

Two: Patrol submarines

A very important element in layered defence was to provide an observational, close blockade of the German North Sea naval bases. By 1913, the larger submarine, starting with the D Class, were capable of operations off the German North Sea naval bases and coast, and were designated as overseas submarines.³¹³ By mid-1915 a large programme of building E and G

³¹² 'Proposed Allocation of 6 H Class Submarines' 5 August 1915, Policy Various Matters July-Dec. 1915, ADM 137/1098, TNA, ff 286-295.

³¹³ 'Ship's Cover D Class', ADM/SC/212, Brass Foundry, NMM.

Classes was underway, and many were expected to be commissioned in the immediate future.³¹⁴

The D Class submarines were designed with two torpedo tubes in the bow and one in the stern. The standard submarine torpedo was 18" diameter, and not having a reliable gyro mechanism for deflection firing, to achieve a hit the torpedo tube and hence the submarine had to be in the correct position and orientation relative to the target ship, complicated further as the target was often fast moving and manoeuvring. Torpedoes were fired from their tubes by compressed air and the resulting water disturbance on the surface could be observed, thus giving the target the opportunity to take evasive action. To mitigate against this, torpedoes were to be fired at close range, the optimum being considered as 500 yards. A torpedo fired from a tube in the bow require the submarine to turn away immediately to avoid the risk of colliding with the target. When the D Class was designed, it was felt that the limit in length had been reached as regards end-on attack as it was becoming more and more difficult to manoeuvre clear after firing torpedoes at the short range necessary to ensure success.

The initial design solution in the E Class submarines was therefore to have one tube in the bow, one in the stern and two beam tubes with one each to port and starboard. The beam tubes allowed the submarine to be more parallel to the target vessel, avoiding the necessity to turn away so quickly on firing. The location of the four tubes was considered to provide the best opportunity of firing rather than the complex manoeuvring of the relatively slow submerged submarine into an optimum attack to use the bow mounted tubes. Opinion in the submarine service was against bow tubes and their complete omission was considered; however, from E.9 onwards, two bow tubes were fitted. Wartime experience with this layout showed that against a fast-moving target, there was time only to fire a single torpedo, and due to the difficulty of accurately predicting the target course and speed through the periscope, there was a minimum chance of obtaining a hit. Later experience showed that it was very difficult to hit a small target, such as a U Boat, with a single torpedo, so a salvo of torpedoes, fired at slightly different angles was required.

By 1916 the Admiralty recognised the need for ever increasing numbers of overseas type submarines, soon to be re-designated as patrol submarines. A new design of patrol submarine was ordered in early 1916 to provide the enhanced capacities required for these defence layers. Initially referred to as an Improved E Class, the design progressed into the L

³¹⁴ 'Ship's Cover E Class', ADM/SC/291, Brass Foundry, NMM.

Class.³¹⁵ The hull shape included four bow mounted torpedo tubes thus enabling salvo firing, with the greater probability of achieving a hit. Two beam tubes were retained, but the stern tube was omitted, and they were designed to be larger with more internal space for new and improved equipment to be installed. More powerful diesel engines provided a higher surface speed. Hydrophones and a gun were installed to improve the capabilities as an anti-U Boat weapon. Many L Class were ordered and if the war had continued beyond November 1918, these would have become the predominant patrol submarine.

Three: Fleet submarines

In 1912 the German High Seas Fleet exercised off the Danish Jutland coast together with their U Boat flotilla transferred temporarily from Kiel. Naval intelligence received a report from a Danish Naval Officer that a component of these exercises was that following an initial fleet action, the HSF would withdraw to lead the Grand Fleet over a U Boat ambush.³¹⁶ Although these U Boats were not fast enough to be considered fleet type, this was a new capability in naval warfare. Admiral Jellicoe, Commander-in-Chief of the Grand Fleet, expressed his concerns, and informed the Admiralty that the Germans would use submarines and minelayers in a fleet action, and if fought in the southern North Sea would also involve aircraft.³¹⁷ His objective was therefore to fight any fleet action in the northern North Sea but would decline to pursue a retreating HSF. On 15 May 1916, a message decoded by Room 40 "may indicate that the Germans are developing their submarines tactically for fleet work".³¹⁸ This intelligence proved to be wrong, but it increased the urgency to build comparable, large, high-speed submarines to operate directly with the Grand Fleet. In a fleet action, their role would be to proceed to the disengaged side of the HSF and deliver a massed torpedo attack against their battleship line. In such an attack there would be a high probability of multiple torpedo hits.

A fleet submarine needed to achieve and sustain a surface speed of 21 knots to maintain operations with the battleships. In early 1915 a new submarine design was prepared using diesel engines for surface propulsion. Powerful diesels were unavailable, so the existing Vickers diesels used in the E and G Classes were modified with twelve rather than eight cylinders, and three of these diesels were installed with three propeller shafts.³¹⁹ To facilitate

³¹⁵ 'Ship's Cover L Class', ADM/SC/393, Brass Foundry, NMM.

³¹⁶ 'Naval Intelligence notes on German Submarine Construction, Report of German Fleet exercises', 30 May 1912, ADM 137/3905, TNA.

³¹⁷ 'Jellicoe to the Secretary of the Admiralty', 30 October 1914, MSS 49012, British Library, ff 23-25.

³¹⁸ P Beesly, *Room 40 British Naval Intelligence 1914-1918*, p 154.

³¹⁹ 'Ship's Cover J Class', ADM/SC/326, Brass Foundry NMM.

high, sustained surfaced speed, the outer hull shape of the J Class was based upon that of fast light cruisers and was model tested in the Haslar towing tank.³²⁰ It was apparent before completion that the J Class engines would fail to deliver the power to achieve the required 21 knots, with their maximum being 19 knots. Unable to operate directly with the Grand Fleet, they were re-deployed as patrol submarines. Only seven were built as they were unnecessarily large and expensive for such a patrol role, where their higher surface speed was considered as of limited benefit.

The only power-plants capable of achieving this speed were steam turbines. Based upon earlier designs, new designs were prepared by the Admiralty and by Vickers. The Admiralty selected their own design and in June 1915 placed orders with Vickers to create the production drawings and to start building.³²¹ The K Class had a similar hull shape to the J Class, optimised for surface speed, and achieved a maximum surface speed of 23 knots, so could keep pace with Grand Fleet.³²² The Admiralty intended to supply two flotillas each of twelve submarines, and seventeen were commissioned between late 1916 and 1917. These submarines were integrated initially within the Grand Fleet, providing a new, flexible tactical capability. The operations of the J and K Classes will be described in the following chapters. Due to notorious accidents, the K Class received a bad name.³²³ However, the concept was correct but by the time they were available to work with the Grand Fleet, it was less likely that there would be another fleet action. K Class submarines were later used in an anti-U Boat role, also described in a later chapter. One of the naval war's "might-have-been" is their role if they had been available at Jutland, particularly if they could have proceeded to the disengaged side of the High Seas Fleet during both their battle turn-away manoeuvres. Note that today a nuclear hunter-killer submarine is often an integral member of a United States aircraft carrier task group.

Four: Cruiser submarines

The concept of a cruiser submarine was to operate worldwide with long-range endurance and therefore would be considerable larger than the current patrol classes. In addition to torpedoes, the design would also have a gun armament of 6" or larger. It would provide a layer of long-range observation and attack capability. Cruiser submarines might also supplement or replace trade protection cruisers. Such a submarine had been proposed pre-

³²⁰ D K Brown, *The Grand Fleet, Warship Design and Development 1906-1922*, pp 125.

³²¹ Ibid

³²² 'Ship's Cover K Class', ADM/SC/353, Brass Foundry, NMM.

³²³ J Everitt, *The K Boats*, (London: NEL, 1972).

war by Churchill and others, as a useful weapon system for the Mediterranean.³²⁴ By 1915 there were few if any German warship and merchant ship targets remaining abroad, so a British cruiser type submarine design was not progressed. Germany identified their requirement for cruiser submarines with heavy gun armament, based initially on their successful merchant submarines. These U Boats were able to operate against British and Allied merchant vessels as far as the east coast of the United States and in the Azores-Canaries area.³²⁵

Post war there was a growing awareness of the threat posed by Japan in the Far East and possibly against Australia and New Zealand.³²⁶ Britain could not afford to keep a substantial battle fleet in Singapore, and assuming the warships were available, it would take time to assemble and send a fleet to Singapore. A policy was adopted to build cruiser submarines to be positioned in Singapore, with an advanced base in Hong Kong, to “hold the fort” until the arrival of the fleet.³²⁷ Those based in Hong Kong were capable of operating to the Japanese coastal waters. These submarines were to provide a deterrent role against the Japanese fleet, rather than the very costly need of deploying a battleship-based fleet continuously in the Far East. The large submarine X.1 with a heavy gun armament of two twin 5.2-inch guns was designed and commissioned in the 1920s.³²⁸ Although unsuccessful, the experience was useful for the interwar designs of large cruiser submarines of the O, P, and R Classes.³²⁹ The concept of this cruiser submarine defence layer was thus vindicated.

Five: Minelaying submarines

In 1915 the old, converted cruisers used as minelayers, were being replaced by higher speed, larger mine capacity converted merchant ships. Surface minelayers had limited capability to penetrate close to the German coast or within a swept channel between British and German minefields. The German UC class minelaying U Boats had shown their utility, so six E Class were converted to carry twenty mines, two each inside ten vertical tubes in their saddle tanks.³³⁰ The E.45 was commissioned in August 1916 and the other five by January 1917, so the committee decided to await their operational progress before ordering more. They could

³²⁴ C M Bell, *Churchill & Sea Power*, pp 45-47.

³²⁵ R H Gibson and M Prendergast, *The German Submarine war 1914-1918*, p 282.

³²⁶ C M Bell, *The Royal Navy Seapower and Strategy Between the Wars, Far East War Plans and the Myth of the Singapore Strategy* (Basingstoke: MacMillan, 2000), pp 59-98.

³²⁷ Cited in D Henry in *British Submarine Policy 1918-1939*, in B Ranft (ED.) *Naval Policy 1860-1939* (London: Holder and Stoughton, 1977), p103.

³²⁸ ‘X Class, The Development of HM Submarines’, BR 3043, Chapter 13.

³²⁹ ‘O, P & R Classes, The Development of HM Submarines’, BR 3043, Chapters 14 & 15.

³³⁰ ‘E Class Minelayers, The Development of HM Submarines’, BR 3043, Chapter 4.

penetrate locations much too dangerous for surface minelayers, and often laying their mines in channels swept previously by the Germans. Mines provided a very effective frontline offensive layer in sinking German vessels, tying up enormous minesweeping resources and severely disrupting operations of German U boats and surface warships. With the benefit of hindsight, it is surprising that more E Class were not converted. The success of this new minelaying defence layer prompted the completion of six of the new L Class submarines to be fitted out as minelayers, although these were incomplete by the end of the war.³³¹ Each carried sixteen mines in vertical tubes. In 1927 submarine M.3 (see monitor submarines below) was converted to carry one hundred mines in a long compartment above the pressure hull. Following successful trials, she was scrapped in 1933 but became the prototype for the World War 2 successful Purpose Class minelaying submarines.³³²

Six: Monitor submarines

The concept of mounting a heavy gun on a submarine, provided an innovative technical capability and a new layer. The German surface warship bombardments of East Coast towns had caused deep concerns to the British public. The Admiralty was worried of the consequences if a U Boat could surface without warning off a port, bombard the port installations and town, and then withdraw unopposed. The Director of Naval Construction was asked therefore to prepare designs of a submarine with a single 12" gun and a submarine with two or more 7.5" guns. The objective of such submarines was to provide a new layer for shore bombardment, but it is unclear where this novel weapon system was intended to be used. The option of the 12" gun was progressed, and four submarines were ordered in late 1916, although only M.1 was commissioned before the end of the war.³³³ These were referred to as monitor submarines although this might be due to the coincidence that their pendant number prefixed with the letter "M". The guns were 12" from pre-dreadnought battleships and could be elevated to 20° and traversed port and starboard by 5°. The gun could be fired under periscope control with just the muzzle above water level but could only be re-loaded while the submarine was on the surface. High speed was not essential for their planned operations, so diesels were installed for surface propulsion.

The primary role of monitor submarines transitioned from shore bombardment to an anti-ship layer. In mid-1915, the Committee was aware that for a successful torpedo attack, the

³³¹ 'Ship's Cover L Class', ADM/SC/393, Brass Foundry, NMM.

³³² 'Porpoise Class', The Development of HM Submarines', BR 3043, Chapter 17.

³³³ 'Ship's Cover M Class', ADM/SC/374, Brass Foundry, NMM.

optimum range was around 500-yards, while a longer-range attack gave the enemy vessel the opportunity to manoeuvre to avoid the torpedo. From surfacing, to firing the gun and re-submerging took approximately 30 seconds, and at such short range, it could hardly miss. A similar sized submarine could carry about 15 torpedoes whereas M.1 carried 50 shells. A hit from a 12" shell could destroy an enemy destroyer or naval auxiliary and cause severe damage to an armoured warship. Royal Navy submarines were bound by international laws, so it was unlikely these to be used in this manner against merchant ships during the war. Torpedoes were also considered expensive, particularly when they missed their target. A monitor submarine provided new capabilities in different roles, thus providing further, innovative offensive layers. When completed M.1 did not have a useful operational role in the North Sea, and to preserve secrecy, was exiled to the Mediterranean where it did not fire its gun in action. Post war the Admiralty presumably had continuing faith in monitor submarines as M.1 was kept until lost in a collision with a merchant ship in November 1926. M.2 was converted to carry and launch a small purpose-built sea plane, until lost by an accident in January 1932, M.3 was converted to a minelayer, and M.4 cancelled. Although the concept of this layer can be considered a failure, the monitor submarine pre-dated by eighty years, the concept of cruise missile armed submarines, now considered a revolutionary layer.

Weapon Systems, Machinery and Equipment Development

In addition to the rapid developments in submarine design, the on-board weapon systems, machinery, and equipment were also developed rapidly. An issue with warships is that they are designed and build around the current weapon systems and equipment, and cost constraints generally prevent addition space being included for possible future developments of weapon systems and equipment. This is applicable particularly to submarine designs as they are complex and packed with equipment and weight is a critical design factor.³³⁴ A warship is designed typically for at least a twenty five-year life, and inevitably there is a need to install new and developed systems. In wartime the pace of developments is higher, so the space problem is greater. In the D, E and G Classes, there was insufficient space to install the necessary new equipment. For example, to install the latest wireless telegraphy equipment essential for operations, either the port or starboard torpedo tube was removed to create space for the wireless cabinet for the bulkier equipment and telegraphist. Space was required for other equipment including Fessenden sound signalling, a water jet system for

³³⁴ D K Brown, 'The Technology of Submarine Design, A historical Survey 1905-1945', *Interdisciplinary Science Reviews*, 1990, Vol.15, (3), pp 235-251.

rapid identification while surfaced, a gun on the casing plus space for stowage and transfer of ammunition, a Forbes Log for measuring speed while submerged, a depth sound machine to assist accurate navigation, air purifiers and ventilation to prolong submerged endurance, machinery to raise and lower wireless telegraphy masts, and many more. Further space was then required for the additional specialist crew members to operate the equipment, plus the extra stores to sustain them on patrol. The installation of equipment was almost always at the expense of the habitability for the crew. Weight and ship stability are always critical issues to be considered when installing additional equipment. There quickly comes a time when no further equipment can be installed withing a given design.

Weapon System - Torpedoes

Torpedoes were the principal submarine weapon system. The capability of delivering a large explosive charge against the underwater hull of a target, was the rationale of submarine involvement in all the layered defence systems. Heavy guns had a small percentage of hits at typical battle ranges and required multiple hits to sink a heavily armed target, for example SMS *Lützow* at Jutland, unless the hit caused a magazine explosion, for example HMS *Invincible* at Jutland.³³⁵ A torpedo, fired by a submarine at shorter range, had a higher probability of a hit that was below the waterline, often below the side armour of a battleship. The ingress of water caused severe damage, and the wiping effect of the explosion caused damage to sensitive equipment and to rotating machinery. Even if the target was not sunk, it was likely to require extensive, time-consuming repairs.³³⁶

In 1914, the Royal Navy's submarine launched torpedo was of 18-inch diameter, and a hit by a single torpedo could sink a destroyer, a U Boat and a merchant ship, and perhaps an older light cruiser, but only cause damage to a battleship or battle cruiser. Torpedo machinery, depth-keeping and course control mechanisms were complex and needed regular checking and maintenance. Torpedoes had to be kept in dry tubes that were flooded shortly before firing. At the beginning of the war, submarine commanding officers were often sure that their torpedoes had been aimed and run correctly but appeared to pass under their target. Test firing a torpedo while at periscope depth and at short range, showed that their depth-keeping mechanism was taking too long for the torpedo to reach the required depth.³³⁷ By comparison,

³³⁵ J Campbell, *Jutland, An Analysis of the Fighting* (London: Conway, 1986).

³³⁶ D K Brown, *The Grand Fleet, Warship Design and Development 1906-1922, Chapter 11 Action Damage and the Experience of War, Torpedo Damage*, pp162-165.

³³⁷ 'Operations of the 8TH Submarine Flotilla', Memoranda & Reports of Commodore (S), ADM 137/225. TNA.

the standard surface warship torpedo was 21-inch diameter, and was a much more powerful weapon, and would cause much more damage to a large, armoured warship. The additional weight, equipment and space require for 21-inch torpedoes precluded their installation in the submarines design around the 18-inch torpedo system. For example, to install 21-inch tubes in the bow of an existing submarine required it to be lengthened by over 20-feet and many consequential changes. It was cheaper and more effective to design a new class of submarine around the 21" torpedoes. War experience showed that the probability was low of a hit by a single torpedo against a fast moving, manoeuvring warship, especially as the range increase. More emphasis was placed therefore on providing the capability of firing a salvo of say four torpedoes all on slightly different courses. The H Class submarines built to an American design, were fitted with four bow mounted torpedo tube. Beam tubes were fitted up to the K Class but not beyond. On the much larger K Class double, rotatable torpedo tubes were mounted on the casing, to be used while on the surface in night attacks. These being outside the protection of the pressure hull the tubes and the torpedo mechanisms were difficult to maintain and were quickly removed.³³⁸

The better solution for all torpedo firing was the development that after firing, an internal gyroscope turned the torpedo and then maintained a pre-set course.³³⁹ This development took time to perfect and was operational by the end of the war. Early in the war, torpedoes were fired based upon the captain's periscope observation of the target, and thus depended on his skill. To assist, a torpedo attack analogue computer was developed called an IS-WAS. Target course and speed plus the submarine's course and speed were fed into this mechanical device and a firing angle was output. This device eliminated mental calculations, thus increasing the probability of a hit.

Weapon System - Guns

The D, E and G Class overseas submarines were designed to provide a close observation blockade capability and attack German surface warships, with their principal weapon system being torpedoes. A surfaced submarine would be very vulnerable in any gun battle with a surface warship. Pre-war various small calibre guns were installed in some submarines, but not consistently.³⁴⁰ Only a limited number of torpedoes were carried, and they were often too expensive to use against a small target, for example an armed trawler. Guns increased the

³³⁸ 'Ship's Covers K Class', ADM/SC/353, Brass Foundry, NMM.

³³⁹ 'Submarine Administration, Training & Construction', Technical History & Index, ADM 237/19, TNA.

³⁴⁰ 'Gun Armament, The Development of HM Submarines', BR 3043, Chapter 28.

capabilities of submarines to be used in diverse layered defence systems. Whereas torpedoes were essentially an anti-warship weapon, guns could be used offensively against merchant ships, auxiliary warships and in anti-U Boat warfare, and defensively for anti-Zeppelin and anti-aircraft.

As early as 1914, when operating in the observation-reconnaissance layer in the Kattegat, the need for a submarine mounted gun was identified to force merchant ships to stop for inspection.³⁴¹ Using submarines against enemy merchant ships was a new layer in naval warfare, that was not anticipated pre-war. German and neutral merchant ships knew that Royal Navy submarines were following international agreement and would not therefore fire a torpedo at an unarmed merchant ship. Experience during 1915 in the Sea of Marmara highlighted the benefits of a suitable submarine mounted gun in dealing with small merchant ships upon which it was not worth expending a torpedo.³⁴² By fitting a gun, the submarine could fire warning shots across the bow of the merchant ship, forcing it to stop and submit to inspection for contraband. If it was a German merchant ship, once the safety of the crew had been achieved, it could be sunk by explosive charge or by gunfire rather than expending a torpedo. Anti-ship guns, initially 6 or 12-pounder and later the more effective 4-inch, were installed progressively on most patrol submarines. On-board space within the pressure hull was also allocated for shells so that they could be transferred quickly to the gun once the submarine surfaced. Well maintained guns were not susceptible to damage by sea water but being mounted on the casing caused hydrodynamic drag and a loss of up to one knot of underwater speed.

Throughout the war, there were many instances of submarines sighting U Boats, but these were small and illusive targets for a torpedo. To use a submarine in the anti-U Boat layer, a solution against a surfaced U Boat was to install a suitable gun. The theory being that on sighting a U Boat through the periscope, the submarine would surface quickly and open fire with the gun before the U Boat had time to submerge. The first guns were mounted on the submarine's casing and were found to be almost unusable as being too close to the water, often being awash. The conning tower was then re-designed with a gun and with separate access for the gun crew, and this configuration became standard on the L Class.³⁴³ Upon surfacing, the gun crew could get the gun into operation with the minimum delay before the U

³⁴¹ 'Commodore (S) War Records 1914, Volume 1', ADM 137/2067, TNA.

³⁴² P Shankland & A Hunter, *Dardanelles Patrol* (London: Collins, 1964).

³⁴³ 'E T d'Eyncourt papers' DEY/31, Caird Library, NMM.

Boat could submerge. Even this brought little success as only a few shots could be fired before the U Boat submerged. As will be seen in subsequent chapter, gun-armed submarines were used to disrupt U Boats on transit by forcing them to submerge thus shortening the time they could spend on patrol. Submarines operated in conjunction with surface warships by forcing the U Boats to submerge and exhaust their batteries, and thus making it difficult to evade anti U Boat warships in the adjacent area where they re-surfaced.

Guns were the only weapon available to a submarine in an anti-Zeppelin layer, and later anti-aircraft layer. Germany's possession of Zeppelins gave them a major advantage with their ability to undertake long-range reconnaissance, especially before and during a sortie by the High Seas Fleet. This was a constant worry to Admiral Jellicoe, Commander-in-Chief Grand Fleet. Zeppelins sighted surface warships in sufficient time to allow them to gain height and be out of range of the warships' guns. Zeppelins also patrolled the Heligoland Bight and were armed with bombs for attacking British submarines. A somewhat surprising role for submarines was fitting some E Class with 6-pounder A/A guns to attack Zeppelins. It was expected that while submerged, they would sight the Zeppelin via their periscope, and when close would surface quickly opening gun fire before the Zeppelin could escape by gaining height. It was recommended therefore that the submarines being fitted with more powerful, 4-inch A/A guns.³⁴⁴ The only occasion a submarine destroyed a Zeppelin was on 4 May 1916 when E.31 sighted Zeppelin LZ.32 on the sea surface off Horns Reef.³⁴⁵ It transpired later that this Zeppelin had been damaged previously by gunfire from the light cruisers HMS *Galatea* and HMS *Phaeton*. By 1917 and 1918, submarines were vulnerable to attacks by German aircraft using bombs and machine gun fire. Although submarine guns that could be elevated sufficiently to be used in an anti-aircraft role provided some protection, it was generally safer for the submarine to submerge.

Weapon System - Mines

Minefields had been envisaged pre-war but laid by surface ships. Submarine minelaying was a new defence layer that had not been anticipated pre-war. The stealth capability of minelaying submarines became very important providing a new layer in British minelaying strategy. The stealth capability of submarines enabled them to lay mines in areas, typically close to German naval bases, that were too dangerous for surface minelayers to penetrate,

³⁴⁴ 'Submarine Patrol Report', Captain (S) to Admiralty, 24 September 1915, ADM 137/1922, TNA. f 362.

³⁴⁵ 'Submarine Patrol Report, E.31', 5 May 1915, ADM 137/2069, TNA, ff 344-351.

and their operations are described in a later chapter. Initial trials were based upon mines discharged from submarine torpedo tubes, but this restricted the diameter of the mines being 18-inches and therefore limited the explosive charge and made it difficult to install the mechanisms into the space available. This was changed quickly to installing 30-inch diameter tubes into the saddle tanks, thus allowing a larger, more reliable mine to be developed. These mines used the reliable Hertz horns for detonation.³⁴⁶

Weapon System - Depth Charges

The most effective weapon against submerged U Boats was the depth charge. In 1917 it was decided to evaluate a submarine being fitted with depth charges to attack a submerged U Boat. It was assumed that a U Boat would submerge upon sighting a fleet submarine, particularly if attacked first by gun fire. The J and K Classes were selected as their higher surface speed enabled them to proceed quickly to this position. In December 1917 submarine J.1 was fitted with shoots on its casing so that up to four depth charges could be dropped.³⁴⁷ Set to explode when they reached 90 feet depth, the higher speed of the submarine allowed it to get clear of the resulting explosions. There is at least one recorded case of J.1 dropping a depth charge on a U Boat, although the attack was unsuccessful.³⁴⁸ In August 1918, trials were made using a depth charge thrower fitted at the stern of submarine K.6 to throw a depth charge ahead and to the side of the submarine.³⁴⁹ In both cases, the depth charge firing pistol was inserted just prior to firing as the submarine would have been unable to submerge with a primed depth charge on the casing. A further anti-U Boat weapon considered was to fire stick-bombs from a submarine's 4-inch deck gun.³⁵⁰ Subsequent chapters will deal with the very extensive use made of submarines in integrated layered defence anti-U Boat operations.

Machinery - Surface

From as early as the B Class design, the Admiralty considered the surface speed of a submarine to be solely strategic, and not of tactical value.³⁵¹ Surface speed had to get the submarine from place to place, whereas higher additional surface speed required larger

³⁴⁶ Capt. J S Cowie, *Mines, Minelayers and Minelaying* (Oxford: OUP, 1949).

³⁴⁷ 'Report of Dropping Depth Charges from Submarine J.1', 9 December 1917, ADM 137/1926, TNA; 'Extract from Trials of Depth Charges', Ship's Cover J Class, ADM 138/514, Brass Foundry NMM.

³⁴⁸ 'Report of Proceedings, J.1', Lt. Cdr. Kennedy, 9 November 1918, Commodore (S) War Records Volume 7, ADM 137/2077, TNA, f 131.

³⁴⁹ 'Report of Trials of Depth Charge Thrower fitted to Submarine K.6', 13 August 1918, ADM 137/1936, TNA.

³⁵⁰ 'Trials to be Made with Dummy Stick-Bombs', 21 October 1918, ADM 137/1936, TNA.

³⁵¹ 'Memorandum for the Controller by Inspecting Captain of Submarines on New B type Submarines', 7 November 1903, Ship's Cover, SC/290.

engines and more fuel, thus sacrificing radius of action. Submerged speed was needed when in contact with the enemy and attacking or escaping, therefore being of tactical value. For any surface warship and particularly submarine design, compromises were needed to achieve the submarines' objectives.

A serious constraint on British submarine operations, and their role in all defence layers, was the relatively poor performance of their diesel engines compared to those in German U Boats.³⁵² British submarine diesel engines were designed and manufactured by Vickers and developed 100 brake horsepower per cylinder, by comparison, U Boat diesels developed 300 horsepower per cylinder, enabling the equivalent overseas U Boats to be a couple of knots faster than the D, E and G Classes.³⁵³ The U Boats' faster surface speed made it very difficult for British submarines to get into a position to attack them with either a torpedo or by gun fire. For the J Class submarines, an attempt to provide more power was to increase the number of cylinders on a standard diesel, and to install three diesels rather than the two in the overseas classes. More power was required for a fleet submarine to achieve the requisite 21-knots so oil-fired boilers and steam turbines were installed.

Machinery - Submerged

Submarine submerged capability was an important attribute while operating in all layered defence system. When submerged the submarines used their electric motors powered by re-chargeable batteries. These batteries were developed to provide more power and less weight, to maximise the submarines' underwater range.³⁵⁴ British submarines could typically travel underwater for up to one hundred nautical miles or use higher speed to get into an attacking position or to evade German anti-submarine warships. Electric power was also essential for all equipment and for ventilation.³⁵⁵

Equipment - Wireless Telegraphy Communication

The Admiralty recognised that to achieve a fully integrated layered defence, submarines needed to transmit and receive wireless telegraphy signals. In pre-war manoeuvres each group of submarines was accompanied by a destroyer with a senior officer on board. He would be in contact with his C-in-C or the Admiralty by W/T and receive instructions for the disposition of the submarines. He would then pass these orders to the submarines via visual

³⁵² A W Johns, 'German Submarines', 1920 *Transactions of the Institution of Naval Architects*, London.

³⁵³ 'Main Engines, The Development of HM Submarines', BR 3043. Chapter 25.

³⁵⁴ A Hezlet, *The Submarine and Sea Power*.

³⁵⁵ 'Main Motors and Batteries, The Development of HM Submarines', BR 3043, Chapter 26.

signalling. As the integrated layered defence evolved, the need for direct communications between submarines, the shore and with other warships became apparent. As planned pre-war, and maintained throughout the war, a primary task for overseas submarines was to report on the movements of German warships. Intercepted German W/T transmissions gave the Admiralty warning of a sortie but not necessarily their operational objective, for example a raid on the east coast, to protect a minelaying operation, or for gunnery exercise. Submarines were the only type of British warship that could maintain regular observational patrols in the Heligoland Bight. It was essential therefore that these submarines had reliable, long-range W/T equipment to report sightings on German warships, their location, course, and speed. W/T technology was developed almost in parallel with submarines. By 1910 some submarines were fitted with experimental W/T installations, known as Type 10, that had a transmission range of 30 to 50 miles.³⁵⁶ As explained already, in 1914 submarines operating in the Heligoland Bight had to rely on passing a W/T message via a linking surface warship positioned typically off the Dutch coast. They also carried homing pigeons that were slow and were clearly unreliable. In 1915 the Admiralty received intelligence that German U-Boats were communicating directly with Germany from a range of 300 miles, and a comparable British capability was needed. The urgency is emphasised in a memorandum by Churchill on 23 April 1915:

I await a special report on the fitting of overseas submarines and selected destroyers with special long-distance wireless. It is indispensable that a submarine should be able to communicate with our receiving stations when operating in the Heligoland Bight. It is also necessary that a certain number of destroyers should have the special faculty of long-distance communication in order that they may be used in connection with submarines. The matter is urgent.³⁵⁷

Fisher concurred:

It seems desirable to pursue this subject with all dispatch.³⁵⁸

As a trial, an E Class submarine and a destroyer were dispatched from Harwich to Devonport to record the ranges at which messages were received and transmitted. Ipswich W/T station was designated to deal only with submarines, transmitting messages at specific times throughout the 24-hour period. The submarines would listen for messages at these specific

³⁵⁶ A Hezlet, *The Electron and Sea Power*.

³⁵⁷ W S Churchill, *World Crisis 1915, Appendix H* (London: Penguin, 2005).

³⁵⁸ 'Annotation, Wireless in Submarines, Report of Conference held on 21 April 1915', 23 April 1915, ADM 1/8471/241, TNA.

times, and the messages would be repeated to increase the probability of them being received. The existing W/T equipment on-board submarines was clearly inadequate. The Poulsen arc system (Type 14) developed in the US, with a potential range of up to 300 nautical miles, was selected as replacements.³⁵⁹ The Poulsen equipment required extra space and in E Class submarines usually required the removal of one of the beam torpedo-tubes. Poulsen equipment was installed also in submarine depot ships as well as the *Iron Duke*, flagship of the Grand Fleet. Submarines still needed to be surfaced and erect large aerial masts to receive and transmit, and these were slow to dismantle delaying diving. Submarines would only transmit urgent messages, such as sighting the High Seas Fleet, as transmitting allowed the Germans to locate their position by direction finding. Upon sighting a warship sortie, the submarine would need to wait until it was safe to surface, rig the masts and then transmit such a message. During the delay, the tactical situation could change considerably. Conversely when a British submarine attacked a sortie, the Germans used their own W/T to report the attack, allowing the British to obtain the position by direction finding and often de-code the message to discover what had happened.³⁶⁰

Equipment - Periscope

All wartime layered defence systems depend on visual observations. When a submarine was on the surface, visible range was limited by the height of the officer-of-the-watch and lookout on the top of the conning tower, that on a clear day was a few miles. While on observation patrol off the German North Sea coast, it was usually too dangerous to remain on the surface in daylight, so observation depended on visibility through the periscope. Pre-war the firm of Grubb had a monopoly of designing and manufacturing submarine periscopes, but it was suspected that foreign designs were better, and technical visits to foreign companies revealed that these were producing better periscopes.³⁶¹ The start of the war precluded the purchase of any foreign periscopes, but the knowledge gained from these visits was used to improve the British designs. A submerged submarine operating near the surface on a clear, calm day could be seen from the air so there was an obvious benefit of the hull being at a greater depth. Longer periscopes allowed the top lens to be higher above the surface, thus increasing the visible range, or enabled the submarine to operate further below the surface, but long periscopes were also prone to vibration from machinery and wave action. Royal Navy submarine designs located the whole attack team in the control room from where the captain

³⁵⁹ A Hezlet, *The Electron and Sea Power*, p 129.

³⁶⁰ Ibid, p133.

³⁶¹ Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes, Volume 1*, p 30-32.

used the periscope and co-ordinated the team. By comparison, in German U Boats the captain was positioned in a small compartment within the conning tower and directly above the control room. This allowed the use of longer periscope but at the expense of separating the captain from the attack team.³⁶² The range of vision through all periscopes was poor, particularly if there was fog or poor visibility and in waves. Submarines were vulnerable immediately on surfacing, as although no surface ship may have been seen through the periscope, a Zeppelin or aircraft could be overhead. An urgent development was the ability to tilt the top lens skyward to check before surfacing.

Equipment - Hydrophones

The Admiralty's acquisition of the first submarines was to develop an anti-submarine capability. The detection of U Boats became an essential layer as the war progressed. Given the technology available pre-war, the best option was the hydrophone which used an underwater microphone to detect the noise of a submarine. While submerged, noise was generated by the electric motors and the propeller through the water. The successes and threat of U Boats against warships and their use in unrestricted warfare necessitate the rapid development of hydrophones as anti-U Boat warfare became a dominant defence layer. An experimental station to develop and to trial hydrophones was established at Hawkraig in the Firth of Forth.³⁶³ An experimental station was later established in Harwich and developments were encouraged in many laboratories and universities. This extent and urgency of this research and development was comparable to the development of radar in the Second World War.³⁶⁴

The early hydrophones could detect the noise of a U Boat but not the direction or range of the noise. The first viable hydrophones were installed in anti-U Boat surface warships that were formed into flotillas making this technology critical for anti-U Boat layer defence. To use these hydrophones, the warships had to be stopped to avoid the noise of its own engines, and then to exchange cross-bearing to obtain the position of the U Boat.³⁶⁵ From 1916 when the role of Royal Navy submarines was participating in the anti-U Boat layer, it was important that they had hydrophones with directional capability. Hydrophone equipment was installed in all patrol

³⁶² D K Brown, 'The Technology of Submarine Design', *Interdisciplinary Science Review*, Vol.15, No.3, 1990.

³⁶³ B Head, 'The Hawkraig Experiments, The Beginning of Submarine Detection', *Warship*, January 1989, No.49.

³⁶⁴ B Johnson, *The Secret War, Chapter 2 Radar*, (London: BBC, 1978).

³⁶⁵ 'Submarine and Anti-Submarine Policy', War Operations and Policy, 1917 Vol.2, ADM 116/1349, TNA.

and anti-U Boat submarines. Detection range and accurate direction improved throughout the war, as hydrophone technology developments were shared between Britain, United States and France. The technology of hydrophones was a passive listening device. This led to ASDIC, an active system whereby a reflected audio signal was received from a submerged U Boat. Although not available for operations during the war, ASDIC, later renamed SONAR, was viable from the 1920s.³⁶⁶ The operations submarines, within an anti-U Boat layered defence system, are described in subsequent chapters.

Equipment - Underwater Communication

For the effective operations of submarines in all layers, an issue that became apparent early in the war was the inability to communicate with submarines once they submerged. For example, when Commodore Keyes was endeavouring to co-ordinate a flotilla of submarine from his destroyer, hand grenades were dropped overboard to attract the attention of the submarines to issue new orders.³⁶⁷ This was clearly impractical for fast-moving operations, so the Admiralty bought sets of the Fessenden Underwater Sound Telegraphy system from the United States.³⁶⁸ This equipment could be installed in submarines and surface warships.³⁶⁹ The system consisted of an oscillator positioned underwater on each bow that transmitted a loud audible sound, and on trials a range of 30 nautical miles was obtained. The equipment was installed first in the H Class submarines building in Canada, and from November 1915 it was installed in all submarines.³⁷⁰ Later it was found that the equipment could operate also as a sensitive directional hydrophone.

Training

The efficient and effective operations of a submarine depended on many factors including the skill of the commanding officer and the ability of the crew to operate the equipment. An officer who volunteered for submarine service would start typically as the First Lieutenant of a coastal submarine and remain there to gain experience of submarine technology, later transferring to be First Lieutenant of an overseas submarine. He would then return to a coastal submarine as a commanding officer before becoming commanding officer of a patrol submarine.

³⁶⁶ A Hezlet, *The Electron and Sea Power*, pp 164-171.

³⁶⁷ 'Commodore (S) War Records, Volume 1', ADM 137/2067, TNA. ff 568-570; Keyes, *The Naval Memoirs 1910-1915*, p 145.

³⁶⁸ G L Frost, 'Inventing Schemes and Strategies, The Making and Selling of the Fessenden Oscillator', *Technology and Culture*, July 2001, Vol.42.

³⁶⁹ E Bruton and E Coleman, 'Listening in the dark: audio surveillance, communication technology and the submarine threat during the First World War', *History and Technology*, 2016, Vol.32 (3).

³⁷⁰ A Hezlet, *The Electron and Sea Power*, p 108.

Commanding officers were generally Lieutenants or Lieutenant Commanders and occasionally Commanders. All submarines spent much time on exercises, particularly firing torpedoes. The commanding officer had to acquire skill in using the periscope to estimate the speed and course of a target in addition to evading any escorting anti-submarine warships. In 1915 a Periscope Course was established for commanding officers, and any officer failing to meet the grade was dismissed the submarine service and reverted to surface warships, resulting in the course being referred to as the Perisher Course – a name still used to this day.³⁷¹

Accurate navigation was also necessary particularly when laying a minefield or operating close to one. Naval Officers were trained in navigation, but few had experience in operating in coastal areas such as the Heligoland Bight with its sandbanks, strong currents and tides. A solution was for overseas submarines to have a third officer from the Merchant Navy experienced in navigation in coast waters and with a commission in the Royal Navy Reserve.

Habitability

The capability for submarine operations in all layered defence system, was dependent also on the skill of the captain, officers, and crew to fulfil their roles and to operate the equipment efficiently. Unlike large surface warships, all submarine personnel were specialists and vital to the submarine's safety and to the operations' effectiveness. Submarines being relatively small had poor seakeeping ability and the resulting motions were severe in bad weather. Sea sickness and tiredness were problems, as all submarine crew members had to remain alert. Very poor air quality after prolonged submergence effected their judgement. The constant dangers of patrols from attack and from mines was a serious strain both physically and mentally.

Habitability was a problem in all submarines, with the early British submarines up to and including the C Class having no designed crew accommodation.³⁷² At best there was the facility to make a hot drink and their patrol endurance was determined by how long the crew could cope. Facilities in the first D Class overseas submarine were improved but the additional equipment carried left very little space available for crew comfort. Space had to be provided for drinking water, food and for cooking and sleeping facilities. Although conditions were improved in successive submarine classes, they were harsh. Submarines, like all warships

³⁷¹ 'Submarine Service Periodic Report, 1 January to 30 June 1918', Commodore (S) War Records Volume 7, ADM 137/2077, TNA, ff 103-105.

³⁷² 'Habitability, The Development of HM Submarines', BR 3043, Chapter 32.

designed and built during peacetime were generally cost-constrained so there was little if any margin built-in to allow for additional equipment. With all warships, wartime experience inevitably results in many additional items of equipment being installed during building and once in commission. Space for new and larger equipment was often at the expense of crew space.

German Anti-Submarine Warfare

Anti-submarine warfare was not as important to Germany as it was for Britain and the Allies, but essentially their response was similar.³⁷³ Their main weapon was the mine, adapted from their anti-shipping mine with the Hertz horn mechanism for detonation. It is believed that the Royal Navy lost ten submarines to German mines, but a further ten disappeared without trace and were likely to have hit mines, albeit some could have been mines adrift from German or British minefields.³⁷⁴ There were seldom survivors from such a sinking, so unless the wreck is discovered and examined, these remain a mystery. Throughout the war German relied on gunfire and ramming but these were weapons-of-opportunity. An anti-submarine depth charge was developed that was triggered by the float and line principal, backed up by a timer. Although being unreliable, it had a deterrent effect that by dropping a few these allowed the target vessel to escape. Germany developed explosive sweeps that were towed behind anti-submarine vessels, but these also were unreliable.

Germany also used Zeppelins and aircraft for anti-submarine warfare. Airmen inevitably claimed many sightings and successful attacks that were often false. U Boats probably torpedoed and sank five British submarines but were usually opportune encounters rather than deliberate anti-submarine operations. German development of hydrophones to detect submarines was probably somewhat behind equivalent British and Allied developments. By 1917 Germany used anti-submarine nets to protect anchorages but as with British nets, these were vulnerable to damage by tides and storms.

Submarine Design Committee

Throughout the war, the Admiralty established committees of experts to advise on overall design and equipment technology. The requirement for submarines with different capabilities to fulfil different roles changed as the war progressed. The Admiralty generally implemented the committees' recommendations thus confirming the further integration of submarines with

³⁷³ D R Messimer, *Find and Destroy, Antisubmarine Warfare in World War 1*, (Annapolis: NIP, 2001).

³⁷⁴ F J Dittmar & J J Colledge, *British Warships 1914-1919*.

the other naval assets within different scenarios. This confirms the argument that submarines were key to implementing layered defence and were a force multiplier, enabling surface warships being used to their designed capabilities.

The very heavy losses of British and Allied merchant vessels to the unrestricted German U Boat campaign caused the Admiralty and the Submarine Design Committee to consider using submarines against U Boats. Throughout the war, coastal and patrol submarines had some successes in sinking U Boats with torpedoes, but this now became the primary role of submarines. In effect, a new submarine layer was needed urgently. Submarine versus U Boat was difficult as when on the surface they sighted each other, the U Boat generally escaped due to their more powerful diesels providing greater surface speed. To hit the small U Boat target at long range with a torpedo was very difficult especially if the U Boat was taking evasive manoeuvres. There was therefore a requirement for a specialised anti-U Boat submarine, new technology and a new layer. In 1917 a submarine was designed with a high submerged speed, so that upon sighting a U Boat, it could obtain an optimum torpedo firing position without being sighted.³⁷⁵ The resulting R Class mounted six bow torpedo tubes to enable a large salvo to be fired. They had a larger battery capacity, and the shape of their hull was optimised for submerged rather than surfaced speed. The hull shape is now referred to as teardrop, similar to modern nuclear submarines, and with all deck fittings removed and no deck gun, so there was minimum hydrodynamic resistance.³⁷⁶ The first was ordered in October 1917 and completed and commissioned in June 1918. Before the end of the war, eight were completed, but by then there was little opportunity for them to be in action. In September 1918, R.7 and R.8, the first of the class were ready for service and carried out several patrols north of Ireland and in the Irish Sea. On 13 October R.7 sighted a U Boat, and by making use of her high submerged speed, she succeeded in placing herself in a very favourable position from which to continue the attack at low speed. Upon the approach of a steamer, the U Boat submerged before the attack could be completed. This was the only occasion that an R Class encountered a U Boat.³⁷⁷ It was unfortunate that this class came into service too late in the war to have the opportunities to prove their value. The Admiralty's speed of decision making shows the advanced thinking of a specialist submarine being used

³⁷⁵ 'New Design of Submarine for Anti-submarine work, 26 September 1917'. Board Meeting 27, September 1917, ADM 167/54, TNA.

³⁷⁶ 'Ship's Cover R Class', ADM/SC/292, Brass Foundry, NMM.

³⁷⁷ 'Report, of Proceedings R.7, Lt. Lockhart, 10 October 1918', Commodore (S) War Records Volume 7, ADM 137/2077, TNA, f 125.

against U Boats. Today this concept has developed into the nuclear-powered hunter-killer submarines.

The Admiralty plan to use overseas submarines for a close observational blockade of the German North Sea naval bases was implemented immediately on the outbreak of war by the first two submarines proceeding on 5 August 1914. The D and E Classes vindicated their original design specifications with their ability to patrol off the entrance of the River Ems and observe the German warships stationed there. They clearly demonstrated their capability to do this, thus ensuring there was no need for cruisers and destroyers to make high-risk close blockade patrol. The submarines formed the foremost layer in the flexible layered defence systems that were to meet any defensive and offensive layered system. Their offensive capability was to attack German warships using torpedoes, and their defensive capability was to provide early warning of any German sortie, to allow the Grand Fleet to intercept, for example prior to a coastal bombardment or raid. The submarines freed-up surface warships that then reinforced the important layers, particularly the Grand Fleet and the Harwich Force. Further submarine patrols quickly disclosed an accurate picture of the German patrols in the Heligoland Bight of destroyers and armed trawlers supported by cruisers and Zeppelins. This intelligence was the basis for planning the Battle of the Heligoland Bight. The Admiralty realised that there were insufficient submarines in commission and under construction to maintain contiguous observational patrols, reconnaissance of Scandinavian coasts, to project British warships into the Baltic, and to reinforce the Dardanelles. Under Admiral Fisher, a further twenty were ordered and their building expedited. Fisher decided also that these would be the proven E Class design rather than waste time on the structurally more complex G Class. These E Class were deployed extensively in all theatres where they were used in offensive operations as important layers in the local layered defence system.

The coast submarines that were designed to attack an enemy amphibious landing or bombardment force were found to be inadequate, and quickly re-deployed to east-coast ports, being probably more for political reasons as the Grand Fleet was too far north to intercept and attack such enemy forces. For example, at the bombardment of Hartlepool, the C Class submarine had difficulty even leaving the harbour and ran aground while under gunfire. To fire a torpedo at an enemy ship, such a C Class needed to be in precise position in advance. This planned layer was thus a failure, albeit expected, and at best, they would be a last stopgap should an attack be made on the port. Later in the war, the C Class coastal submarines were found useful roles later for short duration anti-U Boat patrols and training crews for the

overseas submarine. The Admiralty did not build further coastal types and disposed of the new, experimental, double-hulled types built pre-war. As the war progressed, the possibility decreased of a German amphibious landing. Should this occur, the overseas submarines were designated to become an important layer to attack the German warships and troopships.

The overseas submarines were designed to torpedo German warships, but from experience in the early patrols, it was recognised that torpedoing small, fast-moving, manoeuvring surface warship was very difficult. On discharging a torpedo, the disturbance in the water could be seen, giving the target vessel an opportunity to avoid the torpedo, so to maximise the probability of hitting a target, the optimum range was a mere 500-yards requiring the whole submarine to be the correct position and alignment. A hit on an armoured warship by an 18-inch diameter torpedo would cause damage but was unlikely to cause it to sink. It was not practical to re-design the E Class with more and larger torpedo tubes, but these requirements were considered for new classes to be designed. The lack of a deck gun was also found as a problem, first for forcing a merchant ship to stop for examination, and secondly as an anti-Zeppelin and anti-aircraft weapon. It was relatively straightforward to mount a gun up to 4-inch on the casing of an E Class, thus giving them greater capabilities. Gun-armed submarine were particularly successful when used offensively against merchant ships in the Baltic and Sea of Marmara, providing the capabilities for further layers. Guns used against Zeppelins and aircraft were more defensive purposes as it was unnecessary to risk a valuable submarine against aircraft.

The Admiralty, and in particular the Submarine Committee, were quick to understand the need for specialised submarines. These new submarine types were designed for new roles, and new layers. The limitations of the D, E and G Classes of overseas submarine were addressed in the design of the superior L Class. If the war had continued beyond 1918, these would have become the dominant patrol submarines and been used in different layered defence systems, for example, observational, reconnaissance, and anti-U Boat. The fleet submarines were also designed and built very quickly, albeit based on experience of experimental designs. Integrated with the Grand Fleet they provided a unique, powerful capability in a fleet action. Utilising their high speed they created a new layer to be used to intercept a retreating High Seas Fleet following a fleet action. The fleet J Class were limited by the unavailability of powerful diesel engines to achieve the requisite surface speed, but the seven built were a useful addition the patrol submarine layer. The K Class were hampered by accidents and there were command and control difficulties operating with the fleet. By 1917 the unrestricted

U Boat campaign was a larger problem than a less likely fleet action, so the K Class high surface speed enabled them to be used to proceed to a U Boat sighting position. The experiments for K Class to carry anti-U Boat depth charges was not pursued although if successful, would have been a useful new layer. The M Class monitor submarines seemed a useful addition in 1915, but when the first was commissioned in 1918, there were no useful role for these.³⁷⁸ If they had been used against German surface warships, or in a shore bombardment role, these capabilities would have been innovative layers. M.1 was deployed to the Mediterranean to be used to perhaps bombard Pola, Cattaro or Trieste, but nothing was done. The cruiser submarine was deferred as there was not a role for these large, long-range submarines. The E Class submarines converted for minelaying had been successful and some of the newer L Class were converted. Submarine minelaying was a unique capability and provided a very useful layer in the extensive mine laying campaign. The H Class were smaller than the overseas / patrol classes but were very useful in operations for example into the central North Sea and in the Aegean. In the latter, they were an important layer in the Otranto Barrage. A few were kept and carried out patrol as the start of the Second World War.

The pressure of war also encouraged rapid development of submarine equipment and weapons. The most pressing need was to find a submerged U Boat and the hydrophone was the most promising technology. Enormous effort was made in Britain and by Allies to develop hydrophones, comparable to the development of radar in World War Two. Hydrophones relied on detecting the sound of a submerged U Boat, that is passive technology. By 1918 an active system was being developed whereby a directed soundwave was bounced off a submarine, that is active technology. Although not available during the war, this became ASDIC, later renamed SONAR. Hydrophones enabled surface warships to actively hunt U Boats and armed with depth charges, became a new layer within anti-U Boat the layered defence system.

Throughout the war, improvements were made to submarine-based weapons: Torpedoes became faster, more accurate and had greater range; Mines were designed to lay from tubes in the submarine's saddle tank. Guns were fitted for anti-ship, anti-U Boat and anti-aircraft. Trials were made with submarine having depth charge launchers but this was not pursued. All of these developments contributed to the capabilities of submarines to operate within their specialised layer. Machinery systems were developed to provide higher speeds and range, albeit diesel engine development was disappointing. Habitability was improved to increase

³⁷⁸ 'Employment of M Class Submarines', 23 August 1918, Plans Division War Records June-November 1918, ADM 137/2709, TNA, ff-340-344.

the endurance of patrols, and commanding officer and crew training and exercises were developed to improve efficiency to ensure submarines fulfilled their layer in each layered defence system.

Chapter 4: Naval Policy, Plans and Layered Defence, 1916 to 1918

This chapter examines the surface naval warfare from 1916 to the Armistice in 1918. Major events are examined, followed by an analysis of the subsequent modifications and enhancements to the layered defences that resulted therefrom. Note that in response to the German unrestricted U Boat warfare the developments in layered defence resulting therefrom are described in the next chapter. Following the Battle of Dogger Bank on 24 January 1915, the High Seas Fleet made only a few sorties but did not proceed far beyond the Heligoland Bight, and there were no fleet actions until Jutland. The Grand Fleet, based at Scapa Flow, had to be ready for any action and so maintained a high degree of readiness with sweeps in the North Sea and regular exercises and gunnery practices. New, more-powerful dreadnought battleships, light cruisers and destroyers were commissioned and joined the Grand Fleet, Battle Cruiser Fleet, and the Harwich Force, thus increasing its superiority over the High Seas Fleet. This allowed the detachment of the 3RD Battle Squadron of pre-dreadnought battleships from the Grand Fleet to be re-deployed in the Nore Command, based at Sheerness in the Thames estuary. These slow, poorly armed battleships were more of a hindrance within the Grand Fleet if involved in a potential fleet action, as illustrated by the loss of the German pre-dreadnought *Pommern* at Jutland and HMS *Formidable* in the Channel, both hit by single torpedoes. However, their re-deployment provided an additional layer as a deterrent against any German sortie into the southern North Sea, the Thames estuary, the English Channel, and also against the diminishing risk of an invasion or military raid on the southern part of the East Coast.

Unknown to the Admiralty, was that after the Battle of Dogger Bank in January 1915, with the loss of *Blücher* and the serious damage to the battle cruisers, the Kaiser's reaction was to add further restrictions on operations of German major warships.³⁷⁹ British submarines had therefore few opportunities to attack these. However, even if the Admiralty had known this, German policy could change quickly, so the Admiralty had to maintain the layered defence systems against the different possible threats, and therefore keep submarines on observational patrols.

The Situation at the Start of 1916

In February 1916 Admiral Sir Henry Jackson, the First Sea Lord, presented a report on the naval situation, which provides a useful summary of the Admiralty's views at the start of the

³⁷⁹ P G Halpern, *A Naval History of World War 1*.

year.³⁸⁰ Although not using the term, it described a layered defence beginning with the Grand Fleet in home waters and culminating in the minefields on the German coast. Regarding the main fleets in home waters, he stated there was little change in the general situations during 1915. The High Seas Fleet had remained in its bases and carried out most of its battle practices in the Baltic due largely to the first of the layers, the British minefields laid in the Heligoland Bight. U Boat warfare had increased and included minelaying. German naval operations were limited to minelaying, submarine attack of any type of vessel, and commerce destruction. Continued economic pressure was kept on Germany by the northern patrols of armed merchant cruisers, a critical layer in the Admiralty's naval strategy, which depended on the presence of the Grand Fleet, the final layer, for their protection against well-armed cruisers. He stated that whatever might happen in distant waters, the Grand Fleet must be kept at sufficient strength, and at full efficiency, in all classes of vessels, to meet the High Sea fleet and stop a potential invasion. To maintain their fighting efficiency, the Grand Fleet periodically carried out tactical exercises and frequent sweeps of the North Sea, by squadrons and flotillas, to ascertain if any enemy ships were present, to show its presence, and to intercept mercantile traffic. A detached cruiser squadron and destroyer flotillas at Harwich made sweeps in the southern North Sea and escorted merchant ships between Harwich and the Hook of Holland. A monitor squadron based at Dover had defined offensive operations off the enemy coast assigned to them.

Regarding coastal patrols, Admiral Jackson pointed out that whereas Germany had 60-miles of North Sea coastline, Britain had 2000-miles of coastline to patrol and protect. German forces were concentrated in a small area, well protected naturally and artificially, ready to combine quickly to act against any raid or attack at any point. This applied also to German Zeppelin and aircraft patrols. By comparison, concentration of British local flotillas to a threatened point, was a lengthy process. The great length of coastline necessitated a very large number of airfield stations to enable the whole East Coast to be properly watched from the sky. The minesweeping of the east coast and estuaries, the patrolling of Britain's coasts to prevent enemy raids on its South and East coasts, which were organised long before the War, had developed into patrols against U Boats and minelaying, to be an organisation of sizeable proportions round the British Isles. The escort of troop transports to France and to

³⁸⁰ 'Summary of Naval Situation', 7 February 1916, Policy 1916 January and February', First Sea Lord, ADM 137/1159, TNA, ff 370-392.

the Atlantic from home waters, required flotillas of torpedo boats and destroyers. This escort was necessary on account of U Boats and had proven their efficiency by the very few losses that occurred to transports in the Channel. Jackson added that these flotillas consisted of the older classes, many of which were barely seaworthy, and only fit for work in estuaries and sheltered positions.

Jackson drew attention to the continued use of all vessels that necessitated a large number of repairs with every British shipyard taking a share of the work, with on average 300 vessels under repair at any given time. Large vessels such as battleships, battle cruisers and cruisers needed docking and repair every six months and torpedo craft every four months, thus reducing the paper strength of each squadron and flotilla. Although German warships also needed docking and repair, in planning a sortie Germany could arrange to have fewer warships absent. He reported on the shortage of destroyers and although five or six new ones were added each month, achieving the target of one hundred and twenty destroyers for the Grand Fleet was delayed from August to December 1916.

It should be noted the emphasis that Jackson placed on the idea that “the Grand Fleet must be kept at sufficient strength, and at full efficiency, in all classes of vessels, to meet the High Sea fleet and stop invasion”. This is the complete antithesis of any flotilla defence plan, as it makes the Grand Fleet the linchpin of the layered defence systems. He also reported on the very large ship repair infrastructure needed to keep the warships updated and operational. This efficient ship repair organisation could also be considered as a supporting layer. He also noted that patrol flotillas consisted of older and “barely seaworthy” vessels, a further indication that there was no attempt to implement any form of flotilla defence policy against a German invasion or raids. This report does not mention the intelligence obtained by direction finding of German wireless telegraphy or by the growing code breaking ability to read such German signals. These may have been considered too secretive to be included in a document that had a wide readership of politicians.

Economic Blockade – A War Winning Layer

The Economic Blockade became the principal layer in the naval offence system to defeat Germany by preventing the import of raw materials for their military industry and food for their army and civilian population. It developed due of the inability to operate a close trade blockade off the German coasts, and involved advantage of the geography, namely the northern entrance to the North Sea and the narrow, easily blocked Dover Straits. The necessary organisation was established pre-war to administer the intercepted material, particularly for

the British justification of the potentially disputed international legal perspectives. Upon the declaration of war, the designated cruiser squadrons immediately took up their designated positions and began intercepting merchant ships suspected of trading with Germany.³⁸¹ The cruisers of the 10TH Cruiser Squadron operating initially between the Shetland Islands and Norway, were found to be unsuitable due to the severe weather conditions, so were quickly replaced by Armed Merchant Cruisers.³⁸² The background to the pre-war establishment process of this defence layer is well documented.³⁸³ When the war started, this crucial layer of the economic blockade continued to be developed with more items being added to the contraband lists.³⁸⁴ By the beginning of 1916 the 10TH Cruiser Squadron, had expanded to twenty-Armed Merchant Cruisers, that operated extensive interlocking patrols north of Scotland and off Iceland. Their principal function continued to be the interception of merchant ships to stop goods and raw materials reaching Germany that were classified as “contraband” by the British Government. They were also to intercept and prevent any German disguised merchant ship raider escaping from the North Sea onto the world trade routes, not a negligible threat.

By early 1917 agreements were eventually reached with the four northern neutral countries, Norway, Sweden, Denmark, and The Netherlands, to ration their imports to pre-war levels, to deter the re-export of such goods and raw materials to Germany.³⁸⁵ These neutral countries had initially been against such rationing but were persuaded to cooperate as they were dependent largely on British coal for both domestic needs and for their merchant ships and fishing fleets. The United States still argued for freedom-of-the-seas as their commercial companies wanted to continue the lucrative business of trading with all belligerent countries. British diplomacy had to draw a fine line between implementing the economic blockade and placating the United States. When a neutral ship was intercepted, she was sent into a British port for examination, where she was detained until a decision was made by the London-based Contraband Committee. By 1916 a further system was implemented whereby the ship’s cargo was examined in the port of loading by a British consular official, and a certificate issued for

³⁸¹ Papers of Adm. de Chair, Document 7865, Imperial War Museum.

³⁸² R Osborne, *Armed Merchant Cruisers 1878-1945* (Windsor: WSS, 2007), pp 40-137.

³⁸³ C M Bell, *Churchill & Sea Power*, pp 42-53; M S Seligman ‘Failing to Prepare for the Great War? The Absence of Grand Strategy in British War Planning before 1914’, *War in History*, 2017, Vol.24 (4), pp 414-437.

³⁸⁴ J D Grainger, Ed. *The Maritime Blockade of Germany in the Great War: The Northern Patrol, 1914-1918* (Aldershot: NRS, 2003).

³⁸⁵ ‘Memorandum on the Position of the Blockade at the Commencement of 1917, and Further Developments Since that Date’, for War Cabinet, War Operation and Policy, ADM 116/1349, TNA.

the cargo. This document referred to as a Navicert or Letter of Assurance, showed that the cargo was as stated, that it was consigned to acceptable recipients, and were within the ration for the neutral destination country. A copy of the cargo manifest and the Navicert number were telegraphed to the Contraband Committee, often negating the need for the intercepted ship being sent into a British port. This system was effective as it was operated with the participation of the neutral countries, whereby the number of intercepted ships sent into a British port diminished. Most of the cargoes came from the United States, so once they entered the war in April 1917, the need for the 10TH Cruiser Squadron largely disappeared, and it was disbanded finally in December 1917, releasing their ships for convoy duties.

The Economic Blockade activities in the English Channel were easier to implement as the minefields of the Dover Barrage forced all merchant ships transiting the Channel to enter the Downs Anchorage, located between the coast of Kent and the Goodwin Sands, where they were inspected. While in the anchorage the merchant ships were under threat from a raid by German torpedo boat destroyers based in Zeebrugge. The anchorage was protected by the same multiple layers of light forces protecting the Dover Barrage and the cross-Channel supply of the British Army in France. Further north there were submarines on patrol off the Dutch coast, and the Harwich Force sweeps in the southern North Sea and patrols off the entrance to the Channel.

Historians have argued over the effect of the economic blockade on Germany. The reduction of food supplies for the German population probably had the greatest effect and became worse as the war progressed.³⁸⁶ Non-ferrous metals were also in short supply, for example sub-standard parts were discovered on war-built U Boats. Commodities such as rubber and fuel also became scarcer as the war progressed. The 10TH Cruiser Squadron intercepted and examined 8,905 vessels of which 1,816 were sent into port for further examination.³⁸⁷ The Squadron's Armed Merchant Cruisers were very vulnerable to an encounter with German heavily armed, fast battle cruiser or cruiser. To prevent this occurring, the Royal Navy implemented a layered defence including submarines being located on the likely routes of such German warships, numerous sweeps of cruisers in the North Sea and off the Norwegian coast, and finally the Grand Fleet and Battle Cruiser Fleet would overwhelm an intercepted German force. Throughout the war Germany made little attempt to interfere with the economic

³⁸⁶ J Ferris, 'Pragmatic hegemony and British economic warfare, 1900–1918' in G Kennedy (ed) *The War they thought and the war they fought* (Westport: Praeger, 2016).

³⁸⁷ R Osborne, *Armed Merchant Cruisers 1878-1945*, p 84.

blockade with no attempt by their surface warships to attack the Armed Merchant Cruiser patrols. Some Armed Merchant Cruisers were torpedoed and sunk by U Boats, but these may have been targets-of-opportunity rather than a deliberate attempt to disrupt the economic blockade.

Minelaying – A Dominant Layer

From a tentative beginning in 1914, defensive and offensive minelaying became a very important component of the Royal Navy's layered defence systems. The Royal Navy converted and commissioned many minelayers and organised their supporting infrastructure. By 1916 large industrial resources were developed to manufacture the mines, and the infrastructure established for the minelaying operations. At the beginning of the war the two types of British mines were the "Standard" and the "British Elia" based upon an Italian design. It became evident that both mines had many defects and were almost ineffective.³⁸⁸ It was not until a German mine with Hertz horns was copied and manufactured, that an efficient, effective mine was available.³⁸⁹ These mines, known as H2 type, also had better mooring capabilities so that they were less susceptible to dragging their position in strong tides and storms. In a layered defence against surface ships, mines were laid so that their moorings kept them just below the surface, whereas in a layered defence against U Boats some mines were laid so that their moorings kept them at depths to catch a submerged U Boat. The technology of British mines progressed throughout the war, for example anti-minesweeping devices were developed that allowed the sweeping cable to pass through the mine's mooring cable. Mines were developed that were triggered by a surface warship or U Boat's magnetic signature, while other mines were developed that were triggered by their acoustic signature. These influence-type mines were not moored via a cable but were laid on the seabed and were thus almost impossible to sweep with First World War technologies. Acoustic triggered mines were not used, whereas magnetic triggered mines, at the time referred to a "Sinker Mk1 (M)" were laid off the Belgium coast in August and September 1918.³⁹⁰ In addition to extensive minelaying in the Dover Straits, minefields were laid in the North Channel and off the east coast of Durham and Yorkshire.

The developing technology of mines also allowed the tactics of minelaying to progress, thus creating new layers in the mine laying strategy. Minefields with dummy mines, lacking a

³⁸⁸ 'The Emergence of the Mine as a Naval Weapon and an Examination of its Use up to the End of World War 1' Introduction to British Mining Operations 1939-1945, ADM 234/560, TNA, ff 1-41.

³⁸⁹ Ibid, p 20.

³⁹⁰ Ibid, p 21.

detonator, were also laid in the Heligoland Bight to keep the German minesweeping forces busy while keeping the area safe for British warships to operate. Explosive charges could be attached to some moored mines that were detonated by and destroyed a sweep wire, thus delaying the sweeping operation. Soluble plugs were fitted to some H2 type mines whereby after a time, usually 38-days, the mine would flood and sink automatically to the seabed and de-activate. This innovation was intended to allow the safe re-visitation of areas already partially swept, and to lay fresh mines, although in practice, these plugs were found to be unreliable, and little advantage was obtained. Minefields were laid usually in a zig-zag pattern making it more difficult for sweeping. To find the position of new minefield, aircraft and airships were used to spot moored mines just below the surface.³⁹¹

In October 1915, the activities of the German U Boats of their Flanders Flotilla operating from Bruges via Zeebrugge, and Ostend were sinking many ships off the east coast and in the Channel.³⁹² The UC class were laying mines off the British and French coasts and the UB class were using torpedo, gunnery, and explosive charges. The Flag Officer Dover proposed a Belgium barrage consisted of a long line of mine nets with minefields laid in support, about twelve miles off the coast covering the approaches to Zeebrugge and Ostend. This barrage was to protect Royal Naval ships operating off the enemy's Belgium coast, and also hindered U Boats and their access to the Channel. Positioning the nets and laying the mines began at the end of April 1916 and extensions continued until the end of the year. Known also as the Belgium Zareba, this was a major new defensive layer.³⁹³ Creating this was an enormous effort requiring many warships and auxiliaries and carried out within range of German guns on the Belgium coast. When established, British surface warships and auxiliaries patrolled to maintain the nets and stop the Germans from destroying them. The nets and minefield layer had to be left open at its northern end across the entrance to the Scheldt Estuary as this is inside Dutch territorial waters. U Boats not wanting to risk crossing the minefields could proceed northwards towards the Schouwen Bank and then proceed south westward into the English Channel. The nets were also very susceptible to dragging and being destroyed in storms and the strong local tides that were major limitations to their effectiveness.

The Heligoland Bight was very dangerous for British surface minelayers to operate close to the German coast where they could be attacked by German warships, run into a German

³⁹¹ J S Cowie, *Mines, Minelayers and Minelaying*.

³⁹² 'Operations from Zeebrugge and Attempts to Counter Them, October and November 1915' Naval Staff Monograph, Volume XV, pp 15-24.

³⁹³ R H Gibson & M Prendergast, *The German Submarine War 1914-1918*, pp 90-94.

defensive minefield, and risk hitting a British mine laid previously. As noted in the previous chapter, the success of German UC class minelaying U boats prompted the Admiralty to pursue the development of a submarine delivered mine. Mine tubes were installed in the saddle tanks of submarines E.24 and E.41, and subsequently mine tubes were installed in E.45, E.46, E.51 and E.34.³⁹⁴ All joined the 9TH Submarine Flotilla based in Harwich from where they carried out all their operations for the remainder of the war. E.24 was the first to commission and on 7 March 1916 laid a field of 20 mines off the Elbe Light vessel. Further minefields were laid in the Bight as the E Class minelayers commissioned. The activities of these minelaying submarines were integrated with the surface minelayers, making each layer more effective. These submarines, with particularly expert navigators, operating within the Heligoland Bight to lay mines in the German mine-swept routes. Submarines made careful reconnaissance of German minesweeping activity enabled fresh mines to be laid in locations the German navy considered to be safe. These E class minelayers were a new technological factor in the layered defence around mine warfare.

The Heligoland Bight received most mines throughout 1917 with surface minelayers laying minefields outside the existing fields, and by July 1917, these stretched around the northern and western sides of the Heligoland Bight from off the Danish Jutland coast in an arc to the Dutch coast. From intelligence obtained by wireless transmissions and by British submarine observations, it was possible to discover the routes used currently by U boats. Mines were laid in these routes by submarines, and as the Germans changed their routes, these were progressively mined.³⁹⁵ British offensive and German defensive minelaying in the Heligoland Bight had made it a very dangerous place for British submarine operations. Strong currents and tides made accurate navigation very difficult between the known minefields let alone new German defensive fields. The German navy endeavoured to keep three routes clear of mines through the Bight by very extensive minesweeping operations. (Appendix 1 Chart 1). One route was north from the entrance to the river Elbe, parallel to the Danish coast, exiting the Bight in the vicinity of Horn's Reef. A second route was westward from the island of Borkum, exiting the Bight north of the Dutch coast. A third route was from the Jade Bay north-westerly into the North Sea. Discovering the German swept routes from their naval bases, through the heavily mined Heligoland Bight into the central North Sea, and particularly the entrances, was of vital importance for the Royal Navy. Submarines were able to observe the German

³⁹⁴ F J Dittmar & J J Colledge, *British Warships 1914-1919*.

³⁹⁵ 'Commodore (S) War Records Volume VI July-December 1916', ADM 137/2070, TNA.

minesweepers and check the positions of marker buoys laid by the Germans to mark their swept routes. For example, in August 1917 submarine E.31 sighted and fixed the positions of six buoys marking the entrance to a swept route and sighted German minesweepers working near these.³⁹⁶ Consequently a few days later, further mines were laid close to this position by minelaying submarine E.46. These operations were very dangerous as they were on the edge of known and perhaps unknown minefields, so accurate navigation was essential.³⁹⁷ The German navy also lost many minesweepers on these operations, so it appeared that they concentrated only on sweeping the routes while ignoring the remainder of the Bight. This minelaying campaign forced the Germans send their U Boats to their Atlantic operational areas by the Kattegat and then the Fair Isle Channel north of Scotland.³⁹⁸ This added greatly to their transit time and thus less time on patrol to attack merchant ships.

The German decision to implement unrestricted U Boat warfare in February 1917 led to a very large increase in British minelaying, using the new H2 type mines that were much more reliable than their predecessors. Orders were place for over 100,000 of these mines and further vessels, including HMS *Courageous*, light cruisers and destroyers, were converted to lay mines.³⁹⁹ Coastal motorboats were also converted to lay mines in shallow water.⁴⁰⁰ The existing Dover Barrage and the Belgium Barrage were reinforced with the new mines. By 1918 off the East coast of the United Kingdom, defensive minelaying had grown enormously, primarily against German U Boats.⁴⁰¹

The effectiveness of anti-U Boat minefield layers was increased greatly when integrated with other naval assets, for example in the Dover Straits, at night surface vessels and with the suspected presence of unseen British submarines, forced U Boats to submerge into the Dover Barrage minefields and destruction. This layered defence system was strengthened further in 1918 when the Barrage was illuminated at night with powerful shore-based searchlight and those on-board patrolling surface warships.⁴⁰²

³⁹⁶ 'History of British Minefields 1914-1918' compiled by Captain Lockhart Leith, Naval Historical Branch Archive, ff 244-245.

³⁹⁷ W G Carr, *By Guess and by God, The Story of British Submarines in the War* (London: Hutchinson, 1930)

³⁹⁸ 'History of British Minefields 1914-1918' compiled by Captain Lockhart Leith, Naval Historical Branch Archive, f 253.

³⁹⁹ Ibid, ff 37-40.

⁴⁰⁰ Ibid, ff 45-47.

⁴⁰¹ 'British Minelaying Operations Heligoland Bight', ADM 137/837 to 840, TNA.

⁴⁰² H Newbolt, *Naval Operations*, Volume V, pp 178-183.

The British mine laying in the Heligoland Bight necessitate an enormous effort by the German Navy on minesweeping. Minesweeping gear was put on torpedo boat destroyers and many commercial fishing vessels were converted for minesweeping and often manned by their conscripted crews. As German minesweepers operated further and further into the North Sea, they were vulnerable to attack from British forces, so such operations were often escorted by heavy ships of the High Seas Fleet, this supporting role becoming their principal activity. British offensive minelaying thus necessitating the German allocating their scarce resources and manpower to minesweeping. The German navy's endeavour to maintain safe mine-free routes, necessitated minesweeping operating up to 150-nautical miles from their North Sea coast. Wireless telegraphy intercepts had enabled Room 40 in the Admiralty to foretell when major minesweeping operations were expected. A plan was devised to intercept and sink minesweepers at the entrance to route where it exited into the North Sea.⁴⁰³ On 17 November 1917 a force of British light cruisers and destroyers was to surprise and sink the German minesweepers. The German minesweepers were protected by their own light cruisers that were able to make a fighting retreat aided by smoke screens. The British force was supported by the battle cruiser HMS *Repulse* and a squadron of battleships from the Grand Fleet was positioned further north. As the Royal Navy force approached the outer edge of the mined area, they came under fire from two German battleships, *Kaiser* and *Kaiserin*, whereupon they broke off the action, allowing the German minesweepers and light cruisers to escape. Despite the layers being integrated in the plan, the failure was due largely to poor staff work whereby the Admiral commanding the light cruiser was not informed of the latest position of the minefields, and being unclear of their position, he broke off the action earlier than necessary. This action become known as "The Second Battle of the Heligoland Bight",⁴⁰⁴

On entering the war, America was particularly enthusiastic to lay an enormous anti-U Boat minefield between the Orkney Islands and Norway.⁴⁰⁵ America had developed a new type of anti-U boat mine, triggered by antennas to cover a wide range of depths. The mine was anchored to the weight on the seabed by a cable, and a glass float extend a wire above the mine to the surface.⁴⁰⁶ In theory, when the steel hull of a U Boat touched the cable or the wire, the electric charge generated then detonated the mine. In practice they were unreliable and when one mine detonated, it often started a chain reaction by detonating neighbouring mines.

⁴⁰³ Heligoland Bight Operations ,17 November 1917', ADM 137/584, TNA.

⁴⁰⁴ Ibid, pp 176-178.

⁴⁰⁵ 'British and American Minelaying Operations, Northern Barrage', ADM 137/847, TNA.

⁴⁰⁶ Cowie, *Mine, Minelayers and Minelaying*, pp 65-67.

U Boats continued to pass through the minefield, and it is estimated that only six or seven were lost due to mines; a poor result for the enormous effort involved. At the eastern end of the minefield, mines were not laid inside neutral Norwegian territorial waters, and at the western end beside the Orkney Islands, a ten-mile gap was left for the passage of the Grand Fleet. The German Navy knew of the mine-free route, and despite Norwegian diplomatic concerns continued to use it, until near the end of the war then Norway intimated that they had laid mines in their territorial waters.

British Minesweeping

German minelaying off the British coasts, necessitated an enormous fleet of minesweepers being commissioned, thus creating a new layer in naval operations.⁴⁰⁷ This task had been largely ignored pre-war and few naval minesweepers were available initially. Minesweeping gear was added to many trawlers and fishing vessels and their previous civilian crew trained in their operation. German mines were laid by surface warships and auxiliary minelayers.⁴⁰⁸ An early somewhat unexpected success was the sinking of the dreadnought HMS *Audacious* off the north coast of Ireland in a minefield laid by their auxiliary minelayer SS *Berlin*.⁴⁰⁹ Mines were also laid off the Grand Fleet and Harwich Force bases. Prior to a sortie of the High Seas Fleet, tactical minefields were laid on likely routes taken by the Grand Fleet as it proceeded from Scapa Flow and Rosyth on intercepting courses.

From the beginning of the war, extensive German minefields were laid off the East Coast of England and the Thames estuary to sink and disrupt merchant ships. The commissioning of minelaying U Boats enabled minelaying in the English Channel and off the coasts of Ireland. The resulting losses of merchant ships necessitated further increases in minesweeping capability.⁴¹⁰ The coasts around the British Isles were already divided in patrol areas into which light forces were allocated. Minesweeping and its large infrastructure became a major defence layer. Similar to German experience, the resources and manpower needed for this force grew enormously to keep shipping routes and approaches to ports free of mines.

⁴⁰⁷ 'Secret Pack of C-in-C Grand Fleet Volume VI, Minesweeping', ADM 137/1886, TNA.

⁴⁰⁸ Urban F, *Ned's Navy, The private letters of Admiral Sir Edward Charlton*, (Shrewsbury: Airlife, 1998), pp 126-130.

⁴⁰⁹ 'Naval Staffs Monographs Volume XI, Home Waters Part II, Sinking of the Audacious October 27', pp 131-135.

⁴¹⁰ 'Secret Pack of C-in-C Grand Fleet Volume VII, Minesweeping' ADM 137/1887, TNA.

Battle of Jutland, 31 May – 1 June 1916

When the Grand Fleet and the High Seas Fleet encountered each other on 31 May 1916, neither expected it. The British Admiralty thought the High Seas Fleet was still in Wilhelmshaven, and the Germans were unaware that the Grand Fleet was at sea.⁴¹¹ Submarines and U Boats had failed to sight the opposing fleets. Some British overseas submarines were being held in port to intercept a surprise bombardment of an east coast port, and hence were not on observational patrol or available to support the Grand Fleet. The U Boats deployed to observe Scapa Flow and Rosyth arrived on the stations after the Grand Fleet and the Battle Cruiser Fleets had already sailed. As noted earlier, Admiral Jellicoe was anxious for submarines to be integrated with the Grand Fleet, to attack the High Seas Fleet before and after the fleet action. This required the submarines to be in their designated positions before the action, but they had not been ordered to deploy, thus causing a serious failure of Jellicoe's layered defence plans. The consequence of a mass torpedo attack on the battle line by U Boats or destroyers was a predominant concern. Detailed analysis had shown the probability of hits on the battleships, that had probably influenced Jellicoe to turn away when a massed destroyer attack was imminent.⁴¹² After the fleet actions on 31 May, the High Seas Fleet returned to base by proceeding to Horn's Reef and then southward by the Amrun Channel parallel to the Danish coast and returning to Jade Bay and Wilhelmshaven. Three submarines, E.50, E.26 and D.1 were positioned four, twelve and twenty miles west of Vyl lightship but had been ordered to remain submerged at night until 2 June. Although one submarine heard propeller noise in the early morning of 1 June, nothing was sighted.⁴¹³ Poor staff work and the failure to communicate vital information and orders therefore prevented submarines participating in the greatest sea battle of the war. The destroyer HMS *Abdiel* was fitted to carry mines and in 1916 accompanied the Grand Fleet. After the Jutland action during 31 May 1916, she was detached to lay mines off Horn's Reef to the westward of a minefield laid previously.⁴¹⁴ This was an early example of mines that had been laid in a tactical environment. As the High Seas Fleet returned to base, the battleship *Ostfriesland* hit and was damaged by a mine off Horn's Reef but reached port under her own steam. The consequences of Jutland had profound effects on the naval war, with both Germany and Britain analysing their policies and plans and then making changes. Despite claiming a

⁴¹¹ Capt. D Macintyre, *Jutland*, (London: Pan, 1966); V E Tarrant, *Jutland, The German Perspective*, (London: Hodder, 1999).

⁴¹² 'Notes re Torpedoes, 1912', Drax papers, Drax 1-10, Churchill Archive Centre.

⁴¹³ 'Operations of 8TH Submarine Flotilla Reports of Captain (S) 1916', ADM 137/383, TNA, ff 103-104.

⁴¹⁴ J S Corbett, *Naval Operations*, Volume 3, pp 390 & 418-419.

German victory, by 5 June Admiral Scheer was advocating that the offensive should be pressed forward by U Boats, a tacit acceptance that the High Seas Fleet was unlikely to defeat the Grand fleet in any further fleet action.⁴¹⁵ The Germany High Command realised that the High Seas Fleet had a fortunate escape and were unlikely to defeat the Grand Fleet in any future battle. The Kaiser and the High Command wanted to keep the fleet intact and powerful for bargaining in any peace negotiations. These contributed to Germany pursuing an unrestricted U Boat campaign. A British amphibious landing on a German island was considered very unlikely so warships of the High Seas Fleet were therefore available for transfer to the Baltic to support the German army against Russia. Many obsolete pre-dreadnought battleships were paid off to free their officers and crews to man new warships and release the better trained sailors to man U Boats. In Britain there was disappointment that Jutland had not been the resounding victory expected after all the cost and effort of creating the Grand Fleet. There was also widespread anxiety that Germany would begin a major U Boat campaign, and based upon the experience of the 1915 campaign, how it could be countered. On 22 November 1916, Jellicoe was invited and accepted to be First Sea Lord specifically to be responsible for the anticipated unrestricted U Boat campaign, and Admiral Beatty became Commanded-in Chief Grand Fleet.⁴¹⁶ Other senior Grand Fleet officers moved to the Admiralty, for example Admiral C. Burney to be Second Sea Lord and importantly Admiral A.L. Duff to be Director of the Anti-Submarine [U Boat] Division. Admiral Beatty accepted an invitation to become Commander-in-Chief of the Grand Fleet, and this resulted in other changes of senior officers. In December 1916, D. Lloyd George replaced Asquith as Prime Minister, and Sir Edward Carson replaced Arthur Balfour as First Lord of the Admiralty.⁴¹⁷ These appointments invigorated the Admiralty, and it will be seen, the development and strengthening of the layered defence systems.

Layered Defence and the Re-Organisation of the Submarine Flotillas

This apparent failure of the submarine layer at Jutland contributed to a major re-organisation of the submarine flotillas and their future roles. By mid-1916 the submarines ordered in 1913-14, and those ordered by Admiral Fisher in late 1914, were commissioning, and together with their trained crews, provided the opportunity for a major re-organisation of the submarine flotillas. The re-deployment of these submarines presaged major enhancements to layered

⁴¹⁵ R H Gibson and M Prendergast, *The German Submarine War 1914-1918*, p 101.

⁴¹⁶ A J Marder, *From the Dreadnought to Scapa Flow*, Volume III, pp 330-341.

⁴¹⁷ Ibid

defence systems. It also provided resilience in the use of the layers being integrated into various potential scenarios. The disposition, composition and operational roles were:⁴¹⁸

- 1ST Submarine Flotilla, Firth of Forth: 3 C and 1 B, local defence.
- 2ND Submarine Flotilla, Tyne: 8 C, local defence.
- 3RD Submarine Flotilla Immingham: 6 D and 4 W, local defence.
- 4TH Submarine Flotilla, Queenborough [Nore]: 6 C, local defence.
- 5TH Submarine Flotilla, Dover: 12 C, local defence.
- 6TH Submarine Flotilla, Portsmouth: 2 C and 1 B, training.
- 7TH Submarine Flotilla, Ardrossan: 2 B and 1 A, training.
- 8TH Submarine Flotilla, Yarmouth: 5 H, 4 V and 3 F, southern North Sea.
- 9TH Submarine Flotilla, Harwich: 20 E and 5 E minelayers, southern North Sea and Heligoland Bight.
- 10TH Submarine Flotilla, Tees: 8 G and 4 E, northern North Sea, Kattegat, Danish and Norwegian coasts.
- 11TH Submarine Flotilla, Blyth: 6 J and 6 G, northern North Sea, Kattegat, Danish and Norwegian coasts.
- 12TH Submarine Flotilla, Grand Fleet: 8 K, Grand Fleet.
- 13TH Submarine Flotilla, Grand Fleet: 6 K, Grand Fleet.

Submarines of the 1ST, 2ND, 3RD, 4TH, and 5TH flotillas were within the coastal defence layer. These C Class submarines were barely capable of intercepting, let alone attacking a German bombardment raid. Moreover, should there have been a German military landing, it is doubtful if the C Class submarines could have even penetrated the screen of the naval escorting force let alone torpedo the German transport ships. Yet, with the Grand Fleet stationed so far north and unable to intervene quickly, these submarines provided a sop to the demands of local east coast politicians for naval protection. However, they provided a useful role training officers and crews who progressed into the increasing numbers of overseas submarines.⁴¹⁹ Off the East Coast of England, minelaying by U Boats became a serious threat to merchant ships using the swept route between the coast and the offshore defensive minefields. It was observed that these U Boats would often use a prominent headland such as Flamborough Head in Yorkshire, to obtain their accurate position prior to laying their mines in the swept route. When intelligence was available of the presence of such a U Boat, a C Class submarine

⁴¹⁸ 'Redistribution of submarine flotillas and roles, May-June 1916', ADM 137/1161, TNA, f 669.

⁴¹⁹ 'Work of Submarine Service' Policy Various Volume VII 1917, ADM 137/1332, TNA, ff 66-97.

could be used to ambush it off the headland.⁴²⁰ Their activity was integrated closely in a layered defence with surface anti-U Boat warships and disguised Q ships.⁴²¹ The 6TH and 7TH flotillas, with a few obsolete submarines, provided basic training.

The 8TH and 9TH Submarine Flotillas were under direct Admiralty orders and generally employed to the southward of a line joining Flamborough Head, along latitude 55° to the Danish Coast. The H, V and F Classes of submarine, became a new 8TH Submarine Flotilla based in Yarmouth, albeit under operational control of the 9TH Flotilla. These small submarines were capable of patrols to the centre of the southern North Sea to the western edge of the Heligoland Bight mined area, and off the Dutch coast. The older 8TH Submarine Flotilla of E Class submarines based in Harwich was renamed 9TH Submarine Flotilla and continued in their forward defence layer to observe and attack any German surface warship sorties. There were few sorties by German warships, so it was considered not worth the inevitable high losses of these submarine in maintaining a close observational patrols off the German North Sea coast inside the Heligoland Bight minefields.⁴²² Instead, the flotilla's overseas submarines provided observational patrols off the exits of the German swept routes to obtain visual warnings of any German sortie. They could on occasions, patrol inside the dangerous Heligoland Bight if there was a compelling reason. Submarines were ordered to report on the outward movement of German warships, but not to attack them, as if they sank or damaged any warship, it would probably result in the cancellation of the sortie, thus precluding an opportunity for a decisive fleet action. The submarines were allowed to attack inward bound German warships, and then report their presence.

The minelaying submarines, all within the 9TH Flotilla, were a very important component within the overall minelaying defence layer as they were capable of penetrating into the already heavily mined areas. They operated routinely within the Heligoland Bight and had the most experienced navigators for their safety and to ensure the new minefield was laid the correct position, often in a complex pattern to hinder sweeping. All these submarines provided extensive intelligence on the positions of German minefields, minesweeping operations, positions of navigation buoys, and patrols of anti-submarine warships, Zeppelins, and aircraft. Should the Grand Fleet proceed to sea with the prospect of a fleet action, the submarines on

⁴²⁰ 'British Submarines 1914-1918', ADM 137/1926, TNA, f 106.

⁴²¹ R H Gibson & M Pendergast, *The German Submarine War 1914-1918*; D R Messimer, *Find and Destroy, Antisubmarine Warfare in World War 1* (Annapolis: NIP, 2001).

⁴²² 'Notes on the Employment of British Submarine during the Summer Months of 1917, British Submarines 1914-1918', ADM 137/1926, TNA, f 109.

patrol in the North Sea were to be ordered to take positions ten miles apart on one or more designated patrol lines with the primary object of attacking enemy heavy ships retreating to their bases. These submarines provided an essential, forward, intelligence layer for the efficient operation of the Grand Fleet, the Battle Cruiser Fleet, and the Harwich Force.

The 10TH and 11TH flotillas located in Teesside and Blyth in the north-east England, were placed under the direct orders of the Grand Fleet. They patrolled in the northern North Sea, into the Kattegat and off the coasts of Norway and Denmark. They were generally employed in patrols north of the parallel of 55°N. They would have been used in a defence role if there was a German raid or invasion north of Flamborough Head. For organising patrols, the North Sea was divided into an array of navigational boxes, each designated by a letter.⁴²³ Depending on the latest intelligence, submarines were allocated a patrol box and typically spent seven-days on patrol. Some patrols were close to navigation buoys and lightships, such as the northern and southern Dogger Bank lightships, as German U Boats returning from an Atlantic patrol often used these to obtain an accurate navigational fix to avoid known minefields on their return to their base.⁴²⁴ They could also be used within a further layer in direct support of surface warships. If a major fleet action were considered imminent, submarines on patrol would proceed to designated positions to operate with the Grand Fleet. The J Class had a higher surface speed of 19 knots, and the G Class had a better sea-keeping hull form compared to the relatively slower E Class with a surface speed of only 13 knots, allowing them to get to their designated positions faster. The J Class submarines in harbour, with available destroyers, would be ordered to a rendezvous to join the fleet. During the battle, the 10TH and 11TH Flotillas were to attack as soon as possible, and when they had expended all their torpedoes were to proceed to their bases. Submarines that were unable to attack the enemy's line, or which lost and could not regain contact with the enemy battlefleet, were to proceed towards the line of the enemy's retreat to its bases to intercept its return. If the submarines of the 10TH and 11TH Flotillas missed the rendezvous, one flotilla would proceed to the Skaw, and the other flotilla proceed towards Horn's Reef.

The 12TH and 13TH Flotillas consisted of the steam-powered K Class submarines and were integrated with the Grand Fleet and Battle Cruiser Fleet respectively. The K Class began commissioning in May 1916 and continued into 1917, and with their high surface speed, were

⁴²³ 'Commodore (S) War Records, 1914-1918', ADM 137/2067-2077, TNA.

⁴²⁴ 'Reports of Proceedings of Submarines Attached to HMS *Titania*, *Lucia*', Commodore (S) War Records, Volume IX, ADM 137/2075, TNA.

classified as fleet submarines. When the fleets proceeded to sea, these submarines took up their allotted positions in the Cruising Dispositions. Both flotillas were led by a light cruiser that accommodated the flotilla's Captain (S) and staff. They accompanied the battlefleet on sweeps in the North Sea, and in the event of a fleet action, they were to proceed to the disengaged side of the High Seas Fleet and launch a mass torpedo attack. After such an action they were to torpedo and sink any damaged German warships. The war ended without a further fleet action, so the K Class did not have the opportunity to prove their value, but exercises showed that would have made a major contribution to the Grand Fleet.⁴²⁵

The Grand Fleet Battle Orders later renamed Battle Instructions, for submarines operating with the Grand Fleet remained largely unchanged during 1916 and 1917. In January 1918 the Instructions for submarines were modified, being more explicit for a fleet action by anticipating the probable routes of surviving warships of a retreating High Seas Fleet.⁴²⁶ This ensured better integration of the different layers. All submarines available and capable of participating in a fleet action had a designated role and were ordered to take up positions in interlocking layers. The K Class were an integral part of the Grand Fleet with the specific task of engaging the High Seas Fleet on its disengaged side by a massed torpedo attack, particularly if it were to execute a battle 180° turn-away to reverse course. The faster J Class were to rendezvous with the Grand Fleet if possible, or otherwise to join the slower G and E Classes on the probable return routes of the High Seas Fleet. These orders were based on the experiences from the Battle of Jutland, particularly when the High Seas Fleet was under overwhelming gun fire it executed two battle turn-aways behind smokescreens that the Grand Fleet was reluctant to follow. During the night, the High Seas Fleet had escaped to Horn's Reef and safety behind the minefields, and the submarines now positioned along the possible escape routes would oppose such a retreat. Regarding the operations of the K Class fleet submarines, it is relevant that the instructions included the comment that "More detailed instructions would be given for their guidance when experience of their capabilities has been obtained", thus recognizing the novelty of submarines integrated with the battlefleet.⁴²⁷

Grand Fleet Submarine Committee and Change of Policy 1917

In October 1916 Admiral Jellicoe, while C-in-C Grand Fleet, requested Captain Roger Keyes, Captain Algernon Candy and Commander Charles Little to form a committee and advise on

⁴²⁵ 'Grand Fleet Battle Orders, 17 September 1914 to 16 January 1918', ADM 137/4049, TNA.

⁴²⁶ Ibid

⁴²⁷ Ibid, f 329.

the deployment of submarines.⁴²⁸ At the beginning of the war, Keyes had been Commodore (S) responsible for the submarine service and implemented the initial wartime operating procedures that established the roles and development of submarines. Candy and Little were experienced submarine commanding officers, and all were now commanding officers of surface warships in the Grand Fleet. The Committee's initial report was concerned with the appearance of U Boats off New York and attacks on British merchant ships.⁴²⁹ Destroyers did not have the required radius of operations to be based in a Canadian port and work along the Atlantic coast of America, so sending submarines to Canada to operate as a deterrent. In the event, this was not pursued largely due to the potential diplomatic consequences of submarines operation off the coast of neutral United States.

When Admiral Beatty became C-in-C, he used this committee to question the overall role of submarines.⁴³⁰ He began by questioning the Admiralty as to the details of submarine patrols being maintained, and why so many were held in harbour awaiting intelligence as to any movement of the German fleet. In reply, submarines of the 8TH and 9TH Flotillas based at Yarmouth and Harwich, maintained patrols off the Dutch coast near the Mass and Schouwen Banks. If knowledge was obtained that the German fleet had put to sea, but it was not known where, submarines were to be positioned off ports withing gun range to attack German warships. If the German fleet had gone north, the submarines were sent to intercept their retreat off Terschelling and off the Heligoland Bight. Beatty sent a report to the Admiralty, prior to a meeting, claiming wrongly that only ten out of eight-six submarines were being used on offensive patrols.⁴³¹ These figures were misleading as more submarines were already conducting anti-U Boat patrols (See next chapter). Beatty wanted the flotillas re-organised so that most of the submarines would be under the direct control of the Grand Fleet and would be used for continuous offensive operations. He stated rightly that the submarines being held for coastal defence were wasted and incapable of stopping an invasion. Divisions of submarines would be sent to areas where U Boats were known to be operating, rather than the current static patrols. Beatty's policy, in addition to showing how layered defence evolved, further undermines the theory of flotilla defence.

⁴²⁸ Submarine Committee, Adm. Jellicoe, 14 October 1916, 'British Submarines 1914-1918', ADM 137/1926, TNA, f 80.

⁴²⁹ Ibid, ff 81-89.

⁴³⁰ Ibid, ff 90-101.

⁴³¹ Ibid, ff 92-94 & 112.

The core of the committee's recommendations was that although submarines were not ideal to attack U Boats, the situation with the U Boat campaign necessitated submarines be used.⁴³² Patrol submarines released from the protection of coast towns, should be employed on trade routes, in the vicinity of fishing fleets and in areas where U Boats were active and through which they had to pass proceeding to and from their bases. The threat of submarines would force the U Boats to submerge, limiting their vision and compelling them to expend torpedoes rather than operate on the surface with gun fire.⁴³³ This was a fundamental change of priorities for submarines, largely possible by the increasing number being commissioned. As will be seen in the next chapter, these submarines used in an anti-U Boat role became a flexible layer as with their supporting depot ship, they moved quickly to a threatened location.

Naval Policy, July 1917

In July 1917 Admiral John Jellicoe, First Sea Lord, submitted a paper on Britain's overall Naval policy to the War Cabinet:⁴³⁴

The ultimate objectives of British naval policy are first, to bring pressure to bear on the enemy people so as to compel their government to come to terms, and second, to resist the pressure applied by them so that we can carry on the struggle undisturbed. Positive results are naturally only obtained by offensive action, but the defence side cannot be neglected by a country which is dependent on the seas for its existence. In order to attain these objects, the power of the British navy is directed into the following channels:

1. The protection of the sea communications of the Allied armies, more particularly in France, where the main offensive lies.
2. Prevention of enemy trade as a means of handicapping his military operations and exerting pressure on the mass of his people.
3. Protection of British and Allied trade, on which depends the supply of munitions and food to the Allied armies and people.
4. Resistance to invasion and raids.

Jellicoe stated that these four objects could only be completely and permanently attained by defeating the High Seas Fleet in a decisive battle, and by defeating the U Boats in their unrestricted warfare campaign. The continuing problem was that the High Seas Fleet, being

⁴³² Ibid, 104-111.

⁴³³ R B Keyes, *Naval Memoirs, Scapa Flow to the Dover Straits, 1916-1918 Volume 2* (London: Butterworth, 1935).

⁴³⁴ 'British Naval Policy July 1917', Adm. Sir John Jellicoe, CAB 24/18/73, TNA.

weaker than the Grand Fleet, stayed in its dockyards and refused action. Jellicoe emphasised that it was the Grand Fleet that provided the protection for the smaller warship forces that kept open the sea communications. "The whole Allied cause, both ashore and afloat, is therefore based on the latent power of the Grand Fleet. This is a fact which is apt to be forgotten".⁴³⁵ Within the document, Table 1 contained a list entitled "Allocation of British Naval Forces in vicinity of the United Kingdom on 26TH June 1917". The modules-of-force listed were:

- A. Grand Fleet.
- B. Grand Fleet submarines based at Blyth.
- C. Battle cruiser force.
- D. 2ND and 10TH Cruiser Squadrons based on Shetland Islands.
- E. Dover force.
- F. Harwich force.
- G. Sheerness force.
- H. East Coast convoy.
- I. Submarines patrolling North Sea based on Yarmouth and Harwich.
- J. Protection of cross-Channel communications and general anti-submarine duties between Beachy Head and Portland based on Portsmouth.
- K. Escort duties from Newhaven.
- L. Trade protection and general anti-submarine duties on the approaches to the Channel based on Devonport.
- M. Anti-submarine and trade protection south and west of Ireland.
- N. Anti-submarine and trade protection north of Ireland based on Lough Swilly and Liverpool.
- O. Submarine patrolling north and west of Ireland based on Lough Swilly and Killybegs
- P. Anti-submarine duties in Irish Sea based on Pembroke.
- Q. Local defence and patrolling on vicinity of Scapa, Cromarty, Tyne, Lowestoft, Harwich, and the Thames Estuary.
- R. Local defence and patrolling in vicinity of Portsmouth, Portland, Devonport, and Pembroke.

Jellicoe's four requirements, and his list of forces, defined the defence layers that were available in the summer of 1917. Jellicoe's priorities and concerns can be seen in his list

⁴³⁵ Ibid, f 305.

commencing with maintaining the Grand Fleet, including the Blyth-based supporting submarines, and the Battle cruiser force. This is followed by the squadron of Armed Merchant Cruisers positioned north of the Shetland Islands that maintained the economic blockade, the primary naval means of putting pressure on Germany. The remaining layers are the large number of forces, stationed around the British Isles, responsible for defeating Germany's unrestricted U Boat warfare that was a very major concern in 1917. Missing from Jellicoe's list of forces were the extensive minelaying operations, aimed primarily against the German U Boats, and the on-going wireless telegraphy intercepts and associated code breaking. Code breaking was centred by staff within the Admiralty's Room 40, and their highly secret work was known only by a few people. As noted previously, the increased minelaying and code breaking intelligence could have been missed deliberately from this document as a precaution against politicians leaking this highly secret information. Note that in May 1917, Room 40 activities were absorbed into the Naval Intelligence Department and the bureaucracy created to disseminate the information without compromising its source.⁴³⁶

In the campaign against the unrestricted U Boat warfare, as detailed in the next chapter, the adoption of convoys had been a slow process due to scepticism as to their effectiveness, and to a serious lack of convoy escort vessels. By November 1917 an extensive network of convoys had been implemented but Jellicoe presented a pessimistic memorandum for the War Cabinet on the influence German U Boats were having on overall British naval policy.⁴³⁷ In this he highlighted that there was a serious shortage of destroyers for escort purposes, so that Grand Fleet destroyers had to be used, and in addition, the Admiralty received demands for more destroyers from all the forces world-wide. Jellicoe pointed out the need for major warships to be escorted by smaller high-speed vessels against the large number of German U Boats. This was less of a problem for the German navy as between August 1916 and September 1917 no German vessel larger than a destroyer was known to have proceeded further than 150 miles from Heligoland, whereas the Royal Navy vessels were necessarily constantly at sea, and the strain upon destroyers for purely Fleet work was therefore immense. The number of destroyers allotted to the Grand Fleet was one hundred, but of this number there were always at least one-third engaged in the convoy of merchant vessels, both British, Allied and Neutral, and very often the number of destroyers so employed was considerably higher. The method of U Boat warfare adopted by Germany against merchant ships also

⁴³⁶ P Beesly. *Room 40 British Naval Intelligence 1914-1918*.

⁴³⁷ 'The Influence of the Submarine [U Boats] upon Naval Policy and operations, 18 November 1917', Adm. John Jellicoe, ADM 116/1806, TNA.

necessitated the employment of a very large number of destroyers for convoy and escort work outside the North Sea, and the protection of the sea communications of armies overseas imposed a further and very considerable strain of the same nature. Jellicoe stated that the whole of naval policy was governed by the adequacy of the available destroyer forces. Intended operations were postponed because of insufficient numbers of destroyers for the service required, and the risk that whilst destroyers were being used for one operation, Germany could take some step which would necessitate a move on the part of the Grand Fleet, in which the Fleet might need to go to sea with an entirely inadequate destroyer force to accompany it. The Grand Fleet was always held ready to deal with any landing raids and coastal bombardments. The major ships were exposed to U Boat attack while at sea, and should a fleet action result, the Grand Fleet would be at a serious disadvantage with the High Sea Fleet. The High Sea Fleet could have at least a total of eighty-eight destroyers, whilst the Grand Fleet could have less than half that number, the outcome particularly with low visibility, might be disastrous. The radius of action of the Grand Fleet was limited therefore to that of the escorting destroyers, and their inability to keep station and maintain speed in bad weather such as occurs often in the North Sea.

Jellicoe's concerns highlighted how the lack of destroyers was having a detrimental effect on the ability of multiple defence layers to carry out their function. In the shipbuilding industry, priority was given to completing new destroyers and escort vessels, but they could not be built quickly.⁴³⁸ Some relief was obtained from 4 May 1917 when the first United States Navy destroyers crossed the Atlantic and were based in Queenstown, where they operated on anti-U Boat patrols and convoy escorts to the south of Ireland and the south-west approaches.⁴³⁹ Jellicoe was criticized as being reluctant to implement convoys, but a factor was his awareness of the critical constraint imposed by the lack of destroyers for escort duties. It should be noted that the pessimistic content of Jellicoe's memorandum which identified the problem, without offering any solution, contributed further to his dismissal on 24 December 1917.⁴⁴⁰

Entry of the United States of America, 6 April 1917

When the United States joined the Allies, their Army was small and ill prepared immediately to join the Western Front, but their navy was available immediately to reinforce the existing

⁴³⁸ 'Destroyers' Report c1917, Churchill papers, CHAR 13/6A/154-156, Churchill Archive Centre.

⁴³⁹ D Brunicardi, 'The US Navy at Queenstown', *History Ireland*, June 2017, Vol.25, pp38-40.

⁴⁴⁰ A J Marder, *From the Dreadnought to Scapa Flow*, Volume 4 pp 323-349; J A C Macfarlane, *A Naval Travesty: The Dismissal of Admiral John Jellicoe, 1917*, PhD Thesis, University of St Andrews, 2014.

naval layered systems. A squadron of battleships joined the Grand Fleet in December 1917 to become the 6TH Battle Squadron. Initially their gunnery was poor, but they quickly improved and adopted the Grand Fleet's operational and signalling procedures.⁴⁴¹ Of more significant benefit was the deployment of many destroyers to operate from Queenstown, Ireland on anti-U Boat patrols in the south-west approaches. Their integration with the Royal Navy's operation was due largely to the good working relationship quickly created between the two navies. A squadron of submarines also joined the command, and although lacking experience, carried out anti-U Boat patrols off the west coast of Ireland. In August 1918 a further division of fast, modern battleships was stationed at Berehaven, south-west Ireland, to escort the vital Atlantic troop convoys as they approached the disembarkation ports on the west of France, against potential attack by German surface raiders, particularly battle cruisers.⁴⁴²

A major United States contribution to the naval war was the North Barrage between the Shetland and the Norwegian coast, effectively a new layer.⁴⁴³ This required the development and manufacture of an enormous number of new mines, their transport and handling in Scotland and then their laying in deep water. This minefield, a new layer, was for anti-U Boat warfare and will be described in the next chapter. Overall, the United States Navy battle ships played a limited role in the later stages of the war, albeit their most important contribution were the valuable destroyers for convoy escort off Ireland.

The Baltic and the Defeat of Russia, October 1917

In September 1917, the German Supreme Army Command asked for the co-operation of the High Seas Fleet in a major maritime operation to capture the Baltic Islands.⁴⁴⁴ Germany was aware of the difficulties of such an action from studying the Allied 1915 landings at Gallipoli. The German warships also had to clear the approaches of extensive Russian minefields and powerful shore batteries. A very powerful force of battleships, cruisers, destroyers, minesweepers, and U Boats was sent to the Baltic via the Kaiser Wilhelm Canal. Their tasks were to bombard the Russian positions, clear the mines, escort the troop transports and get the troops ashore. Despite damage to battleships by hitting mines, the operation was

⁴⁴¹ A J Marder, *From the Dreadnought to Scapa Flow, Volume 5*, pp 124-127.

⁴⁴² 'New US Battleship Division based at Berehaven', Plans Division War Records June-November 1918, ADM 137/2709, TNA. ff 321-322.

⁴⁴³ 'British and American Minelaying Operations and Northern Barrage, September 1917 – February 1918', ADM 137/847, TNA.

⁴⁴⁴ R Scheer, *Germany's High Sea Fleet in the World War*.

completed successfully, and contributed to the Russian revolution and their exit from the war.⁴⁴⁵ The Royal Navy had not sent any surface warships to the Baltic or taken advantage of the absence of the High Seas Fleet to take any offensive actions off the German North Sea coast. An immediate consequence of Russia's surrender was to deny any base for Royal Navy warships, terminating the long-sought opportunity to send a fleet to the Baltic. The continued operation of the Royal Navy's submarines in the Baltic became untenable. It had been increasing difficult to operate due to logistic problems, and compared to the latest submarines, they were obsolescent. At the peace talks in Brest-Litovsk, Germany demanded that the submarines would be handed over. With the uncertain situation with the Bolsheviks, the Admiralty decided that the submarine crews were of greater value than the submarines, so they ordered the crews return home. A few remained with the submarines in Helsingfors, now Helsinki Finland, and to prevent their capture by the approaching German army, the submarines were taken to sea and scuttled between 3 and 5 April 1918.⁴⁴⁶

The Russian surrender released German troops from the Eastern Front to be used against Britain and France, albeit not as many as was feared. The threat of a German invasion or military raid against Britain had decreased as the war progressed. The availability of German troops raised concern, so that in December 1917 there was a conference between the Admiralty War Staff and the General Staff to consider the size of a German force that could be transported and landed in the United Kingdom.⁴⁴⁷ The Army representatives estimated Germany could find a force of 160,000 men and with a limited amount of transport and artillery, land on open beaches within 30 to 36 hours, provided the weather was good and the landing was unopposed. The Admiralty representatives outlined the integrated layered defences that would act as a barrier. They stated that with the entry of the United States into the war, there would be an increase in the number of ships being available and an increase output of mines. The extension of submarine patrols increased the opportunity of obtaining warning. The extension of minelaying within the Heligoland Bight added to the difficulty of Germany assembling and moving large convoys without previous minesweeping which could hardly pass unnoticed. Both Army and Naval representatives agreed to use greater air resources for reconnaissance, a rapidly growing and important defence layer for air superiority, and for

⁴⁴⁵ G Staff, *Battle of the Baltic Islands 1917, Triumph of the Imperial German Navy*, (Barnsley: Pen & Sword, 2008).

⁴⁴⁶ M Wilson, *Baltic Assignment, British Submariners in Russia 1914-1919*, pp 208-211.

⁴⁴⁷ 'Report of a Conference between representatives of the Admiralty War Staff and the General Staff, held to consider the possibilities of Attack on the United Kingdom, December 1917', ADM 167/54, TNA.

offensive action against troops disembarking. A joint Military and Naval policy was therefore to strengthen the existing layered defence system against possible German invasion and amphibious landing. The conclusions drawn were:

1. The warning of such a German force would be obtained.
2. The ability of Germany moving the ships required is practically insuperable.
3. The interception and destruction of subsequent convoys would ensure the complete failure of the expedition.
4. The maximum German force in one convoy would be limited to 30,000 men.
5. Any attempted German landing of on the west coast would be detected. A raid on the east coast would be impossible to re-embark, leading to the sacrificed of 20,000 men.⁴⁴⁸

This conference concluded those multiple, integrated naval layers were a strong deterrence of such a landing. Minefields within the Heligoland Bight restricted the German freedom-of-movement to assemble the ships needed to transport their troops. Submarine patrols would almost certainly detect such a convoy and provide early warning. The increasing capabilities of air power provided a further layer for reconnaissance and attacking the German landings. In the event, in March 1918 the German troops were used for the *Kaiserschlacht* offensive on the Western Front, endeavouring to defeat the Allies before larger numbers of United States troops arrived.⁴⁴⁹

Blocking the German Naval Bases, Re-considered August 1917

Potential layers that were proposed pre-war and throughout the war, were the capture of Heligoland or a German Frisian Island and the physical blocking of the German naval bases.⁴⁵⁰ Such plans continued to be rejected by the Admiralty and most Flag Officers afloat as they were considered as not worth the risks involved. Some plans were probably driven by a political wish for the Royal Navy to have a more offensive role, rather than the long-term, economic blockade policy. In July 1917 Admiral Jellicoe, First Sea Lord, was worried that there did not seem to be a solution to the U Boat campaign, so he ordered the Operations Division's Planning Section to examine blocking the North Sea and Baltic exits. In addition to using obsolete battleships and cruisers filled with concrete as blockships, the plan included occupying German Islands and extensive minelaying.⁴⁵¹ Jellicoe asked Admiral Beatty,

⁴⁴⁸ Ibid.

⁴⁴⁹ R Gray, *Kaiserschlacht 1918, The final German offensive*, (Oxford: Osprey, 1991).

⁴⁵⁰ 'Seizure of Advanced Bases, 1913 & 1915', ADM 137/452, TNA.

⁴⁵¹ 'Plans Division War Records, Blocking', ADM 137/2712, TNA, f 60.

Commander-in-Chief Grand Fleet, to consider such a plan so in August 1917 Admiral C Madden, then second in command of the Grand Fleet, produced a plan for blocking the German North Sea naval bases and the Baltic entrances.⁴⁵² The four North Sea locations were: 1. the Jade (Schillig Roads) with the principal dockyard for the High Seas Fleet at Wilhelmshaven, 2. the River Elbe with the dockyard at Cuxhaven, plus the entrance to the Kaiser Wilhelm canal at Brunsbüttel, and the commercial port of Hamburg, 3. the River Ems with the dockyard at Emden, and 4. the River Weser with the port of Bremerhaven. In summary his conclusions were:

- Blocking the deep water exits of the rivers by blockships was impracticable and would have required a large number of old battleships including those from Allied navies.
- The erection of a barrage of mines and nets is of such a gigantic nature, including the co-operation of all the neighbouring countries, that it makes the proposition impractical under existing conditions.
- The possibility of blockading enemy submarines by new types of mines in conjunction with hydrophones etc., is now under consideration.

Madden's report also covered the impossibility of closing the Kattegat and the difficulties of closing The Sound plus Greater and Lesser Belts. He reviewed the political situation with the Scandinavian neutral countries, and the probable reaction of Germany to invade Denmark.⁴⁵³ If any such plan had been progressed, it would have required multiple layers and much expenditure and industrial resources on providing the material.

Aviation Layer Advances, 1917-1918

The Admiralty recognised the benefits and threats of aviation. The German navy had an advantage of operating Zeppelins that provided reconnaissance and bombing capabilities beyond anything comparable in the Royal Navy.⁴⁵⁴ Germany started the war with few operational Zeppelins, but technology developments and production were rapid. The British policy of not implementing a close blockade made the Zeppelin the only viable German asset capable of reconnaissance due to its superior range and endurance. Until the development of the incendiary bullet late in the war, the hydrogen filled Zeppelins were very hard to destroy. British attempts to design and build comparable airships were failures, although non-rigid

⁴⁵² 'Operation ZZ – Blockade of Germany, Proposal by Admiral Second-in-Command, August 1917', Secret Pack of C-in-C Grand Fleet, Volume LVI, ADM 137/1936, TNA, ff 201-237.

⁴⁵³ Ibid

⁴⁵⁴ R D Layman, *Naval Aviation in the First World War, Its Impact and Influence* (London: Chatham, 1996).

airships were developed and used effectively in anti-U Boat operations. The German navy also operated seaplanes and land-based aircraft, and with Zeppelins and surface patrol warships, implemented an effective layered defence system in the Heligoland Bight and off the Belgium coast.⁴⁵⁵ Chapter 3 describes the early Royal Navy's attempt in 1914 to use seaplanes to bomb Zeppelin sheds and destroy the craft within these. These seaplane carriers took the seaplanes to within range of the target, lifted them into the sea from where they took off, and after the raid they should return to the ship, and be hoisted back on board.⁴⁵⁶ The available technologies and operating procedures were not good enough for success. Later attempts were to fly off an aircraft from in the sea for the pilot to be rescued by the destroyer. On battleships and cruisers, platforms were constructed over gun turrets from which small aircraft could become airborne, with ditching being their only option on returning to the warship.⁴⁵⁷ The Admiralty wanted these aircraft to provide reconnaissance for example to identify the position, course and speed of the German fleet, and to shoot down Zeppelins to prevent them doing the same for their fleet. For most of the war, the aircraft available were incapable of climbing fast enough or have the weapons to destroy a Zeppelin that could climb faster. By 1917 better aircraft were available and they could be launched from platforms on converted battle cruisers.⁴⁵⁸ By 1918 the first true aircraft carrier, HMS *Argus*, was commissioning, and with her continuous flat deck, enable the aircraft to land back on board.⁴⁵⁹

A good of example of the integration of different layers in a coherent plan was the Royal Navy attack on the Zeppelin hangars at Tondern, Scheswig, now renamed Tønder in Denmark, selected for its proximity to the coast of the Heligoland Bight.⁴⁶⁰ Based upon intelligence, on 19 July 1918 in operation F7, the aircraft carrier HMS *Furious* escorted by light cruisers and destroyers, deployed off the Danish coast. Seven Sopwith Camel aircraft flew off *Furious* and attacked the hangars with bombs.⁴⁶¹ Scoring a direct hit on the large "Toska" hangar, within it the two hydrogen-filled Zeppelins L.54 and L.60 burst into flames and were destroyed totally. Three of the pilots later landed in Denmark and one was reported missing. This raid was the first to be launched from a ship to attack a target on enemy territory. The force was supported

⁴⁵⁵ 'Report Enemy Aircraft in the North Sea July 1918', Secret Pack of C-in-C Grand Fleet Volume LXXVI, ADM 137/1954, TNA, ff 375-385.

⁴⁵⁶ D K Brown, *Grand Fleet, Warship Design and Development 1906-1922*, pp 111-112

⁴⁵⁷ Ibid, pp 122-123.

⁴⁵⁸ Ibid, pp 113-114.

⁴⁵⁹ Ibid, pp 115-120.

⁴⁶⁰ 'Report Enemy Aircraft in North Sea July 1918', Secret Pack of the C-in-C Grand Fleet, Volume LXXIV, ADM 137/1954, TNA, p 375.

⁴⁶¹ Papers of Adm. R F Phillimore, Documents 6515, Imperial War Museum

by heavy warships of the Grand Fleet positioned further north as protection against any sortie of German warships. The raid was thus dependent on the integrated defence layers of latest aircraft carrier, wheeled aircraft, supporting light forces and the heavy warships of the Grand Fleet. This operation also extended the naval aviation layer to over the German coast, a location then beyond the range of land-based aircraft.

In November 1918 the Grand Fleet had the capability of launching one hundred and twenty aircraft. The Sopwith T1 aircraft had been developed to carry and launch an 18" torpedo, and a plan was developed for a mass attack in 1919 on the High Seas Fleet in its Wilhelmshaven base and in the Schellig Roads.⁴⁶² Numerous problems had to be solved, not least the ability to launch a torpedo into shallow water without it hitting the seabed. The Armistice precluded this operation, and with the transfer of the Royal Naval Air Service into the newly formed Royal Air Force, development of aircraft and procedures slowed. There was also a proposal for aircraft to torpedo the lock gates of the Kaiser Wilhelm Canal at Brunsbüttel, where the canal joins the river Elbe. Torpedoes would be dropped by single-seat aircraft flying along the canal. Such a successful attack would have disrupted the use of the canal to transfer warships and submarines between the North Sea and the Baltic, and of merchant ships trading from the Baltic to Hamburg.⁴⁶³

Aviation created a new dimension, in every sense, in layered defence. The limited range of aircraft necessitated their transport by ship to enable them to reach their target. The technological development and operating procedure were rapid, and seaborne aviation became a dominant weapon in World War Two. The 1919 planned attack on the High Seas Fleet was achieved by the re-constituted Fleet Air Arm's 1940 successful attack on the Italian fleet at Taranto.⁴⁶⁴ This then led to the 1941 successful attack by the Japanese Imperial Navy on the United States Pacific Fleet at Pearl Harbor.⁴⁶⁵

German Successful Attacks on Scandinavian Convoys, 1917

Convoys were implemented in 1917 between Scotland and Norway due to the heavy losses by U Boats to merchant ships proceeding independently (See next chapter). On 17 October 1917 a convoy was attacked by the German light cruisers *Brummer* and *Bremse* that sank

⁴⁶² D Hobbs, *The Royal Navy's Air Service in the Great War*, pp 461-476; 'History of the Development of Torpedo Aircraft', AIR 1/713/27/16, TNA.

⁴⁶³ "Torpedo Attack on Kaiser Wilhelm Canal", Report by Colonel C.R. Samson RAF, 17 September 1918, AIR 1/643/17/122/276, TNA.

⁴⁶⁴ S W Roskill, *The War at Sea*, Volume 1 [Second World War] (London: HMSO, 1954) pp 300-301.

⁴⁶⁵ S E Morison, *The Two-Ocean War, A Short History of the United States Navy in the Second World War, Disaster at Pearl Harbor*, [1963] (New York: Galahad, 1997), pp 46-76.

both escorting destroyers, HMS *Mary Rose* and *Strongbow*, and nine merchant ships.⁴⁶⁶ The light cruisers had arrived undetected and used their high speed to return to their base. On 17 December 1917 a further convoy was attacked by four German destroyers that proceeded to sink an escorting destroyer HMS *Partridge*, and six merchant ships.⁴⁶⁷ The German warships had been undetected before both attacks and returned unscathed despite Royal Naval ships on patrol in the North Sea. It is probable that the Admiralty had been complacent by assuming that advance warning would be obtained from German wireless telegraphy and sighting by patrolling submarines. However, the Germans had reduced their reliance on wireless telegraphy and bad weather prevented sightings. Heavier escorting forces had been at sea but were unaware of the attacks. At the court of enquiry, it was noted "There was a lack of co-ordination in the rather complex problem of arranging protection of convoys".⁴⁶⁸

in April 1918 the High Seas Fleet proceeded northwards without the usual increased wireless telegraphy traffic. They were observed off the Danish coast by the submarine J.6 and identified as cruisers and destroyers. J.6 did not report these, having been informed that Royal Navy warships could be operating in this area. Once clear of the Heligoland Bight minefields, the First Scouting Group of battle cruisers proceeded the High Seas Fleet battleships towards the Norwegian Sea area. Germany was also suffering from poor intelligence as on the 24 April there were no British convoys in the area. The German battle cruiser Moltke then suffered a serious mechanical accident and had to break wireless telegraphy silence. Scheer then ordered all his ships to return to base and Beatty ordered the Grand fleet to intercept. The German ships were sighted by J.6 which reported their presence. The submarine E.42 further damaged the Moltke with a torpedo hit, but she and all the German warships returned to their base.⁴⁶⁹

Priority and Policy, January 1918

Admiral Beatty, C-in-C Grand Fleet, visited the Admiralty on 2 January 1918 for discussions with Eric Geddes, the First Lord, and General Sir William Robertson, Chief of the General Staff [to 18 February 1918], regarding naval policy.⁴⁷⁰ Beatty believed that the High Seas Fleet had obtained superiority in new battle cruisers that were faster and better armoured than their

⁴⁶⁶ 'Loss of HMS *Mary Rose* and HMS *Strongbow*', ADM 137/3723, TNA.

⁴⁶⁷ 'Loss of HMS *Partridge*, 4 Armed Trawlers and Convoy', ADM 137/3704, TNA.

⁴⁶⁸ 'Attack by enemy destroyers on Scandinavian convoy', ADM 137/3744, TNA.

⁴⁶⁹ 'Report by Lt. C.H. Allen, E.42', Commodore (S) War Records Volume 7, January-May 1918, ADM 137/2073, TNA, pp 375-378.

⁴⁷⁰ 'Discussion at Admiralty on Occasion of Visit of Commander-in-Chief, Grand Fleet, on 2nd – 3rd January 1918', Geddes Papers, ADM 116/1806, TNA.

Grand Fleet counterparts. The weakness of the British armour piercing shells in breaking up when hitting at an oblique angle that had become apparent at Jutland, were being replaced but still in insufficient numbers. There were insufficient destroyers to escort the Grand Fleet as they were being re-deployed for convoy protection in the fight against German U Boat attacks. Beatty's intention was therefore to postpone any fleet action so far as this was practicable and compatible with the necessity of exercising complete control of communications. He considered the destruction of the German High Seas Fleet would make minimum difference to Britain in the naval war, so there were few benefits in risking damage or losses in the Grand Fleet. Geddes and the Admiralty staff concurred with this policy, and Geddes presented this view to the War Cabinet. This decision highlighted the ongoing success of the general layered defence strategy, using the patrol submarines in the anti-U Boat layered defence system.

In postponing a fleet action, Beatty wanted more patrol submarines deployed in the North Sea to contain the High Seas Fleet. The important point under discussion was the principle of concentrating submarines in the North Sea, as opposed to general dispersion on Trade Routes. The Director of the Anti-Submarine Division explained that the presence of submarines at the mouth of the Channel and off the Coast of Ireland had undoubtedly a great deterrent effect, and he was averse to withdrawing British submarines from the important Trade foci. It was proposed therefore that these Flotillas should remain of approximately the same composition, but that as new submarines commissioned, they would be concentrated in the North Sea. This view was concurred in by the Conference. Beatty also wanted more destroyers allocated to the Grand Fleet in case a fleet action should occur. The Chief of the Naval Staff, after carefully reviewing the facts, stated that he could not recommend any alterations in the present disposition of destroyers. The number of destroyers detailed for the protection of Troop transports, the mouth of the Channel, and important Atlantic convoys, was down to a dangerous minimum. Regarding the employment of the Harwich Force, Beatty concurred that it must remain to the southern North Sea until the situation developed sufficiently to allow of the enemy's intentions being arrived at, however he explained that its movements should ensure there being no possibility of the Force being cut off from the Grand Fleet. It was agreed that should the enemy move towards the English Channel, the Harwich Force would proceed it through the Straits of Dover.

These documents describe how the roles and priorities of the naval layers were changing to deal with different scenarios. Despite publicly advocating a major fleet action, Beatty

perpetuated the policy that sea command could be maintained without risking a major fleet action. The Admiralty give priority to destroyers used for trade protection rather than escorting the Grand Fleet, and the continued wide disposition of submarine flotillas clearly confirms the importance they placed on the layers for the protection of trade and the defeat of the unrestricted U Boat warfare campaign. [See the next Chapter].

Chapter conclusions

Throughout the war, the strength and integrity of the Grand Fleet was the base of the layered defence systems for all other activity. The Admiralty was aware that the German navy hoped to isolate and destroy a portion of the Grand Fleet, as a prerequisite to a successful fleet battle. The Admiralty considered numerous possible German actions including an invasion, amphibious military raids and bombardment raids. There was also the possibility of a major raid by surface warships through the Straits of Dover to disrupt the supply of the British Army in France. The Grand Fleet had the optimum balance of warship types including battleships, battle cruisers, armoured and light cruisers, and destroyers to fulfil these possible actions. The Grand Fleet being based in Scapa Flow, Cromarty and Rosyth presented enormous challenges in maintenance and supply being far from the long-established naval bases of Devonport, Portland, Portsmouth, and Sheerness-Chatham. By comparison, the German High Seas Fleet was based in their established bases at Wilhelmshaven and Cuxhaven on their North Sea coast. A further issue was that the Grand Fleet had to be maintained and fully trained ready for battle at any time, while the High Seas Fleet had to be ready only when they decided to sortie for a fleet action. After Jutland the layered defence system was modified progressively due to the changing situation and also due to technology developments. For example, the availability of better mines in greater numbers allowed the laying of more minefields in the Heligoland Bight. Regular British submarine patrols were withdrawn from observing the German bases and were repositioned at the seaward entrances of the German swept routes through the minefields. The German navy began to use wireless telegraph less while in port, thus making it harder for British naval intelligence forecast an imminent sortie. For example, when the High Seas Fleet sortied on 22 April 1918, wireless telegraphy silence was maintained.⁴⁷¹ By 1917 the Grand Fleet did not need to make major sweeps into the central North Sea with all their warships, but replaced these with high-speed sweeps by light cruiser squadrons.⁴⁷² The battle squadrons proceeded to sea each month for gunnery training.

⁴⁷¹ A Hezlet, *The Electron & Sea Power*, pp 138-139.

⁴⁷² 'Miscellaneous Sweeps by the Grand Fleet 1917-1918', Secret Pack of C-in-C Grand Fleet Volume LXII, ADM 137/1942, TNA.

Independent battle squadrons and cruiser squadrons proceeded to be in supporting range of Scandinavian convoys in protection against attack by German surface warships. Note this layered defence policy was repeated in World War Two on the Arctic for Russia convoys and in the Mediterranean for Malta convoys. At the beginning of 1918, the Admiralty and War Cabinet endorsed the Commander-in-Chief Grand Fleet that a major fleet action was of limited value unless on an obviously favourable opportunity.

Regarding the diminishing threat of an invasion or raid, wireless telegraphy intercepts was an important layer in the early detection of a raid against the East Coast. Minefields and patrolling submarines provided further layers. Early warning would enable the Harwich Force of light cruisers and destroyers to intercept and report on the German raiders. Local coastal defence patrols would provide intelligence of the composition and location of German warships and military transports. Underpinning these layers, knowing the location and positions would enable the Grand Fleet to intercept the raiders in overwhelming strength. By 1916, the obsolete battleships of the 3RD Battle Squadron, transferred from the Grand Fleet to be based at the Nore provided an emergency layer should a German raid penetrate the Thames estuary. In the event of a major German raid into the Dover Straits or further into the Channel, it was planned that the Harwich Force would proceed it, providing a layer to attack if an opportunity arose.

The Admiralty's principal offensive layered defence system for the naval-based defeat of Germany was the economic blockade against German trade, implemented progressively from the start of the war. The northern blockade was initially old cruisers of the 10TH Cruiser Squadron patrolling between the Shetland Islands and the Norwegian coast. These were unsuitable and were replaced by Armed Merchant Cruisers and the patrol areas moved to between the Shetland Islands and Iceland and also north of Iceland into the Denmark Straits. Their remit was to intercept German and neutral merchant ships to inspect for contraband, and also to intercept and attack German disguised merchant ship raiders. The Armed Merchant Cruisers were virtually powerless against a raid by heavy German surface warships and were defended therefore by the presence at Scapa Flow and on patrol of Grand Fleet warships. Intelligence, often obtained from the port of departure, on the movement of the merchant ships was an important layer to increase the opportunities of their interceptions. The navy was unable to intercept merchant ships in the Baltic using surface warships. Merchant ships keeping inside the territorial waters of neutral countries were also immune from interception for surface warships and submarines. An increasing layer in this defence system

was the progressive increase of diplomatic pressure to stop neutral countries trading with Germany. The entry of the United States into the war caused the end of neutral countries trying to bring contraband cargoes across the Atlantic. The opportunity was taken therefore to remove most of the armed merchant cruisers from patrolling and convert them back to useful merchant ships.

The technology developments of mines caused major changes to the defence layers. In addition to the superior Hertz-horn contact mines, there were mines activated by the magnetic signature of a steel vessel and those activated by the noise created by a passing vessel. The extended minefields of the Heligoland Bight were for strategic purposes as they bottled-up the High Seas Fleet. Minefields laid within the German swept routes, targeting U Boats, were for tactical purposes. Overall, the effect on the German navy was that continual minesweeping and the use of battleships and cruisers to support the minesweepers, became the primary task of their surface warships. The requirements for manpower, building and repair resources thus hindering the growth and operations of their U Boat campaign. The minefield layer is still significant today with the continued development of mines and mine-hunting technologies.

The aviation layer was also developed enormously in the latter half of the war. Ship-board aviation became an important layer for scouting, if the war had continued into 1919, for a new layer based upon torpedo carrying aircraft attacking the High Seas Fleet while in harbour. In 1914 Churchill had talked foolishly about attacking the Fleet while in harbour, but it was not until the 1919 aviation layer, supported by the battle squadrons of the Grand Fleet, that could achieve this. The faster shipboard and land-based fighter aircraft armed with the newly developed incendiary bullets, provided a new layer in destroying Zeppelins, and thus removed the German's primary observation layer and their offensive-terror layer of creating civilian fear by their bombing activities.

All strategic and tactical naval operations were dependent on wireless telegraphy interception technology including cross-bearing positioning of transmissions, signal traffic analysis and codebreaking, and when used correctly, provided vital supporting layers. The most famous decoding was the Zimmerman telegram that expedited the United States entry into the war.⁴⁷³ Naval intelligence was obtained from the legal interrogation of prisoners of war and retrieving documents and equipment by diving on and occasionally salvaging U Boat wrecks. The enormous scientific effort to develop an effective hydrophone system was a very important

⁴⁷³ Adm. Sir W James, *The Eyes of the Navy, A Biographical Study of Admiral Sir Reginald Hall* (London: Methuen, 1955), pp 128-154.

layer for the detection of submerged U Boats. On-going development led from the passive hydrophone to the active ASDIC/Sonar systems, critical in anti-U Boat warfare in World War Two. All aspects of weapon technologies developed throughout the war, including gunnery control, anti-U Boat depth charges, and torpedo size, speed, accuracy, and range. The training of warship crews, the organisation of Admiralty and shore-based support functions, all contributed to the success of the defensive and offensive layers.

At the beginning of the war, the principal submarine layer was their unique capability of operating a close, observational blockade off the German North Sea naval bases. There they could provide visual warning of any German surface warship sortie and also be an offensive layer with their torpedo capability. As the war progressed the submarines' minelaying technology opened a new layer in stealth warfare by proceeding to positions inaccessible to surface minelayers. Post Jutland and the main offensive layer for submarines moved to anti-U Boat warfare, although the existing submarines lacked the torpedo salvo and gun weapon systems to be fully effective. The new L Class patrol submarines with four bow torpedo tubes and a gun, were better. The rapid design and building of the fast underwater R Class specialist anti-U Boat submarines would have been more effective. The quest for a fleet type submarine and the integration of the fast K Class submarines into the Grand Fleet provided a completely new tactical layer capability. The unique capabilities and layers provided by submarines freed other warship types to use their capabilities more effectively. Submarines were therefore "an enabling technology". The experiences of submarines during the war, and their on-going design developments in the 1920s and 1930s provide the navy with very effective submarine layers in the Second World War.

Chapter 5: German Unrestricted U Boat Warfare, 1917-1918

Layered Defence and Anti-U Boat Warfare

This chapter argues that specialised layered defence systems were created to deal with the German unrestricted U Boat warfare against British, Allied, and neutral merchant ships. These layers were in addition to those existing already to deal with surface warships. The layered defence systems were tailored to meet the geographical needs of each area, to meet the strategic situation and to counter the evolving U Boat tactics and weapons. Although the Admiralty had detailed plans to deal with the threat from German surface raiders, they had not anticipated or planned for the consequences of unrestricted U Boat warfare against merchant ships, and consequently, at the beginning of the war, they did not have an organisation, plans or bureaucratic infrastructure to conduct anti-U Boat warfare.⁴⁷⁴ Initially everything depended on the visual sighting of a surfaced U Boat which could then be attacked by gunfire or if possible, by ramming. Once the U Boat submerged, there were hand launched bombs and towed explosive sweeps, but none of these were successful. Even by September 1915, Admiral Percy Scott who was advising on anti-U Boat warfare, reported to Balfour the First Lord, that the best methods were, fitting strengthened rams to torpedo-boat-destroyers and to trawlers, bomb lances and dropping bombs from aircraft.⁴⁷⁵ However, to counter the 1917 unrestricted U Boat campaign there were technological developments that were built into a more effective layered defence system. The principal layers were:

- Intelligence about U Boat operations and tactics, and the dissemination of this, became critical in countering U Boats. Wireless telegraphy direction finding to identify U Boats at sea was well established. The ability to read German coded signals also gave warning of U Boat intentions.
- Hydrophones for U Boat detection was developing rapidly and many surface warships were fitted with these, to operate in anti-U Boat flotillas. Submarines were also fitted with hydrophone equipment for U Boat hunting.
- Extensive minefields of much improved mines were laid to destroy U Boats. Patrols by submarines and surface warship, plus the use of illumination at night of the Dover Barrage, forced U Boats to submerge into these minefields.

⁴⁷⁴ R Donley, 'Anti-Submarine Warfare in the Pre-First World War, A Cultural Failure', *War in History*, 2019, pp 1-26.

⁴⁷⁵ 'Report on anti-U Boat warfare', 6 September 1915, by Admiral Scott, Balfour Papers, MS 49715, Volume XXXIII, British Library, ff 24-25.

- Anti-U Boat weapons had developed from the earlier lance bombs and explosive sweeps, with the introduction of the depth charge with selectable depth setting. Depth charge throwers were developed also to spread these over a wider area.
- The organisation of escorted convoys was much more effective than the previous policy of merchant ships proceeding independently along prescribed routes that were patrolled by surface warship hunting groups.
- Innocent-looking merchant ships with a disguised armament were referred to as Q Ships and could destroy a U Boat by gunfire should it surface within range.
- From mid-war British submarines were used progressively against U Boats. Specialist anti-U Boat submarines were design and built.

The Admiralty became proficient at effectively integrating these elements into the layered defence system most appropriate to the changing locations and operations of the U Boat unrestricted campaign.

German U Boat Policy

German submarines, generally and popularly referred to as U Boats, did not appear until U1 at the end of 1906, and a training flotilla established in Kiel.⁴⁷⁶ Germany expected the Grand Fleet to implement a close blockade off their North Sea naval. The U Boats were designed for North Sea operations against the British fleet, where it was anticipated they would torpedo warships operating a close blockade within the Heligoland Bight.⁴⁷⁷ This was a component of Germany's naval strategy to reduce the size of the British fleet to enable it to be engaged in a fleet action. By the start of the war there were only twenty-eight U Boats in commission, considerably fewer than the number of submarines in commission in the Royal Navy. When the Grand Fleet did not appear, to locate it, on 8TH August 1914 ten U Boats proceeded northward in parallel lines in the central North Sea until the latitude of the Orkney Islands. One U Boat sighted British warships, but two U Boats were lost.⁴⁷⁸ During subsequent patrols U Boats were successful in torpedoing and sinking the cruiser *Pathfinder* off St. Abbs Head, the armoured cruisers *Cressy*, *Hogue* and *Aboukir* in the Broad Fourteens, the cruiser *Hawke* between Shetland and Norway, and the pre-dreadnought battleship *Formidable* in the

⁴⁷⁶ A Hezlet, *The Submarine & Sea Power*.

⁴⁷⁷ V E Tarrant, *The U-Boat Offensive 1914-1945*, (London: Arms & Armour, 1989).

⁴⁷⁸ 'Naval Staff Monographs Volume X, Home Waters 1, From Outbreak of War to 27 August 1914', ADM 186/619, TNA.

Channel.⁴⁷⁹ Apart from the heavy loss of life, the loss of these old warships did not reduce significantly the superiority of the Grand Fleet. The Grand Fleet was based in the undefended Scapa Flow and had been operating extensively at sea including sweeps within the North Sea. Until Scapa Flow received anti-U Boat defences, the threat of such U Boat torpedo attacks forced the Grand Fleet to withdraw to temporary bases in sea lochs on the west coast of Scotland and Lough Swilly on the north coast of Ireland.⁴⁸⁰ If Germany had realised this, they that the potential opportunity to send a raiding force to the English Channel and have time to return to their bases before the Grand Fleet could intervene. Pre-war Germany had not planned to use U Boats against merchant ships, but this policy changed in February 1915.⁴⁸¹ Considering German strategy, when U Boats were used in North Sea and Baltic naval operations, they were within a German layered defence system integrating mine warfare, Zeppelins, and the surface warships of the High Seas Fleet. However, when used against British and Allied merchant ships, the U Boats operated alone. When convoys were introduced in mid-1917, Germany failed to develop tactics to deal with them, whereas the convoys were deliberately integrated within British layered defence systems.

Development of U Boats in Germany was rapid in terms of overall design and the on-board weapons, machinery, and equipment. Although known collectively as U Boats, there were three distinct types, namely U Boats, UB Boats and UC Boats.⁴⁸² The campaign against merchant ships in the Atlantic south-west and north-west approaches off Ireland necessitated a progressive increase in size. U Boats therefore became larger, fitted with improved diesels for faster surface speed, more heavily armed with torpedo re-loads and guns, more fuel capacity and better crew facilities. These increased their endurance to operate on patrols lasting weeks compared to the typical one-week patrol of a British submarine. German diesel engines were substantially superior to British designs and their 19.7-inch diameter torpedoes were more reliable and more accurate than the British 18-inch torpedoes.⁴⁸³ A few merchant U Boats were built to cross the Atlantic and obtained useful, albeit limited, supplies of scarce commodities from the United States.⁴⁸⁴ This was considered as a propaganda coup to outwit the Royal Navy. These were later converted to carry weapons and along with new very large

⁴⁷⁹ 'Naval Staff Monographs Volumes XI & XII, Home Waters 1 & 2, to end January 1915', ADM 186/620 & 621, TNA.

⁴⁸⁰ J R Jellicoe, *The Grand Fleet 1914-16, Its Creation, Development and Work*.

⁴⁸¹ V E Tarrant, *The U-Boat Offensive 1914-1945*, pp 15-24.

⁴⁸² R H Gibson & M Prendergast, *The German Submarine War 1914-1918*, p 38.

⁴⁸³ W Jameson, *The Most Formidable Thing, The Story of the Submarine from its earliest days to the end of World War 1*, p 181.

⁴⁸⁴ R H Gibson & M Prendergast, *The German Submarine War 1914-1918*, p 103.

U Boats, were capable of patrols on the Atlantic coasts of Canada and the United States, and as far southward as the Azores. With the German occupation of Belgium, the need was identified for a smaller U Boat to operate in the Channel, off the East Coast of England and the southern North Sea. This led to the design of a series of torpedo carrying UB Classes, and small minelaying UC Classes. The early classes of both were small, slow and with limited endurance. These were initially fabricated in Germany and sent to Antwerp by railway, where they were assembled, and then transferred to Bruges via inland canals where they joined the Flanders Flotilla, formed on 29 March 1915.⁴⁸⁵ From Bruges they used canals to Zeebrugge and Ostend to gain access to the southern North Sea. During the war all three types grew in overall size and capabilities. By the end of the war, there were four U Boat flotillas located in North Sea bases and the training flotilla in Kiel, all reporting to the Commander-in-Chief of the High Seas Fleet, and the two flotillas based in Bruges reporting to the Commander-in-Chief Flanders.

German Unrestricted U Boat Campaigns

Pre-war the majority opinion in Britain was that Germany would not use U Boats against merchant ships. It was clear that submarines and U Boats did not have the facilities to look after the crews and passengers of ships sunk, and to abandon them to their fate was considered uncivilised for a country such as Germany. Six months before the start of the war, Admiral Fisher forecast that U Boats would be used against merchant ships.

Again the question arises as to what a submarine can do against a merchant ship when she has found her. She cannot capture the merchant ship, she has no spare hands to put a prize crew on board, little or nothing would be gained by disabling her engines or propeller, she cannot convey her into harbour, and in fact, it is impossible for submarines to deal with commerce in the light and provisions of accepted international law. Under these circumstances, it is presumed that the hostile submarine will disregard such law and sink any vessel heading for a British commercial port and certainly any that is armed or carrying contraband? There is nothing else a submarine can do except sink her capture, and it must be admitted that (provided it is done, and however inhuman and barbarous it may appear) this submarine menace is

⁴⁸⁵ M D Karau, *The Naval Flank of the Western Front, The German MarineKorps Flandern 1914-1918*, (Barnsley: Seaforth, 2003), p 42.

a terrible one for British commerce and Great Britain alike, for no means can be suggested at present of meeting it except by reprisals.⁴⁸⁶

Both Battenberg and Churchill rejected Fisher's forecast.

Neither the First Sea Lord nor I shared Lord Fisher's belief that the Germans would use submarines for sinking unarmed merchantmen without challenge or any means of rescuing the crews. It was abhorrent to the immemorial law and practice of the sea. Prince Louis wrote to me that Lord Fisher's brilliant paper "was marred by this suggestion."⁴⁸⁷

Fisher was wrong about this pre-war as Germany intended to use U Boats against British warships and not against merchant ships.⁴⁸⁸ However, he was proven correct as the war progressed and Germany realised that the British economic blockade and the increasing items listed as contraband, particularly food for the civilian population, was a very serious issue for their ability to continue the war. German considered this blockade to a breach of International Law and declared their use of the unrestricted U Boat warfare against British merchant trade as a justifiable retaliation. There were diverse views within German about the military benefits from U Boat warfare against upsetting neutral countries. In particular, German concern about America's reactions was a dominant factor in their U Boat policy. After much indecision, on 4 February 1915, Admiral von Pohl Commander-in-Chief of the High Sea Fleet Germany declared a war zone around the United Kingdom, in which merchant ships would be destroyed regardless of the safety of the crews and passengers. Diplomatic exchanges with America continued, and the Kaiser approved that U Boats would be instructed to "refrain from violent action against American merchant vessels so far as these can be recognised as such".⁴⁸⁹ On 18 February 1915 orders to U Boats to sink all hostile ships, but to spare neutrals and hospital ships (unless the latter were obviously engaged in trooping) and Belgium Relief steamers; moreover "if, in spite of the exercise of great care, mistakes should be made, the commanding officers will not be held responsible".⁴⁹⁰

Germany had relatively few U Boats at the start of their campaign, and with the time taken in transit to and from their patrol areas, had little time for operations. Inevitably neutral ships

⁴⁸⁶ "The Submarine, The Submarine and Commerce', Memorandum presented to the Prime Minister, 1913', Adm. J Fisher, FISR 5/24, Churchill Archive Cambridge.

⁴⁸⁷ W S Churchill, *The World Crisis Volume 2 1915*, pp 210-211.

⁴⁸⁸ R Scheer, *Germany's High Seas Fleet in the World War*.

⁴⁸⁹ W Jameson, *The Most Formidable Thing, The Story of the Submarine from its earliest days to the end of World War 1*, p 156.

⁴⁹⁰ R H Gibson and M Prendergast, *The German Submarine War 1914-1918*, p 31.

were sunk, and this drew protests. The dramatic sinking of the *Lusitania* on 7 May 1915 with the loss of 128 American civilian lives, plus inept diplomacy and propaganda, caused a major protest from President Wilson. Germany consequentially agreed not to sink passenger ships without warning, and to ensure the safety of passengers and crew. The subsequent sinking without warning of the *Arabic* on 19 August 1915 generated a further storm of American protests. On 28 August, Chancellor Bethmann-Hollweg informed President Wilson committing Germany to stop such attacks against all passenger-carrying ships.⁴⁹¹ The German Navy did not want to risk U Boats by giving warnings, so orders were issued to stop all attacks around the British coasts on 19 September 1915.⁴⁹²

American President Wilson wished to avoid joining the war and 18 January 1916, the United States Government issued a note to the Allies that admitted the legality of U Boat warfare, provided merchant ships were stopped and everyone on-board was allowed to leave before the ship was sunk.⁴⁹³ It suggested that “definitely armed merchant ships might be treated as armed merchant cruisers or as auxiliary cruisers”. A surfaced U Boat approaching a potentially armed merchant ship, was running a dangerous risk, thus encouraging the U Boat to remain submerged and sink the ship by torpedo. This method increased the chance of mis-identifying the ship and sinking a neutral. The German navy issued orders to U Boats that from 29 February 1916, they were to treat armed merchant ships as warships and therefore sink them without warning. Admiral Scheer, the newly appointed Commander-in-Chief of the High Seas Fleet, considered that restrictions placed on these orders, made it too dangerous for U Boats to operate. Scheer had direct command of the U Boats based in the North Sea bases, and he withdrew these from operations against merchant ships. On 6 March the Kaiser approved unrestricted U Boat warfare in well-defined areas around the UK but not against hospital ships. (Appendix 1: Chart 2). On 24 March the cross-Channel steamer *Sussex* was torpedoed without warning and damaged badly, resulting in 50 deaths including some Americans. On 19 April 1916 the United States Government issued a statement “unless the Imperial German Government shall now immediately declare and carry into effect the abandonment of their present method of warfare against passenger and freight-carrying vessels, the Government have no choice but to sever diplomatic relations with the German Government altogether”.⁴⁹⁴

⁴⁹¹ H J Koerver. *The Kaiser's U-Boat Assault on America* (Barnsley: Pen & Sword, 2020), p 76.

⁴⁹² Ibid, p 79.

⁴⁹³ A S Link, *Wilson, The Struggle for Neutrality 1915-1916*, cited in Koerver. *The Kaiser's U-Boat Assault on America*, p 95.

⁴⁹⁴ J S Corbett, *Naval Operations, History of the Great War, Volume 3*, p 286.

On 4 May 1916 the German Government agreed that further U Boat warfare against merchant ships, would be under Prize Rules. The German Navy therefore recalled the U Boats to their bases. Scheer was then able to integrate the U Boats under his command with the High Seas Fleet North Sea in naval operations. In planning the bombardment of Sunderland at the end of May, U Boats were positioned in lines to attack the Grand Fleet leaving its bases. The U Boats failed to do this, and neither did they participate in the resulting Battle of Jutland. U Boats were also positioned in lines for the High Seas Fleet's sortie on 18 August. Despite the Admiralty knowing the U Boats could be positioned in areas between the extensive minefields, the U Boats were successful in torpedoing and sinking the light cruisers *Nottingham* and *Falmouth*. Due to the U Boat danger, Admiral Jellicoe then confirmed that that Grand Fleet would normally operate in the northern sector of the North Sea.⁴⁹⁵

In Germany during 1915 and 1916, Admiral von Tirpitz, Secretary of the Navy responsible for construction, and Admiral von Holtzendorff, Chief of the naval General Staff responsible for the operational planning, supported by Falkenhayn the Army Chief of Staff argued for the resumption of unrestricted U Boat warfare stating that it would force Britain to capitulate within a short time. Chancellor Bethmann Hollweg continued to oppose this as he was more concerned that this would make America join the Allies. The Kaiser, in his role of supreme war leader, was indecisive and so no firm decision was taken.⁴⁹⁶ On 28 August 1916, the appointments of Hindenburg and Ludendorff to German Supreme Command gave them effective control of all decisions regarding the course of the war. By October 1916, they concluded that a military victory could not be won on land and turned to the Navy and thus unrestricted U Boat warfare.⁴⁹⁷ The valuable naval intelligence layer provided by the ability to intercept and decode German diplomatic and naval wireless telegraphy signals provide the British Admiralty with information as to German policy and operational plans. These highlight the German progression to implementing unlimited U Boat warfare. On 4 November a decoded German naval signal stated:

⁴⁹⁵ 'War Plans and Organisation 1914-1916, Orders for the Operation of the Grand Fleet in the North Sea, 27 September 1916', ADM 116/3131, TNA.

⁴⁹⁶ H J Koerver. *The Kaiser's U-Boat Assault on America*, pp 195-204.

⁴⁹⁷ Nebelin, *Ludendorff*, cited in Koerver, *The Kaiser's U-Boat Assault on America*, pp 199.

Ships on a course between England & France may be sunk without warning in the English Channel between Beechy Head and a line, St. Albans Head – Cape de la Hague.⁴⁹⁸

On 8 January 1917, at a conference at Pless to discuss the future course of the war, Admiral von Holtzendorff, the Chief of the Naval Staff, wanted to restart unrestricted U Boat warfare, but this was again opposed by politicians who did not want to risk the America entering the war.⁴⁹⁹ The decision was postponed and would be left to Hindenburg to decide but on 31 January, a further decoded signal to U Boats stated:

S/Ms [U Boats] which left the Bight before 20 January, are to attack from 1 February: all armed merchant ships including armed passenger steamers without warning,⁵⁰⁰

In Washington, the German Ambassador in America Count von Bernstorff presented a note to Secretary of State Lansing in which they referred to the Allies rejection of peace terms and the continuation of their blockade and used this to justify their use of all weapons at their disposal.⁵⁰¹ A zone was declared dangerous to all merchant traffic, from the Norwegian coast to the Faroe Islands and south to Cape Finisterre, the boundary being approximately 400-miles to the west of Ireland, and most of the Mediterranean was also included. Also on 31 January, the Chancellor announced to the Reichstag that unrestricted U Boat warfare had commenced. against Allied and neutral merchant shipping. A further decoded signal to the U Boats on 2 February stated:

Within the blockade are announced today by clear wireless, all ships, with the exception of Hospital ships are today to be attacked without warning, other ships to be treated according to Prize regulations. Outside the blockade area, only armed ships to be attacked without warning, other ships to be treated according to Prize regulations. Inside the passages to Greece E of 6°E all ships to be regarded as armed. Limitations: Neutral steamers and un-armed enemy passenger steamers are to be treated according to Prize regulations until February 10: neutral sailing ships until February 28.⁵⁰²

⁴⁹⁸ 'Intercepted German messages broadcast by W/T stations Nordeich, Nauen, Bruges, etc. relating to movements of British and allied naval and merchant ships', ADM 137/4069, TNA, f 12.

⁴⁹⁹ V E Tarrant, *The U Boat Offensive 1914-1945*.

⁵⁰⁰ 'Intercepted German messages broadcast by W/T stations', ADM 137/4069, TNA, f 26.

⁵⁰¹ H J Koerver, *The Kaiser's U-Boat Assault on America*, p 224.

⁵⁰² 'Intercepted German messages broadcast by W/T stations', ADM 137/4069, TNA, f 148.

President Wilson announced to Congress on 3 February of breaking of diplomatic relations with Germany. It was not until further American ships were torpedoed and the publication of the Zimmermann telegram, that Congress declared war against Germany on 6 April 1917.⁵⁰³

The British Response to the 1917 Unrestricted U Boat Campaign

Following the German 1915 unrestricted U Boat campaign, Britain had anticipated its resumption. Admiral Jellicoe was appointed First Sea Lord in November 1916 and his immediate priority was countering the German unrestricted U Boat warfare. He was assisted by Rear Admiral A.L. Duff and a team of officers in the newly formed Anti-Submarine [U Boat] Division. Their initial activities were to expedite progress on the technologies and weapons already under development, to improve the anti-U Boat methods already in use, and to implement new capabilities. These activities were listed by Jellicoe, and as they became available, were integrated immediately into the anti-U Boat defence layers.

1. Providing many more aircraft (aeroplanes, seaplanes, and airships) for anti-U Boat work, of improved types and heavier bombs.
2. Developing U Boat locating hydrophones for ship and harbour use.
3. Developing “otter gear” (paravanes) to protect merchant ships against mines.
4. Increasing the number of Q-ships, and of submarines employed on anti-U Boat patrol.
5. Greatly increasing the supply of depth-charges and developing a “thrower” for them.
6. Building high-speed motorboats for anti-U Boat work.
7. Speeding the manufacture of the Mark H mine, which would not, however, be available in quantity until July 1917.
8. Making more guns available for the direct defence of merchant ships (some taken from warships) and developing and supplying smoke screen apparatus.⁵⁰⁴

Jellicoe and his team identified aviation (item 1) as an important layer in the tactics of attacking U Boats, albeit the aircraft had to be capable of carrying a heavier payload than were currently available. They also identified the need to locate submerged U Boats (item 2) with the best prospects being the ongoing development of hydrophones, a necessity in the attacking layer. The fitting of paravanes (item 3) was a defensive device in response to the loss of merchant ships in coastal waters to operations of UC Class U Boat minelayers based in Flanders. Q ships (item 4) had been successful of sinking U Boats, and more were to be commissioned. The addition of anti-U Boat operations to the roles of submarines created the opportunity for

⁵⁰³ H J Koerver, *The Kaiser's U-Boat Assault on America*, pp 225-255.

⁵⁰⁴ Adm. J R Jellicoe, *The Crisis of the Naval War*.

a new layer. Depth charges (item 5) were anticipated to be a successful weapon against submerged U Boats that had been located and were being tracked by hydrophones, the combination becoming a powerful new layer. High-speed motorboats (item 6) were expected to be a new layer against U Boats operating in coastal areas. The ongoing development of mines (item 7) was recognised as providing an important layer in destroying U Boats in both offensive and defensive minefields. Arming merchant ships (item 8) was expected to force U Boats to change their tactics, making it dangerous for them to conduct surfaced attacks with gun fire, and operate by submerged attacks with their limited supply of torpedoes.

It is noted that this priority list from late 1916 did not include the implementation of merchant ship escorted convoys. The Admiralty persisted on a policy of specifying routes for merchant ships to follow while in danger zones and then providing U Boat hunting groups to patrol along these routes.⁵⁰⁵ (Appendix 1: Chart 3). The Admiralty preferred to use available destroyers in offensive U Boat hunting groups, whereas they considered convoys to be a defensive measure. Unsurprisingly hunting groups failed as the U Boat would invariably sight them first, and then submerge until they passed by. The above list did not mention the roles of naval intelligence on discovering U Boat capabilities and tactics, wireless telegraphy direction finding to reveal the position of a U Boat, or the codebreaking to reveal the U Boats' planned operations. It is probable that the Admiralty considered these too secret to be included withing a list that would be in the hands of politicians.

The Admiralty and the Implementation of Convoys

From the beginning of the war, the Admiralty had the power to requisition merchant ships for naval and for military transport use. In 1916 a Shipping Controller was appointed for the best use of merchant shipping but lacked executive powers to be effective. In June 1917 a Ministry of Shipping was established with responsibility for the control of merchant ships, their cargos, and the ports for loading and unloading.⁵⁰⁶ In effect, the merchant ships were nationalised with the ship owning companies' profits fixed.⁵⁰⁷ A group of experienced merchant navy captains were consulted in February 1917 and told the Admiralty of the difficulties of steamships proceeding closely together in a convoy.⁵⁰⁸ Many merchant navy deck officers had been transferred to the Royal Navy Reserve to man naval auxiliaries and patrol vessels and those remaining and recruited, lacked ship handling experience. Engine room crews

⁵⁰⁵ R H Gibson & M Prendergast, *The German Submarine War 1914-1918*, p 147.

⁵⁰⁶ A J Marder, *From Dreadnought to Scapa Flow*, Volume 4, pp 63-64.

⁵⁰⁷ 'War Cabinet Minutes', 17 April 1917, Item 13, CAB 23/2/39, TNA.

⁵⁰⁸ A J Marder, *From Dreadnought to Scapa Flow*, Volume 4, pp 173-174.

would have difficulty keeping to the convoy's speed and therefore there were risks of collisions. There were also concerns about delays caused by convoys including in waiting for the convoy to form, then proceed at the speed of the slowest ship, and then further delays in port resulting from a number of ships arriving together. It was feared that should a convoy encounter a minefield, there would be multiple ships sunk and damaged before it could be extricated. Most importantly there were insufficient cruisers and auxiliary cruisers to protect against German surface raiders while a convoy was in the Atlantic, and insufficient escorts to protect against U Boat attack when it neared the British coast. In January 1917, the Admiralty War Staff official view had hardened against convoys.

Wherever possible, vessels should sail singly, escorted as considered necessary. The system of several ships sailing together in convoy is not recommended in any area where submarine attack is a probability. It is evident that the larger number of ships forming a convoy, the greater is the chance of a submarine being enabled to attack successfully, the greater the difficulty of the escort in preventing such an attack.⁵⁰⁹

The Admiralty's attitude began to change in mid-1917 influenced by different factors. The very high losses of merchant ships and their cargos meant that the war could not be continued. A re-analysis of merchant ship weekly movements disclosed that there were fewer merchant ships arriving in ports after trans-ocean voyages, whilst many coastal vessels were making multiple port visits in a single week. Congestion in ports would therefore not be as bad as previously expected. Escorted convoys had been implemented for specific reasons, and experience showed the officers and crews of merchant ship were able to maintain position and speed within the convoy environment. Weekly convoys had been running between Harwich and Rotterdam from almost the beginning of the war, albeit these tended to be a loose line of ships proceeding independently with the Harwich Force nearby to counter German surface warships. France was dependent on importing large quantities of coal from the United Kingdom, and after losses to U Boats of colliers sailing independently, in February 1917 they were organised in "controlled sailings" effectively escorted convoys. It was apparent that colliers proceeding in escorted convoys suffered fewer loss.⁵¹⁰

From the beginning of the war, the Scandinavian countries had tried to continue trading with both Britain and with Germany, with diplomatic pressures being exerted by all concerned.⁵¹¹

⁵⁰⁹ 'Atlantic Convoy System 1917-1918' TH14, ADM 137/3050, TNA, f 3.

⁵¹⁰ Ibid, f 5-10.

⁵¹¹ S R Dunn, *Southern Thunder, The Royal Navy and the Scandinavian Trade in World War One* (Barnsley: Seaforth, 2019).

By 1917 an effect of the economic blockade against German was also causing shortages, particularly food, in Norway and Sweden. Britain needed Scandinavian cooperation in the supply of pitprops for coal mining and to charter their merchant ships, and in turn, they needed British coal for their industries and for their merchant shipping. The unrestricted U Boat campaign caused the loss of increasing numbers of Scandinavian merchant ships and loss of life. The Scandinavian countries did not have sufficient warships, or the diplomatic desire, to begin operating escorted convoys, so Britain was obliged to establish these. In March 1917, “protected sailings”, another name for escorted convoys, were started to operate initially between Lerwick in the Shetland Islands and Bergen in Norway. (Appendix 1: Chart 4). The eastward and westward convoys between Lerwick and the Norwegian coast sailed every few days and typically consisted of up to a dozen merchant ships with an escort of two modern destroyers and four or five armed trawlers. Destroyers were provided from the Grand Fleet and the Harwich Force. Initially the eastern end of the route was made at night, and the escort provided at the western end made in daylight. To get the merchant ships safely to and from Lerwick, escorted convoys were needed between there and British East Coast ports, with escorts provide by older often obsolete destroyers and trawlers from the local East Coast patrol flotillas.⁵¹² The Norwegian convoys were a further example of the multiple-faceted layer defence system. The convoys reduced the number of ships being sunk, although the U Boats began operating off the Norwegian coast to attack merchant ships proceeding independently after the convoys dispersed. The individual merchant ships needed to be loaded and then organised into East Coast escorted convoys. As the war progressed, aircraft and airships carried out anti-U Boat patrols off the east coast to provide further protection. On arrival at Lerwick, and later Methil, the merchant ships were organised into Norwegian escorted convoys. The convoys proceeding to and from Norway were organised and co-ordinated to make optimum use of the heavy escorts. The different layers involved in these operations required an efficient organisation to ensure there were no delays to the merchant ships and the convoy escorts.

An important benefit in Britain was the five-man War Cabinet, chaired by Lloyd George which met twice daily, invite expert advisors, and was then able to make decisions immediately as compared to the cumbersome process in Germany leadership. The Cabinet Secretary Maurice Hankey prepared minutes, disseminated the decisions to the appropriate

⁵¹² ‘Longhope Conference of 4 April 1917 on protection of trade between British and Scandinavian Ports, Recommendations’, Policy, Convoys, 1917 1, ADM 137/1322, TNA, ff 102-200.

Government departments, and then ensured that actions were taken to implement these decisions.⁵¹³ For example, at the War Cabinet meeting of 8 February 1917 it was decided to alleviate the situation by (1) A more extensive system of food production, (2) An increase in our tonnage, (3) The restriction of imports, and (4) An examination in the temporary curtailment of imports of raw material, with a view to the accumulation of a larger stockpile of foodstuffs.⁵¹⁴ On 24 February the War Cabinet received a report from the Independent Committee on Import Restrictions recommending specific limitations, and in some cases probation, in the import of paper, timber, fresh fruit, luxury products, certain raw materials, bulky articles, and items for exchange with neutrals and allies.⁵¹⁵ These implementation of these War Cabinet orders underpinned subsequent decisions regarding the integrated defence layers to ensure the safe delivery of the essential imports. By 1917 the Admiralty accepted that convoys provided their escorts with the opportunity to attack U Boats rather than the need to first locate them. They also recognised the important issue was not the sinking of U Boats, but the safe and timely arrival of the merchant ships and their essential cargoes. When the Admiralty decided to implement further convoys, it took time to establish the procedures, issue orders and organise the dispatch, escorts, and reception. Convoys from Gibraltar commenced in July 1917 and across the Atlantic from August 1917. Atlantic convoys were escorted by cruisers or old battleships against potential German surface raiders until about 400 miles west of Ireland. They were then handed over to anti-U Boat escorts for the transit of the danger areas until they reached their dispersal position to proceed to ports. Convoys were good examples of layered defence systems including intelligence, the appropriate escorts, sensors, weapons and most importantly, organisation at both ends.

American Involvement in Anti-U Boat Warfare

Shortly after the America entered the war, Admiral Jellicoe presented a list to Admiral Mayo USN, requesting specific support.⁵¹⁶

1. An increase in the number of destroyers, to enlarge the convoy system and to provide better protection for each convoy. An additional fifty-five destroyers were stated to be required for this service.
2. An increase in the number of convoy cruisers for the same reason. The total number of cruisers and old battleships was given as forty-one.

⁵¹³ H J Koerver, *The Kaiser's U-Boat Assault on America*, pp 231-233.

⁵¹⁴ 'War Cabinet Minutes, Meeting 57, 8 February 1917', CAB 23/1/57, TNA.

⁵¹⁵ 'War Cabinet Minutes, Report on Imports', 14 February 1917, CAB 24/3/29, TNA.

⁵¹⁶ Adm. J R Jellicoe, *The Crisis of the Naval War*.

3. An increase in the number of patrol craft, tugs, etc., for anti-U Boat work.
4. The rapid building of merchant ships.
5. The supply of a large number of mines for the proposed barrage in the North Sea, and assistance towards laying them by the provision of United States minelaying vessels.
6. Aircraft assistance in the shape of three large aeroplane stations on the coast of Ireland, with some thirty-six machines at each station.
7. The provision of four coal-burning battleships of the dreadnought battleships to replace Grand Fleet dreadnoughts which it was desired to use for other purposes.

This list reflects the Admiralty's priorities with the first six concerned with anti-U Boat warfare and only the seventh concerned with the Grand Fleet. All of these, particularly the first six, were to be integrated into and enhance the layered defence systems already in operation. The first destroyers arrived at Queenstown on 4 May 1917, where they were quickly integrated into the anti-U Boat operations.⁵¹⁷ The first four dreadnoughts under the command of Rear Admiral H Rodman arrived at Rosyth on 7 December 1917 to form the 6TH Battle Squadron integrated into the Grand Fleet. The Admiralty shared their naval intelligence with the United States navy, and they were willing to adopt Royal Navy operating procedures and signalling standards.⁵¹⁸ These were achieved by the good relations between the senior British and United States officers, in the Admiralty, within the Grand Fleet, and at Queenstown.⁵¹⁹ The United States navy took responsibility for organising and escorting the convoys bringing the rapidly expanding army from the States to France. They also provided heavy warship escort to Atlantic convoys against potential attack by German surface raiders.⁵²⁰ The United States was also the major force in the creation of the Northern Barrage, both in the provision of new anti-U Boat mines and laying the minefields. (See later).

Naval Intelligence in Anti-U Boat Warfare

The effectiveness of anti-U Boat layered defence systems relied on accurate, current intelligence. The gathering and use of naval intelligence on German technology and operational procedures, developed into a very important factor in anti-U Boat warfare. Knowledge of German weapons and procedures also influenced British countermeasures. Naval intelligence consisted of different components, but it was not until mid-1917 that the Admiralty combined the sources and to disseminate this intelligent efficiently it to the relevant

⁵¹⁷ D Brunicardi, 'The US Navy at Queenstown', *History Ireland*, June 2017, Vol.25, pp 38-40.

⁵¹⁸ A J Marder, *From the Dreadnought to Scapa Flow*, Volume 5, pp 124-126.

⁵¹⁹ M Simpson, *Anglo-American Naval Relations 1917-1919*, (London: NRS, 1991).

⁵²⁰ H Newbolt, *Naval Operations* Volume 5, p 202.

end-users. In 1917 Admiral Jellicoe began major changes to the Admiralty's Naval Staff, and among these was the full responsibility of Room 40 being transferred to Admiral Hall, the Director of Naval Intelligence.⁵²¹ Within the Room 40 organisation, a specialist section was created called the Submarine Tracking Room, and a further section called the Convoy Section. These sections met every morning in front of a large wall-mounted map of the North Atlantic and compared the positions and courses of convoys against those of U Boats. Decisions were then taken for potential convoy re-routing and the distribution of escort vessels where U Boat attacks were anticipated. Within the Admiralty building, the Convoy Section was connected by pneumatic tubes to both the Submarine Tracking Room and the Wireless Telegraphy Direction Finding section, ensuring there were no delays in information getting to officers for the immediately and efficient use to be made of it. In addition, from July 1917 daily U Boat situation reports containing information about U Boat numbers and their current locations were issued to Admiral Beatty, Commander-in-Chief Grand Fleet, and to Admiral Bayly at Queenstown, responsible for merchant ships and convoys transiting the south-western approaches.

The foremost source of intelligence was the German dependence on wireless telegraphy. U Boats on patrol made regular wireless telegraphy signals that were picked up by British shore listening stations, and with cross bearings from different stations, the location of the U Boat could be identified. Listening stations were built initially at Lowestoft, Lerwick, Aberdeen, York, Flamborough Head and Birchington, thus providing a long base line and their separation obtained more accurate cross bearings.⁵²² Eventually fourteen such stations were built, including briefly a clandestine one in Christiane (Oslo) operated by Maurice Wright, father of Peter Wright of the book *Spycatcher* fame. Post war it is estimated that in the North Sea the derived location was accurate to approximately a twenty-mile radius and in the Western Atlantic to a fifty-mile radius. Superficially these seem a lot, but when they were plotted for each U Boat it was much clearer where the U Boat was heading and its arrival time. By comparison Germany had initially only two at Nordholz/Cuxhaven and Borkum, and later at Sylt and Bruges. U Boats routinely signalled that they were leaving their patrol area to return to base and reporting any technical problems. When British code breakers enabled German wireless telegraphy messages to be read, this provided very useful intelligence, for example

⁵²¹ P Beesly, *Room 40 British Naval Intelligence 1914-1918*, p 177.

⁵²² A Hezlet, *The Electron and Sea Power*, p 142; E Bruton & P Coleman, 'Listening in the dark: audio surveillance, communication technology, and the submarine threat during the First World War', *History and Technology*, 2016, Vol.32 (3), pp 245-268.

if the U Boat was damaged or unable to submerge. The Admiralty was able to make a reliable estimate of where and when a U Boat would be on its return journey, and hence send appropriate forces to attack it. Such intelligence also enabled the Admiralty to re-route merchant ships away from dangerous locations and to send anti-U Boat warships to intercept the U Boat. If a particular route within the Heligoland Bight was identified and considered mine-free, further mines could be laid. It was also known that U Boats regularly used lightships, for example, the North and South Dogger Bank lightships, to obtain accurate navigation fixes before entering the area of known minefields. The Admiralty routinely directed submarines to these locations to attempt to ambush the returning U Boat.⁵²³ The British organisations established for direction finding and code breaking became so large that they can be considered as a layer within the overall intelligence system. Great care was taken to ensure that the German navy was unaware of the sources, particularly the ability to read coded wireless telegraphy messages.

Valuable intelligence was obtained by the interrogation of U Boat survivors who had become prisoners of war.⁵²⁴ The interrogators were adroit at getting the prisoners to divulge information, as often they were very relieved to have survived their U Boat sinking and were safely out of the war. The interrogator was already in possession of much intelligence, and if appropriate would let the prisoner know, to encourage him to confirm and provide additional information. For example, the current organisation of U Boats could provide intelligence about German plans, so it was important to know the current disposition of U Boats, the names of the commanding officers, and the composition of flotillas. Details of the last patrol and previous patrols provided intelligence about the sinking of individual ships and the U Boat tactics. Particularly valuable was intelligence of where mines had been laid as this provided the opportunity for minesweeping. Detailed technical information was also obtained about the latest U Boat designs, their capabilities, and their on-board equipment.

The Admiralty indulged in psychological warfare by not declaring the details of a U Boat being sunk, creating worries in the remaining U Boat crews as to what had happened or spreading doubts that there was a new unknown weapon. By the very nature of U Boat warfare, for example when a submerged U Boat detonated a mine, there were seldom any survivors, so the German navy and other crews were unaware what had happened to a missing U Boat. If

⁵²³ 'Commodore S War Records Volume IX, Report of Proceedings of Submarines attached to HMS *Titania*, *Lucia*', ADM 137/2075, TNA.

⁵²⁴ 'Interrogation of survivors of captured and sunk German submarines', ADM 137/3060, TNA; D Nudd, *Castaways in Question*, (Grove, 2020).

there were any survivors, the Admiralty was obliged to inform the Red Cross who would then inform the German navy. When a U Boat was sunk, it was often difficult for the Admiralty to obtain confirmation unless there were survivors, or the wreck was found. Often a U Boat would simply disappear by hitting a mine unseen and unreported, or by maritime accident. The Admiralty might suspect a U Boat was sunk by cessation of wireless telegraphy transmissions but wanted confirmation about those that had not returned for a patrol.⁵²⁵ During the later stages of the war, the Flanders flotillas were losing one U Boat per week, and the average U Boat survived only six patrols. U Boat crews were very aware of the dangers encountered so the interrogators wanted to know about their morale. The interrogators also wanted information of the morale within the High Seas Fleet, as they were aware of mutinies, and the conditions and attitudes of the civil population. It should be noted that post war, information was compared between British and German records, to resolve the fate of all lost U Boats, but in many cases, there remained doubt.⁵²⁶ In recent years divers have found U Boat wrecks and discovered some sunk in different positions and from different causes.⁵²⁷

A further source of intelligence was the examination of U Boat wrecks by Royal Naval divers, and a few wrecks that were salvaged and examined on the surface.⁵²⁸ The Admiralty Salvage Section was formed at the end of 1915 and was credited with recovering and returning to service around four hundred and fifty ships. A group specialising in U Boat wrecks was established under Commander G.C.C. Damant, the former Inspector of Diving.⁵²⁹ Wreck investigation required experience and was used more in late 1917 and 1918. Many U Boats were sunk in shallow coastal water and thus accessible by divers. When a suitable wreck was identified, divers had often to remove the coning tower by explosives and also open a hatch. A diver would search inside the U Boat, and with experience knew where to search for documents, including charts showing minefields, operating procedures, code books, and cypher settings, call signs, machinery manuals, notebooks, etc. Such intelligence could reveal what the German navy knew about the locations of British minefields and anti-U Boat nets. Of value were documents on British anti-U Boat weapons and operating procedures revealing

⁵²⁵ 'Reports concerning cruises, interrogation of survivors, machinery and fittings of German submarines', ADM 137/3875, TNA

⁵²⁶ D R Messimer, *VERSCHOLLEN, World War 1 U Boat Losses* (Annapolis: NIP 2002).

⁵²⁷ I McCartney, 'The Archaeology of First World War U-boat Losses in the English Channel and its Impact on the Historical Record', *The Mariner's Mirror*, April 2019.

⁵²⁸ I McCartney, 'The "Tin Openers" Myth and Reality: Intelligence from U Boat Wrecks During WW1', *Historical Diving Conference*, Poole, 2014.

⁵²⁹ R M Grant, *U-Boat Hunters, Code Breakers, Divers and the Defeat of the U-Boats 1914-1918*, (Penzance: Periscope, 2003), p 12.

how much the German Navy knew about these. Documents also provided the locations of the cables for the navigation system and their operating procedures. Wireless telegraphy and hydrophone equipment were also dismantled, brought to the surface, and examined. Periscopes, mines, and torpedoes with their firing pistol were also salvaged for further examination. Admiralty documents listing dives to U Boats were either not collated during the war or have disappeared, but the number of U Boat wrecks visited by divers is probably around forty of which approximately ten supplied valuable intelligence.

A complete U Boat, the small minelayer UC5, ran aground on the Shipwash Bank on 27 April 1916. Most of the documents appear to have been destroyed by the crew, but they did not blow it up as expected. Once salvaged it was inspected, particularly useful was the intelligence on the mines still on board and the minelaying gear, before it was put on display to the public.⁵³⁰ UC44 had been sunk probably by her own mines off Dunmore, Ireland on 4 August 1917 and when salvaged shortly afterwards, valuable intelligence was obtained from documents.⁵³¹ For example, it was learnt that U Boats were crossing the Dover Barrage quietly at night, while those using the northern route around Scotland were to show themselves to give the impression this was the preferred route.⁵³² UB110 was sunk by convoy escorts off Hartlepool on 19 July 1918, and when salvaged the wreck was brought into Newcastle on Tyne on 4 October for examination where documents were recovered that included charts showing minefields, call signs to identify individual U Boats and codes.⁵³³ Valuable intelligence documents were obtained also from wrecks of Zeppelins brought down over land and in shallow water.⁵³⁴

An important, and little reported, example of the combination of naval intelligence and technology to support a layered system, involved a system of German navigation cables. In 1917 the Admiralty was anxious to obtain details of a German system used for navigation along mine-free routes through minefields. The navigation system consisted of a cable laid on the seabed down which an alternating electric current was passed from a shore station. It was thought that some of these cables were the ends of German telegraph cables that had been cut during the first days of the war, although new cables could have been laid subsequently. British submarines had observed surfaced U Boats close to the Schouwen

⁵³⁰ 'Interrogation of Survivors from German Submarines – UC5', ADM 137/3876, TNA.

⁵³¹ 'German Submarines UC16-UC44, Translation of Officer's Diary' ADM 137/3897, TNA.

⁵³² 'Miscellaneous collection of German Submarine Orders, Instructions and Regulations', ADM 137/3886, TNA.

⁵³³ 'Salvage Record No.22', ADM 116/1851, TNA.

⁵³⁴ R M Grant, *U-Boat Hunters, Code Breakers, Divers and the Defeat of the U-Boats 1914-1918*, p 50

Bank buoy installing equipment on their casings.⁵³⁵ These were copper coils that detected the magnetic field created by the alternating current, thus enabling the U Boat to follow the cable to Zeebrugge. The cable from the Schouwen Bank buoy to Zeebrugge was located across the entrance to the Schelte estuary and therefore through the open entrance of the Zeebrugge of anti-U Boat nets and mines laid off the Belgium coast. White rectangular boards were also erected on the U Boats' casing to identify as German and prevent machine gun and bombing attacks by patrolling German aircraft. Details of the navigation system were obtained from the interrogation of a survivor from UB85. He was a telegraphist who operated and maintained the equipment and he made a sketch of the key components of the system.⁵³⁶ While surfaced, two copper coils were placed on the U Boat's casing, and these detected the magnetic field generated from the cable. Equal strength signals from the coils indicated that the U Boat was directly over the cable. German minesweepers, fitted with the same system would have been able to maintain a mine-free route over the cable, although to date, the author has been unable to obtain evidence of the system being fitted to German surface warships. The Admiralty requested that a British submarine be fitted with similar coils to confirm the existence of the navigation system by detecting the magnetic field off the Schouwen Bank buoy. The Admiralty was also suspicious that a cable, probably an ex-telegraph cable, extended westward from Borkum. It is also possible that cables were laid along the mine-free routes through the Heligoland Bight, but this dissertation has not found explicit evidence of these. There is a lack of evidence concerning this navigation system from German sources. However, in 1923 the German Siemens company was offering this system for ships entering and leaving a port safely in poor or zero visibility.⁵³⁷ For such a commercial system to be available in 1923, it is probable that it was based upon the wartime system developed for the German Navy.

When the Admiralty obtained intelligence that a U Boat was returning from patrol to Zeebrugge, one or two British submarines were sent to patrol off the Schouwen Bank buoy to ambush it while on the surface installing the copper cables. The Admiralty's interest in the German system was due partly to the use of similar technology. A cable was laid from the entrance of Harwich harbour eastward, and this was used to maintain a mine-free route through the off-shore minefields. A Board of Invention and Research (BIR) reports a British destroyer using a similar system to proceed from the port at 30-knots in fog that would normally

⁵³⁵ 'Use of Rectangles in German Submarines', 15 May 1918, ADM 137/1630, TNA.

⁵³⁶ 'Interrogation of survivors of captured and sunk German submarines, UB85', ADM 137/3060, TNA.

⁵³⁷ *Siemens Magazine*, 1923 (3), Berlin.

preclude her leaving.⁵³⁸ In effect, it was an analogue Global Positioning System, and considered secret by both Germany and Britain.

In 1918 United States naval intelligence was able to provide the numbers of U Boats proceeding through The Sound and the Little Belt, both northwards and southwards, and including the time-of-day these passed various locations. Movements of German surface warships were also reported. This added to the information of the number of U Boats on patrol and an estimate of when they would be off the coasts of Scotland and Ireland and be on-station. These reports came from Lt. Commander J.A. Gade of the American Legation in Copenhagen, although this intelligence was provided by, or with assistance from, the neutral Denmark. "Judging from the daily Naval reports as well as conversation with Danish Admiralty yesterday".⁵³⁹

Anti-U Boat Minelaying Operations

The Admiralty realised that minelaying was a vital layer in anti-U Boat warfare. A U Boat hitting a mine invariably was lost, often without survivors. Minefields were the best, often the only, means of preventing U Boats leaving and returning to their bases. The threat or suspicion of such minefields, particularly within supposedly mine-free routes, was usually sufficient to delay U Boats leaving. Analysis revealed that mines accounted for more U Boat losses than any other weapon. Of one hundred and seventy-three U Boats lost, forty-five were due to mines and probably a further seven, equivalent to 30% of all losses.⁵⁴⁰

The German decision to implement unrestricted U Boat warfare in February 1917 led to a very large increase in British minelaying. It coincided also with the availability of the new H2 type mines with their Hertz horns that were much more reliable than their predecessors. Orders were placed for over one hundred thousand of these mines and further vessels, including HMS *Courageous*, light cruisers and destroyers, were converted to have mine laying equipment installed. Coastal motorboats were also converted to lay mines in shallow water. The Heligoland Bight received most mines throughout 1917. The Admiralty planned to lay shallow and deep mines against Germany-based U Boats in a 157-mile arch around the Heligoland Bight. Insufficient mines were available, so a series of new minefields were laid outside the

⁵³⁸ 'Report of Proceedings, December 1916, For the Navy, Leader Gear', Board of Invention and Research. ADM 116/1430, TNA.

⁵³⁹ 'Daily Report(s) of Movements of German S/Ms in The Sound and Little Belt', RG45 Box244, National Archives Washington DC.

⁵⁴⁰ 'British Mining Operations 1939-1945, Chapter 1: The Emergence of the Mine as a Naval Weapon and an Examination of its Use up the End of World War 1', ADM 234/560, TNA, pp 1-41.

existing fields. Intelligence obtained by wireless transmissions and observations by British submarines, enabled the discovery the routes used by U Boats. Mines were laid in these routes, and as the Germans changed their routes, these were progressively mined. British mine laying submarines were used mostly to lay mines in the inshore routes running northwards from Sylt and westwards from Borkum. Surface minelayers laid further fields outside the existing fields and by July 1917 these stretched from off the Danish Jutland coast in a series of lines round to the Dutch coast.⁵⁴¹

As the war progressed, the increased risk of mines in the Heligoland Bight forced U Boats to make more use of the Kattegat, particularly when bad weather prevented German minesweeping in the North Sea. As an alternative to the Heligoland Bight-North Sea transit, U Boats could proceed via the Kaiser Wilhelm Canal to Kiel, and hence via the Kattegat and Skagerrak to Norwegian territorial waters before heading westward around Scotland. Apart from the additional transit time, the northern exits of the Baltic via The Sound and The Greater and Lesser Belts were patrolled regularly by British submarines. The Royal Navy also laid a deep anti-U Boat minefield in the Kattegat using surface minelayers screened by a strong escort.⁵⁴² This was patrolled by submarines to force U Boats to submerge to avoid attack and hence enter the dangerous minefield.⁵⁴³ There were also regular anti-U Boat sweeps by Grand Fleet destroyers.

A major, new layer in anti-U Boat warfare was the enormous Northern Barrage minefields laid in 1918 across the northern exit of the North Sea.⁵⁴⁴ Earlier in the war, the Admiralty had considered mining this, but the distance of approximately 250-miles, and Britain's limited production capability for mines, made this impracticable. When America entered the war, they had few mines, and these were unreliable. During 1917 they quickly designed and developed a new mine that had a copper antenna attached to an electrically activated detonator. When a steel ship or U Boat touched the antenna, an electrical current was created and the mine detonated. The original design was for the mine to be laid at a depth with an antenna above supported by a glass float, and the mooring cable below also acting as an antenna, however in practice, the mines were fitted only with the upper antenna.⁵⁴⁵ This mine was designated the Mark VI and filled with 300-pounds of TNT. After much debate, in December 1917 the

⁵⁴¹ 'British Minelaying Operations Heligoland Bight 1917 May-December', ADM 137/839, TNA.

⁵⁴² 'British Minelaying Operations Heligoland Bight and Kattegat 1918' ADM 137/840, TNA.

⁵⁴³ Ibid

⁵⁴⁴ 'British and American Minelaying Operations Northern Barrage' ADM 137/847 & 848, TNA.

⁵⁴⁵ J S Cowie, *Mines, Minelayers and Minelaying*, p 66.

Americans and British agreed that the minefield would be in three sections that ran roughly from the Orkney Islands to Bergen, Norway. Section B extended 50-miles eastward from the Orkney Islands, to be laid by the British using their H2 mines. Section A started at the outer edge of B and extended 134-miles northeast and used the American Mark VI mines. Section C started at the outer edge of A and extended 60-miles southeast, to be laid by the British using their H2 mines. All three sections were 50-miles wide and the mines were to be laid at various depths.

The Mark VI mine was subject to premature detonation, and one mine exploding could set off several other mines, creating a spontaneous countermining that left large holes in the minefield. The H2 mines were also liable for premature detonation and could break their moorings. Despite these problems, the first British mines were laid in Section B on 2 March 1918 although these were swept quickly when a further fault was discovered. The first joint laying started on 6 June 1918 and continued continuously until 26 October, by which time approximately 73,000 mines were laid.⁵⁴⁶

By August it was apparent that U Boats were avoiding the barrage by proceeding through Norwegian territorial waters. Britain wanted Norway to lay mines, but it was not until 29 September that they issued a warning about mining and its waters would be closed from 7 October. A ten-mile gap remained off the Orkney Islands as the Admiralty wanted it to allow movements of the Grand Fleet. Even with post-war analysis, the number of U Boats destroyed in the barrage is still unknown but was probably five or six.⁵⁴⁷ It did, however, compel U Boats to extend their transits to and from Germany to their operational areas off Ireland and round to the English Channel. Mines accounted for more U Boat losses than any other weapon, so the presence of the barrage created fear in the U Boat crews.

The Royal Navy laid extensive defensive minefields off the east coasts of England and Scotland.⁵⁴⁸ An inshore channel was swept regularly to ensure the safety of the many merchant ships and the transit of warships. Minelaying U Boats, particularly the UC classes operating from Flanders, became a serious problem by their continual laying of fresh mines within the swept channel. Defensive minefields were laid primarily against these U Boats, that by 1918 had grown enormously. The U Boats would often use a prominent headland, such

⁵⁴⁶ 'British and American Minelaying Operations Norther Barrage' ADM 137/847 & 848, TNA.

⁵⁴⁷ R M Grant, *U-Boats Destroyed, The Effect of Anti-Submarine Warfare 1914-18* (Penzance: Periscope, 2002), pp 98-108.

⁵⁴⁸ 'British Minelaying Operations Heligoland Bight', ADM 137/837, TNA.

as Flamborough Head in Yorkshire, to obtain their accurate position prior to laying their mines. When intelligence was available of the presence of such a U Boat, a C Class submarine would be used to ambush it off the headland. Their activity was integrated closely in a layered defence with surface anti-U Boat warships and disguised Q ships.

Influence mines were developed and ready in 1918. Acoustic triggered mines were available but not used whereas magnetic triggered mines were laid off the Belgium coast. Minefields with dummy mines, lacking a detonator, were also laid in the Heligoland Bight to keep the German minesweeping forces busy while keeping the area safe for British warships. By the end of the war, mines accounted for approximately a third of all U Boat losses, more than any other weapon, albeit often the loss went unseen and unrecorded.

Layered Defence against U Boats Operating from Germany

Germany's larger U Boats operated from bases on their North Sea coast, namely Emden, Brunsbüttel and Heligoland. When integrated within German naval operations, they were often stationed off Orkney and Rosyth, and in patrol lines in the North Sea to attack the Grand Fleet as it proceeded to intercept the High Seas Fleet. Against merchant shipping, their areas of operations were off the east coast of northern England, off Scotland, and off Ireland including the Irish Sea. Their most important targets were the merchant ships coming from the United States and Gibraltar, and these were intercepted in the South-Western and the North-Western approaches. In early 1917 there were neither developed sensors to detect a U Boat nor a decisive weapon to sink it. Hydrophones, effective mines, and depth charges were all under intense development and testing. The British Admiralty had to make the best use of what was available, so they implemented a flexible layered defence system that consisted of integrated layers to identify, delay, attack and sink U Boats.

When a U Boat left on operations, the first layer encountered were the extensive minefields in the Heligoland Bight (see earlier), where German minesweepers endeavoured to keep three routes clear of mines. At various stages of the war, Germany-based U Boats would proceed through the Straits of Dover being the shorter route to the south-west approaches, however when this route was considered too dangerous, they would proceed around the north of Scotland. When using the Straits of Dover, their preferred swept route commenced off Borkum westward to the edge of the mined area off Terschelling. When proceeding via Scotland, the U Boat would use either the route northwards along the Danish coast or north-westward until clear of the mined areas. These routes and the exits into the North Sea, were known to the Admiralty through observations by submarines and charts obtained for sunken U Boats. The

German minesweepers laid buoys at the exits to enable returning U Boats to enter the swept routes safely, particularly if they had been navigating by dead-reconning unable to obtain accurate star sights.⁵⁴⁹

The next layer encountered were British submarines on patrol off these exits. The primary task of British submarines had been observational patrols against German surface warship sorties, but in 1917 they were redeployed on anti-U Boat warfare. The Admiralty realised that the unrestricted U Boat campaign was the greatest threat, and although the existing submarines were not ideal in this role, all available weapons were to be used.⁵⁵⁰ Once safely into the North Sea, the U Boats proceeded towards the north of Scotland. British naval intelligence deduced that their transit route resembled a cone shape from the exit and widening out the further north. The Admiralty planning division defined navigational patrol boxes across this conical route. (Appendix 1: Chart 5). The southern-most boxes, the outer layer, were patrolled by submarines, then came a layer patrolled by armed naval trawlers and the northern-most by destroyers, all on anti-U Boat patrols. The boxes were separated to avoid the surface warships mistakenly attacking a Royal Navy submarine.⁵⁵¹ Many smaller anti U Boat warships were manned by reservists and ex-fishermen who tended to attack any submarine, even while surfaced. The early patrol submarines, for example D, E and G Classes, were not ideal for anti-U Boat warfare due to their surface speed being slower than a U Boat, and their inability to fire a salvo of torpedoes against such small, manoeuvrable targets. The submarine while submerged had little chance of sighting a U Boat, and if on the surface was vulnerable to attack by a U Boat. However, even if the submarine did not attack a U Boat, the threat of its presence could force the U Boat to submerge thus making the transit longer and reducing the time spent on operations.⁵⁵²

After the North Sea, the next layer encountered was as the U Boat proceeded westward around Scotland, where there were anti-U Boat patrols by naval trawlers and destroyers and by submarines. (Appendix 1: Chart 6). There also were defensive minefield around the Orkney Islands protecting Scapa Flow. The Pentland Firth with the main exit from Scapa Flow was heavily patrolled by warships and had dangerous navigation hazards for a submerged U

⁵⁴⁹ R M Grant, *U-Boats Destroyed, The Effect of Anti-Submarine Warfare 1914-18*, pp 49-54.

⁵⁵⁰ 'Submarine v Submarine', The Technical History TH1, March 1919, ADM 275/19, TNA.

⁵⁵¹ 'Submarine patrol areas in the North Sea and off the Scandinavian coasts', Secret Pack of C-in-C Grand Fleet 1917-1918, Vol.VII, ADM 137/1926, TNA, f 692.

⁵⁵² 'Commodore S War Records Volume X, Report of Proceedings of Submarines attached to HMS *Vulcan*', ADM 137/2076, TNA, ff 166-202.

Boat. The Fair Isle Channel was used often but also patrolled by coastal-type submarines off Fair Isle to ambush U Boats as they obtained a navigational fix, but in July 1917 submarine C.34 was torpedoed by a U Boat off Fair Island.⁵⁵³ On the route north of the Shetland Islands, British submarines were stationed at Muckle Flugga to intercept and attack passing U Boats. In March 1917, G and E Class submarines were detached from the Tees flotilla to patrol the northern route, and almost immediately G.13 torpedoed UC43 north of Muckle Flugga.⁵⁵⁴ When naval intelligence obtained information on a U Boat on transit, two submarines would proceed quickly to an intercepting position to attack or at least to force the U Boat to submerge and cause further delay.⁵⁵⁵ Two K Class submarines, with their higher surface speed, were used in these operations, but without success. In April the depot ship HMS *Lucia* and her submarine flotilla were transferred from the Tees to Scapa Flow and regular patrols were maintained on the U Boat routes between the North Sea and St Kilda.

Once the U Boat arrived in the north-west approaches, a further layer was encountered of surface warships and submarines. Prior to convoys being implemented, merchant ships sailed singly on routes designated by the Admiralty and patrolled by surface warships. Once U Boat activity was reported, the route was changed although it was difficult to instruct merchant ships as many did not have wireless telegraphy. Old merchant ships manned by naval crews were converted into U Boat traps by having carried hidden guns and referred to as Q-Ships. U Boats preferred to sink such old ships by gunfire or explosive charges rather than by one of their limited supply of torpedoes. Upon surfacing the U Boat would order the merchant ship to stop, and the crew would be seen to abandon ship, often in haste. When the U Boat came close, the hidden crew would drop the disguise to attack and sink the U Boat by overwhelming gunfire. This success of this form of attack decreased as the war progressed as the U Boat captains became more suspicious of such traps. Submarines were also deployed off Ireland but clear of the merchant ship routes, because if sighted and then mistakenly reported as a U Boat, it could initiate the Admiralty changing the route unnecessarily, perhaps to where actual U Boats were operating. In April 1917, the depot ship HMS *Platypus* with six D Class submarines were stationed at Killybegs, Donegal, and HMS *Vulcan* with six E Class and two H Class were transferred to Lough Swilly. Between May and December 1917 these

⁵⁵³ 'Commodore S War Records Volume IX, Report of Proceedings of Submarines attached to HMS *Titania*, *Lucia*', ADM 137/2075, TNA, ff 431-432.

⁵⁵⁴ *Ibid*, f 376.

⁵⁵⁵ 'Operation of Submarines', Secret Packs of the C-in-C Grand Fleet 1914-1918, Volume LIV, ADM 137/1925, TNA.

submarines patrolled the U Boat routes and on their operating areas between 54° and 57° North and West of 9° West. The submarines were initially to patrol along latitude 53°30' North between longitudes 11° and 14° West spaced in a line, to intercept and attack passing U Boats. It is interesting and unresolved, to note that in October 1917, documents from a sunken U Boat disclosed that Germany was quickly aware of these submarine patrol positions.⁵⁵⁶

The main U Boat operational areas were the South-Western and North-Western approaches in the Atlantic off the coast of Ireland. All merchant ships from and to America and Gibraltar had to transit one of these areas. At the beginning of the unrestricted U Boat campaign, independent unarmed merchant ships in the south-western approaches were being attacked and sunk by U Boat gunfire or capture and sunk by explosive charge.⁵⁵⁷ A new submarine flotilla was formed with the depot ship HMS *Vulcan*, and put under the orders of the Commander-in-Chief Queenstown.⁵⁵⁸ This flotilla was gradually increased to six E Class, six D Class and two H Class. These submarines were to operate against U Boats on passage off the west coast of Ireland to their way to their operational area in the southern trade-route approaches. The Admiralty were concerned also that British submarines patrolling the south-western trade routes, could be reported as U Boats, resulting in the route being changed to an area where U Boats were operating. There was concern also that British submarine would be attacked by surface patrol vessels and merchant ships, so the flotilla was transferred to the north-wester approaches. A further integrated layer was implemented whereby by submarines operating together with Q Ships. The concept being that when a U Boat surfaced to inspect the Q Ship, it would be surprised and torpedoed by the submerged submarine. Some submarines also followed unsuspecting merchant ships sailing independently on the expectation that they would be attacked. These had limited success, so were not continued.

The Atlantic convoy reduced the number of merchant ships being sunk, so U Boats were concentrated in the approaches to the Irish Sea and English Channel, where the convoys dispersed. Most surface escorts were being used as convoy escorts so were unavailable for use as U Boat hunting groups. Submarines were therefore to be used as the main weapon to hunt U Boats, thus creating a further layer. In September 1917 HMS *Vulcan* and her flotilla were transferred to Berehaven, with a new system of patrol areas in the approaches to St. George's and the English Channels. The depot ship HMS *Platypus* flotilla of six D Class

⁵⁵⁶ 'Technical History & Index, Submarine v Submarine, TH1', ADM 275/19, TNA, f 5.

⁵⁵⁷ Admiralty, *British Vessels Lost at Sea 1914-18* [1919] (Cambridge: Stephens, 1977)

⁵⁵⁸ 'Technical History & Index, Submarine v Submarine, TH1', ADM 275/19, TNA.

transferred to Campbeltown situated conveniently for operations north of Ireland and the northern part of the Irish Sea. In March 1918, the depot ship HMS *Vulcan* and two H Class left Berehaven and proceeded to Kingstown from where patrols were maintained in the central Irish Sea.⁵⁵⁹ The increasing effectiveness of surface and air patrols, combined with long periods of daylight in the summer of 1918, led to a gradual reduction in U Boat activity in the Irish Sea.

On 27 January 1918, the depot ship USS *Bushnell* with a flotilla of seven American L Class (not be mistaken for British L Class), arrived at Queenstown. They then proceeded to Berehaven, where they received a month's training in the latest methods to attack U Boats. The first AL submarines were on patrol by February, and from then until the Armistice constant patrols were maintained by them south and south-east of Ireland.⁵⁶⁰

Layered Defence against U Boats Operating from Flanders

In 1914, the German army occupied almost all the Belgium coast. Britain quickly built monitors, unarmoured warships carrying two heavy guns, to bombard the German coastal forces.⁵⁶¹ In response, and to deter any British maritime landings, the German built gun emplacements and installed batteries of heavy guns.⁵⁶² The whole coast was progressively fortified. The occupation of Belgium enabled U Boats and torpedo boat destroyers to be based in Bruges with access to the sea via canals to Zeebrugge and Ostend. The successes of these U Boats against merchant ships, and the raids by the German surface warships against the Dover Barrage and the vital cross-Channel supply routes, were very serious threats to Britain. A key target were the lock gates at Zeebrugge in the exit of the canal from Bruges, and despite numerous monitor bombardments and later air attacks, they were not disabled.

The Dover Straits was the shortest route for U Boats to their operating areas in the English Channel, the Bay of Biscay, the South-Western approaches, and the Irish Sea, and so became the focus of a new and intensive layered system. The restart of unrestricted U Boat warfare increased the necessity to block the Dover Straits with an effective Barrage. Admiral Bacon, the C-in-C Dover, had plans to lay further minefields from Folkstone to Cape Gris Nez, but had to wait until the effective H2 mine was available in sufficient quantities, when new minefields were laid between November and December 1917. The mines were laid at different

⁵⁵⁹ Ibid

⁵⁶⁰ 'Submarine Force Atlantic Fleet', RG38 Box1370, National Archives Washington DC.

⁵⁶¹ I L Buxton, *Big Gun Monitors* (Tynemouth: Trident, 1978).

⁵⁶² M D Karau, *The Naval Flank of the Western Front, The German MarineKorps Flanders 1914-1918*.

depths below the surface to destroy submerged U Boats.⁵⁶³ The Admiralty received intelligence that U Boats were still passing the Barrage at night on the surface, although Bacon claimed that it was working. A dispute occurred between Bacon and Admiral Keyes, head of the Plans Division at the Admiralty, concerning the illumination and patrolling of the Barrage at night.⁵⁶⁴ Keyes wanted the Barrage to be illuminated fully and patrolled to compel U Boats to dive into the deep minefield. Admiral Jellicoe ordered Bacon to comply, but he was dilatory in doing so. On the night of 19 December, magnesium flares fired from patrol ships and powerful searchlights mounted ashore, illuminated the Straits and forced UB56 to dive into the minefield where she was destroyed.⁵⁶⁵ On 1 January 1918, Keyes replaced Bacon in command, and he continued to extend the Barrage so by August 1918, ten thousand mines were laid. A controlled minefield was laid at the British end, whereby an electric cable laid in loops on the seabed could detect a steel vessel passing over by changes to the magnetic field. The operator ashore could tell the location and detonate a mine or mines nearest to its location.⁵⁶⁶

Flare and patrol vessels operated two and a half miles either side of the Barrage. Destroyers with searchlights, P-boats, and paddle minesweepers, alternated with trawlers firing flares. Patrol ships also used hydrophones to detect approaching U Boats. Unlighted drifters patrolled directly over the minefield and would fire flares when a U Boat was heard or sighted. Although some U Boats continued to cross the Barrage, some captains considered it too dangerous. German destroyers from the Flanders command raided the Barrage on the night of 14/15 February sinking patrol ships, but these were replaced quickly.⁵⁶⁷ There were probably eight U Boats lost in the new minefields.⁵⁶⁸ By February 1918 the U Boats of the High Seas Fleet based in Germany, were ordered to travel around Scotland to reach their patrol areas in the south-eastern and north-eastern approaches, confirming that the layered defence system of the Dover Barrage was working.⁵⁶⁹ This longer transit time reduced the duration of their patrols. The Flanders based UB and UC boats continued to use the route but minelaying by UC Boats in the Channel was curtailed greatly. In September the losses and the reports of captains, led to them also being ordered not to use the route after September.

⁵⁶³ J S Cowie, *Mines, Minelayers and Minelaying*, pp 78-79.

⁵⁶⁴ A J Marder, *From Dreadnought to Scapa Flow*, Volume 4, p 347; Adm. R B Keyes, *The Naval Memoirs of Admiral of the Fleet Sir Roger Keyes*, Volume 2.

⁵⁶⁵ R M Grant, *U-Boat Intelligence*, [1969] (Penzance: Periscope, 2002), p 79.

⁵⁶⁶ *Ibid*, p 90

⁵⁶⁷ H Newbolt, *Naval Operations*, Vol. 5, pp 210-220.

⁵⁶⁸ R M Grant, *U-Boat Intelligence*, pp 77-97.

⁵⁶⁹ *Ibid*, p 97.

British submarines were integrated with the Dover Barrage deep minefields. During the summer months, and subsequently, C and E Class submarines were employed on night patrols north of the Dover Net Barrage. On 1 November 1917, E.52 patrolling near a buoy used frequently as a navigation mark by both sides, torpedoed UC63 which was on passage.⁵⁷⁰

In the early months of 1917 opinion was against the use of submarines against U Boats in the English Channel. It was considered that the amount of traffic, escorted and unescorted, and the restricted area, would lead to numerous false reports. Royal Navy submarines would run great risks of attack by patrol craft and armed merchant ships. In May, encouraged by the success in the North Sea, patrols were established in mid-Channel areas. On 3 November 1917, C.15 on patrol in the Eastern Channel, succeeded in torpedoing UC65 while on passage.⁵⁷¹ Between January and August 1918, patrols were maintained between the Dungeness to Dieppe line and 3° West. Dolphin's flotilla being reinforced by Ambrose's flotilla, increased during the summer to eight L Class. On 12 May 1918, D.4 torpedoed and sank UB72 whilst operating South of Portland.⁵⁷²

On 23 April 1918 a major raid was made on Zeebrugge to block the exit of the canal from Bruges.⁵⁷³ It was also multi-layered with marines landed on the mole, a submarine rammed and exploded under the mole's connecting viaduct, three old cruisers used as blockships, and supporting escorts and smoke screen. The raid failed to block the canal but was considered a morale boost for the public following the German advances on the Western Front the month before. A follow-up blocking attempt at Ostend also failed.⁵⁷⁴

Changes in the Admiralty and Control of Anti-U Boat Warfare

In July 1917 the Prime Minister Lloyd George appointed, the more forceful Sir Eric Geddes, the Controller, to replace Edward Carson as First Lord.⁵⁷⁵ The Admiralty War Staff was re-organised, including Vice Admiral H. F. Oliver, the long-serving Chief of the Admiralty War Staff appointed Deputy Chief of the Naval Staff, and Admiral Duff appointed Assistant Chief

⁵⁷⁰ 'Report of Proceedings E.52, 1 Nov. 1917', Commodore (S) War Records, Vol. XI, ADM 137/2077, TNA. f166; 'Report of Interrogation of a Survivor UC63', ADM 137/3875, TNA, ff 290-305.

⁵⁷¹ 'Report of Proceedings C.15, 3 Nov. 1917', Commodore (S) War Records, Vol. X, ADM 137/2076, TNA, f 15; 'Interrogation of Survivors UC65', ADM 137/3875, TNA, ff 306-325.

⁵⁷² 'Report of Proceedings D.4, 12 May 1918', Commodore (S) War Records, Vol. X, ADM 137/2076, TNA, ff 692-695.

⁵⁷³ P Kendall, *The Zeebrugge Raid 1918* (Gloucestershire: Speltnmount, 2008).

⁵⁷⁴ 'Report of Zeebrugge and Ostend Operations', ADM 137/3894, TNA.

⁵⁷⁵ A J Marder, *From the Dreadnought to Scapa Flow, Volume 4*, pp 213-224.

of the Naval Staff. Vice Admiral Rosslyn Wemyss replaced Burney as Second Sea Lord, and Sir Oswyn Murray replaced Sir Graham Green as Permanent Secretary. Further re-organisation occurred with the Second Sea Lord becoming Deputy First Sea Lord, taking over further responsibilities. These changes, particularly the appointments, growth and re-organisation of the Naval Staff, provided the opportunities for re-invigoration of naval policies and plans. Lloyd George had been unhappy with Admiral Jellicoe as First Sea Lord due probably to his pessimistic outlook and his perceived reluctance to implement convoys, so on 26 December 1917 Jellicoe was dismissed and replaced by Wemyss,

The Admiralty remained in overall control of submarine operations. The Naval Intelligence Department, located within the Admiralty building, had the best information on the changing pattern of U Boat operations and plotted the latest position of U Boats and convoys. For day-to-day operations off Ireland and English Channel, the submarine flotillas were under the command of the local Commander-in-Chief. To achieve the greatest efficiency and take full advantage of the element of surprise, great flexibility of patrols was necessary. Experience showed that more submarine patrol-days were obtained from a given number of submarines when independent patrols were maintained, with each submarine proceeding on patrol as soon as ready. Good co-ordination between the surface patrols and the submarine patrols of any area was essential, to avoid mutual interference and unnecessary risks to the submarines, and both were represented on the staff of the area command.⁵⁷⁶ In 1918 many new and improved submarines with trained crews were being commissioned, enabling the rapid re-distribution of submarine flotillas to meet the changing locations of German U Boat operations.⁵⁷⁷ These submarines provided a valuable layer that was integrated immediately into the local layered defence system. An important factor in enabling such re-distribution quickly and efficiently was the use of depot ships. These carried stores, additional torpedoes, maintenance facilities etc, and provided crew accommodation for submarines returning from patrol.

The anti-U Boat Aviation Layer

By early 1918, land-based aviation was a developing layer in anti-U Boat warfare, being capable of integration with surface warships. Aircraft typically patrolled out to twenty miles off the coast and provide escorts to convoys. Subject to good visibility, aircraft could sight

⁵⁷⁶ 'Technical History & Index, Submarine v Submarine, TH1', ADM 275/19, TNA.

⁵⁷⁷ 'Submarine Service, Monthly Reports, February to October 1918', RG38 Box 413, National Archives Washington DC.

surfaced U Boats and attack quickly with bombs and depth charges. Seaplanes were used for patrolling further off the coast and worked with surface anti-U Boat surface warships. Patrol patterns were developed, for example the shape of a spider's web, to maximise the probability of sighting a U Boat. British airships were employed principally in escort duties and in searching in advance of a convoy to enable it to be diverted clear of a U Boat position, and also to search for sea mines. Airships had the benefit of being able to hover during an attack but were more prone to adverse weather. Kite balloons towed by suitable surface warships and connected by a telephone wire, were used for sighting surfaced U Boats beyond the visual range at the surface. Kite balloons were used in escorted convoys and by anti-U Boat hunting groups. They were used also in ocean convoys that were beyond the range of aircraft, seaplanes, and airships.⁵⁷⁸

Aircraft, seaplanes, and airships became more effective when they were fitted with wireless telegraphy. Their positions could be obtained by land-based direction finding, compared to U Boat positions, and then vectored into an attack or co-operate with surface warships. This provided a new offensive-type layer. They also provided a defensive-type layer by forcing U Boats to submerge where they were less of a threat to merchant ships. By the Armistice, shore airfields were being constructed and the requisite supporting organisations were being implemented to provide aviation coverage around the coasts.⁵⁷⁹

Land-based aircraft were used to attack with bombs the U Boat bases at Brugge, Zeebrugge and Ostend. Germany built reinforced concrete U Boat shelters at Brugge for protection and allow maintenance activities to continue. This offensive layer was integrated by shore bombardment by heavy-gunned monitors.

Chapter Conclusions

On 23 October 1918, all U Boats were recalled from the Atlantic to concentrate for the planned final sortie of the High Seas Fleet, but the mutinies of many of the crews of the German surface warships led to the cancellation of this sortie.⁵⁸⁰ The Armistice terms imposed by the Allies included the surrender of all U Boats.⁵⁸¹ Starting on 19 November 1918, in total 176 U Boats were surrendered. Some were allocated to Allies, but most were quickly broken up. British submarines were a crucial element in the anti-U Boat campaign. The establishment of an anti-

⁵⁷⁸ 'Review of aircraft and ant-submarine campaign 1918', Lecture by LtCol. Strain, 1918, AIR 1/726/137/4, TNA.

⁵⁷⁹ 'Anti-Submarine Patrolling', RAF Staff College lecture, September 1922, AIR 1/2385/228/1, TNA.

⁵⁸⁰ R Scheer, *Germany's High Sea Fleet in the World War*.

⁵⁸¹ A J Marder, *From the Dreadnought to Scapa Flow*, Volume 5, pp 258-262.

U Boat layered system, using patrolling surface warships, relied on the integration of submarines at several locations. This had not been anticipated prewar, but it was a logical evolution of anti-U Boat layered system modified to the new, developing threats and challenges.

After the war, the perception was that the Admiralty had been forced to implement convoys, and many people including the Prime Minister Lloyd George erroneously claimed the credit of being responsible for them!⁵⁸² Post-war there were also accusations that Sir Henry Newbolt the author of the official history of this period had been under pressure by senior wartime Admiralty personnel to show them in a better light. This is not so, and he produced a balanced history of events.⁵⁸³ Some historians, contemporary politicians, and the public, believe that the implementation of convoys was the whole solution to defeating the U Boats and stopping the critical loss of merchant ships, but the convoys were only one layer in an integrated system. The success was due also to the timely availability of destroyers and other anti-U Boat convoy escort vessels and the invention of the depth charge triggered by hydrostatic fuses. Throughout the war Jellicoe and Beatty as Commander-in-Chief Grand Fleet, complained that there were never sufficient destroyers safely to escort the battle squadron and to deliver torpedo attacks against the enemy should there be a fleet action. All the local and overseas commands were always requesting more destroyers. Pre-war the need for specialist escort vessels was not identified and it was well into 1917 before these became available in sufficient numbers, armed with depth charges.⁵⁸⁴ The success of convoys was due also to the German Navy's failure to change U Boat operating tactics to deal with them. In April 1917, there had been a proposal that the former *U-Deutschland* equipped with the latest wireless telegraphy equipment, be positioned in the convoy routes to co-ordinate attacks by nearby U Boats.⁵⁸⁵ This was not done and would have been a forerunner to the successful Wolf Pack tactics used by U Boats against convoys in the Second World War.

British decision making was also more efficient and effective. The small War Cabinet, with immediate advice from experts and Maurice Hankey, the skilled Secretary, was far superior to the archaic German system involving the Kaiser, Chancellor and an inept Foreign Secretary,

⁵⁸² Adm. J R Jellicoe, *The Crisis of the Naval War*.

⁵⁸³ M S Seligmann, 'Sir Henry Newbolt, the Naval Staff, and the Writing of the Official History of the Origins and Inauguration of Convoy in 1917', *The Journal of Military History*, January 2023, Vol.87, pp 125-144.

⁵⁸⁴ F J Dittmar & J J Colledge, *British Warships 1914-1919*; N Friedman, *Fighting the Great War at Sea, Strategy, Tactics and Technology*, (Barnsley: Seaforth, 2014).

⁵⁸⁵ D R Messimer, *Find and Destroy, Antisubmarine Warfare in World War 1*.

Army Supreme Command and differing Navy departments. The British Admiralty had also developed in 1915 and 1916 with more staff-based planning to develop policy and priorities. Decision making had improved enormously with the code-breaking activities of Room 40 being combined with other intelligence and being available for the operations department. This multi-layered organisation enabled the creation of a situation map showing the positions of convoys, escort vessels and suspected U Boats, became a major factor in defeating the U Boat campaign.

The British Army's 1917 summer campaign was in Flanders aimed from the Ypres salient towards the Belgium coast, to capture Bruges, Zeebrugge and Ostend.⁵⁸⁶ A supporting landing was planned on a three-mile front along the defended coast between Nieuport and Ostend and known as the "Great Landing". Three enormous pontoons were built in Chatham dockyard, each 550-feet long and capable of carrying three tanks, a brigade of infantry and supporting artillery.⁵⁸⁷ These would be pushed onto the beach by two monitors moored to their seaward end and trials took place. In the prolonged battle, that became known as Passchendaele, the Army failed to break through the German lines, and the landing was cancelled. The landing would have used many integrated layers including escorting warships and air cover. This combined operation consisted of many integrated layers including a full Army Division, tank support, an amphibious landing, and air support. Such a strategic-level operation is far in advance of the popular decision-making perception of the British high command.

By the end of the war, Germany was having difficulties commissioning new U Boats to replace losses and continue their unrestricted campaign. There were severe shortages of material and shipyard labour for new building, and there was a shortage of experienced personnel to train new U Boat crews. By comparison, the Royal Navy was commissioning numerous surface anti-U boat warships with trained crews. The L Class was an enhanced patrol submarine and the R Class showed promise as a specific U Boat hunter. Hydrophone technology was improving rapidly and been installed in a very large number of surface warships and submarines. These were all integrated into layered systems to suit different requirements, including convoy escorting, attacking U Boats in transit, countering U Boat

⁵⁸⁶ A J Marder, *From Dreadnought to Scapa Flow*, Volume 4, pp 204-205; L MacDonald, *They Called it Passchendaele* (London: Penguin, 1993), p 65.

⁵⁸⁷ B Friend, 'Landing Craft Through the Ages Part 2 Details of the pontoons', *Warship*, Vol.46, pp 32-47.

minelaying operations, and the enhancing the effectiveness of the Northern and Dover Barrages.

Chapter 6: Submarines and Layered Defence – Analysis and Conclusions

As this dissertation has shown, the current literature on British submarines from their inception to the conclusion of the First World War is flawed and needs to be replaced. There are several reasons for this. Two are key. First the existing works on British submarines during the First World War focus almost entirely on technical developments and/or famous engagements; they say next to nothing about the policy behind this. By contrast, the historiography on British submarines prior to the outbreak of war in 1914 is dominated entirely by policy, but, unfortunately, the policy at its heart is a policy that never existed. Worse, in advancing this mythical 'flotilla defence' policy, the historians behind it demonstrate a fundamental misunderstanding of both the technical details of British submarine development and of the intentions of the people behind it. This dissertation corrects both problems, thereby offering a completely new understanding of British submarine policy that links the pre-war era with wartime operations.

During researching for this dissertation, no evidence was found for the existence of any flotilla defence policy, before or during the war, and that the argument that this was Admiral Fisher's secret plan is false. In the 1890s, the Admiralty realised that their plans to blockade French naval bases would be threatened. Bombarding battleships were slow moving and they needed to be close to their targets due their limited gunnery range and were thus vulnerable to the large number of French torpedo boats and the growing capabilities of unseen submarines. The primary reason for the Admiralty acquiring submarines in 1901 was to develop an anti-submarine capability, and early trial appeared to show that submarines could be effective in torpedoing slow-moving battleships off a naval base, albeit the conditions were unrealistic due the risks of accidental ramming. Admiral Fisher was enthusiastic about submarines and encouraged their incremental designs. However, he focused on building progressive more powerful battleships and a limited number of battle cruisers, at the expense of building the large number of torpedo armed destroyers, support depot ships and the infrastructure of East Coast naval bases that would have been essential to any secret flotilla defence plan.

This dissertation rejects both the Orthodox and the Revisionist historians' portraits of Admiral Fisher making all decisions single-handedly, and his so-called Revolution. Fisher was autocratic when pushing through reforms, and on occasions, vindictive. However, from 1904 to his retirement in 1910, Fisher created an environment in which talented, progressive, like-minded colleagues within the Royal Navy and civilian experts, were able to re-organise the navy, develop warship and equipment designs, war plans and overall strategy. Fisher

managed and encouraged their activities and overcame opposition and bureaucracy that hindered their implementation. In October 1914, Fisher was reappointed as First Sea Lord, and his first action was to order and organise the building of more overseas submarines. On other issues, it was evident that he had lost the drive he showed during his first appointment. By his own admission, he was reluctant to oppose Churchill's schemes, leading to his infamous resignation in May 1915. Fisher was appointed subsequently as Chairman of the Board of Innovation and Research, that was responsible for soliciting expert scientific assistance to solve tactical and technical problems. Again, he managed and encouraged many experts in the development of a wide range of technologies. In addition to his personal knowledge and attributes, Fisher was a successful man-manager.

This dissertation has shown that before and during the war, the Admiralty organisation expanded greatly and was modified and improved to meet the quickly changing situations. The Admiralty was quick to learn from experience and use the latest technology to modernise and enhance their modules-of-force, modifying their roles to meet changing situations. Significant examples include the obsolete armoured cruisers within the Grand Fleet being replaced by fast light cruisers, more capable for scouting duties. Destroyers, used in U Boat hunting groups were re-deployed as essential convoy escorts. When Admiral Beatty planned to avoid a pointless fleet action, the Admiralty concurred with his reasons and decision. Working with other Government departments, the economic blockade was modified and improved to become an effective war-winning operation. The Admiralty managed the development and implementation of new technologies, one of the many examples being the hydrophone for the detection of submerged U Boats. Throughout the war there were many new ships commissioned requiring the training of their officers and crews, many of them hostilities-only. They had to master how to use new weapons and equipment plus obtaining experience of new tactics. It is evidence that the Royal Navy and Admiralty was a progressive, learning-organisation to achieve such war winning capabilities.

The size and endurance of submarines increased with each successive class but there were no means of detection while submerged and no effective anti-submarine weapon. The early submarines, namely Holland, A, B and C Classes were considered as coastal types, whereas the larger and more capable D and E classes were designed to operate off the German North Sea naval bases, referred to as overseas types. Both types were evaluated during different scenarios in the 1912 and 1913 North Sea naval manoeuvres. These showed that the coastal

types were largely ineffective against an amphibious landing, while the overseas types had to be pre-located in the optimum positions to fire torpedoes at an enemy force at sea.

Following the 1914 German bombardments of East Coast ports there was widespread disquiet amongst the civilian population and in the press that the Royal Navy had failed to prevent these. The Grand Fleet was too far north in Scapa Flow and Rosyth to intercept these and the Harwich Force too weak. The Grand Fleet was kept in Scapa Flow being essential to protect the Armed Merchant Cruisers of the northern economic blockading force, plus there were no suitable naval bases on the East Coast. During the war, including while Admiral Fisher was recalled as First Sea Lord, submarines were nominally deployed in East Coast ports for anti-bombardment role and coastal defence against potential German military raids. Their deployments were therefore more for political reasons and a deterrent force, although the Admiralty was aware of these submarines' limitations. These C Class submarines deployed in East Coast ports later had a useful role in anti-U Boat warfare and also in training personnel to man the new submarines being completed.

Around the British coasts, littoral areas were designated for local patrols by surface warships, that were based in a nearby merchant port and with supporting depot ships. The surface warships deployed were often weak, obsolete torpedo-boat-destroyers, and could offer no defence other than provide early warning if German forces were sighted. These patrol areas were augmented by large numbers of minesweepers and anti-U Boat vessels. Later in the war, pre-dreadnought battleships unwanted within the Grand Fleet were deployed to the Nore to protect the Thames estuary and counter a potential German raid into the Channel, however these obsolete warships were de-commissioned to free their crews to man the increasing number of the more important anti-U Boat vessels. Such surface patrol forces were never intended to provide any form of flotilla defence and would have been incapable of doing so.

Evaluation and Effectiveness of Submarine Operations during the First World War

Submarine operations in the North Sea and off the Scandinavian coasts have been treated poorly by naval historians. Their successes in sinking warships and U Boats are limited compared with the number of patrols undertaken throughout the war. This ignores the fact that German surface warships seldom proceeded far into the North Sea. Compared to the unrestricted U Boat campaign, British submarines were obliged to maintain international law in attacking merchant ships whereby the safety of their crews and passengers had to be ensured. British submarines were prevented from attacking or stopping all merchant ships that were inside the territorial waters of neutral countries. This apparent lack of sinking enemy

vessels is not a true reflection of their value in the naval war. Research for this dissertation has revealed the versatile roles and emphasized the real importance of submarine layers in the various naval offensive and defensive systems. From the very beginning of the war, British submarines began a close observational blockade of the German North Sea naval bases. Submarines were the only type of vessel that could undertake this role becoming the outermost and foremost layer in the layered defence systems. Although wireless telegraphy analysis and direction finding provided intelligence of German sorties, submarines could provide direct observations regarding which warships were at sea with their course and speed, to enable the Grand Fleet to intercept. The cruisers and destroyers that otherwise would have been needed to provide an observational blockades or patrols were thus freed to be integrated into the Grand Fleet and Harwich Force where their capabilities were put to better use for example when deployed as valuable convoy escorts. Submarines provided a timely “enabling technology” allowing these surface warships to fulfil further important layers in offensive and defensive systems. Submarines off the German naval bases constrained the ability of the High Seas Fleet to go on exercises and trial in the Heligoland Bight where they would be targets for torpedo attack. This vital deterrent layer was recognised by the German navy. Submarines were the only vessels capable of stealth reconnaissance off the Scandinavian coasts, searching for possible secret German bases and observing merchant ships potentially trading with Germany. This was an important layer in gathering and analysing naval intelligence.

The serious threat of the unrestricted U Boat campaign necessitated submarines being used in anti-U Boat roles. The existing patrol submarines were less suitable for this until the installation of a suitable gun on L Class patrol submarines. The designing and commissioning of R Class submarines with high submerged speed, with the capability of firing a salvo of torpedoes increased greatly their capabilities. Although it was difficult for a submarine to sink the small target a U Boat presented, their presence or suspected presence, forced the U Boat to proceed submerged thus curtailing its ability to get to its war station or find targets. Submarines, often integrated with surface warships, therefore became an important layer in anti-U Boat warfare. The minelaying submarines laid their mines in locations too dangerous for surface minelayers. Their stealth ability allowed mines to be laid unknown by the German navy in recently swept routes. U Boats and minesweepers were lost in these minefields, and the closure of such routes until re-swept, caused disruption to U Boat operations. The continuous minelaying also absorbed a large resource of German minesweepers and personnel. As the Heligoland Bight minefields were extended further from the coast, the

vulnerable minesweepers needed the protection of heavy warships and resources from the High Seas Fleet. This minelaying layer was crucial in anti-U Boat warfare.

By mid-war, patrol submarines were integrated with the Grand Fleet whereby in a fleet action they would proceed to positions to intercept that High Seas Fleet retreating to its bases. The commissioning of fleet submarines integrated fully into the Grand Fleet, provided the opportunity for them to proceed to the disengaged side of the High Seas Fleet to deliver a massed torpedo attack. Although the opportunity did not occur, this was a potentially very valuable, innovative layer. The so-called monitor submarine with a large calibre gun, of which only one was completed, was not used in operations on the pretext that the German navy might develop the same capability. The potential to fire shells into a German navy base or at close range the Bruges canal lock gates at Zeebrugge, would have been an innovative layer in the naval warfare.

Command and control of submarine operations was tailored to facilitate layered defence operations. In broad terms, the Admiralty exercised strategic control whereas the senior Admiral present exercised tactical control. The Admiralty maintained strategic control of the disposition of submarine flotillas and the class and number of submarines in each flotilla. In 1914 the Admiralty exercised direct control of the overseas submarine in the 8TH submarine flotilla. As the war progressed and more flotillas were formed, the local Admiral, for example Admiral Bayly at Queenstown exercised tactical control over the submarine flotillas in the south-west approaches.

The Armistice compelled German to surrender all surviving U Boats to Britain. These proceeded in batches to Harwich, taken over by Royal Navy crews, and the German crews returned immediately in accompanying merchant ships.⁵⁸⁸ Some U Boats were handed over to Allied navies for trials and evaluation. In general, the Royal Navy concluded that British submarines were superior in seakeeping and in quality of construction. The German U Boats had better diesel engines and more reliable torpedoes that could be fired with a gyro setting. Following the trials, no U Boats were commissioned permanently into Royal Navy service, with the majority quickly broken up.

This dissertation has identified that British submarines were more versatile than had been anticipated pre-war, and much more versatile than being credited by contemporary historians. The research for this dissertation concentrated on Royal Navy submarine operations that were

⁵⁸⁸ 'Handing Over of German Submarines', ADM 116/1827, TNA.

based in the British Isles, namely the North Sea and Heligoland Bight, off the coasts of Norway, Denmark, Sweden and Netherlands, in the south-western and north-western approaches of the Atlantic, and the English Channel. Central to the dissertation, the North Sea operations provides the clearest and most extensive examples of the different modules-of-force being integrated into layered defence systems. British submarines were involved in other campaigns including the Dardanelles, in the Aegean and in the Baltic. In the Dardanelles, the Allied surface warships failed to destroy sufficient Turkish forts and guns and were this unable to penetrate the Dardanelles, whereas submarines, albeit with heavy losses penetrated to the Sea of Marmara. There their exploits became famous in intercepting and delaying Turkish reinforcements and re-supply of their army on the Gallipoli peninsula. Operating alone and with limited naval intelligence support, they were the forward module-of-force in the Gallipoli campaign. The relatively few submarines exerted an enormous effect on the land fighting, not achieved in any other theatre during the war. The submarine patrols and their successes have been researched, but there is scope for further research to quantify the disruption caused to the Turkish Army.

Within the Mediterranean, British submarines operated in the Aegean and its entrance, the Straits of Otranto. The first submarines were five obsolete B Class that were based in Venice patrolled off the principal Austro-Hungarian naval base of Pula. Later H Class submarines operated from Italian east coast bases, patrolled off the coast of Austrian controlled Yugoslavia. They were the forward module-of-force of the combined Italian, French and British surface warships against sweeps in the Aegean by the Austro-Hungarian surface warships. British submarines patrolled also off the major German U Boat base at Cattaro, now called Kotar, in Montenegro. British submarines integrated with surface warships patrolled the Straits of Otranto, where an anti-U Boat barrage of nets and minefields was established, comparable to the Straits of Dover barrage. To date, submarine operations in the Aegean have not been researched fully.

There is an opportunity for further research on British submarines operating in the Baltic. It is noted earlier that the Russian navy deployed these into their defence of the Gulf of Finland protecting St Petersburg, in some of the minelaying operations in the southern Baltic, and in the defence of the Gulf of Riga, However, if there are surviving Russian plans, these might be difficult to access. The integration of these submarines with Russian units-of-force has similarities to North Sea operations. British submarines operated successfully in 1915 against the ore trade from Sweden to Germany, in sinking merchant ships and in trade disruption by

forcing them to stay within Swedish territorial waters. These successes were not repeated due largely to diplomatic pressures, including Swedish reaction to the British economic blockade, Russian dependence on Sweden to transport Allied supplies, and Swedish support needed to allow British merchant ships to escape from the Baltic. Research of surviving German records could reveal the effect on their armaments industry, and the German naval resources needed for their trade protection.

Evolution and Progression of Layer Defence Systems

At the end of the nineteenth and early twentieth centuries, naval battles would have been two lines of battleships and armoured vessels firing at each other at relatively short range, with the battle continuing until ships were sunk or were damaged sufficiently to be incapable of continuing. This occurred in the Battle of Yalu River during the 1894-95 Sino-Japanese war, and in the Battle of Tsushima during the 1904-05 Russo-Japanese war.⁵⁸⁹ The daylight stage of the 1905 Battle of Tsushima was fought between Russian and Japanese battleships with the sinking of Russian warships. Some battleships were damaged so badly, and their crew incapacitated, that they were forced to surrender. During the night action Japanese destroyers and torpedo boats were able to get close to the remaining damaged and disorganised Russian ships to deliver torpedo attacks. Both sides had developed effective mines, and their defensive minefields were responsible for the loss of battleships and cruisers.⁵⁹⁰

Between the Russo-Japanese war and the start of the First World War, there were very many technological developments in warship designs, gunnery range and control, other weapon systems, propulsion machinery, communications and in training on-board and shore-based personnel to use these effectively. There was clear delineation between the capabilities of different warship types, including battleships, battle cruisers, armoured and light cruisers, and destroyers.⁵⁹¹ Submarines progressed from limited port protection to being capable of overseas patrols off the enemy's coast. Aviation and mine warfare developed rapidly during the war. There was also a proliferation of anti-U Boat vessels. This dissertation has revealed that the Admiralty was quick to identify defensive and offensive requirements and to create balanced forces to fulfil these different missions. The dispositions of these forces were in discrete defensive layers, that were combined effectively and flexibly to provide the optimum

⁵⁸⁹ J S Corbett, *Maritime Operations in the Russo-Japanese War 1904-1905*, Two volumes [1914] (Annapolis: NIP, 1994).

⁵⁹⁰ D K Brown, *Warrior to Dreadnought, Warship Development 1860-1905*, (London: Chatham, 2003).

⁵⁹¹ D K Brown, *The Grand Fleet, Warship Design and Development 1906-1922*.

solution for each situation. The Admiralty adopted dispositions of forces and warships, enhancing existing and creating new layers to meet the changing wartime requirements and in response to German actions. The Admiralty responded to the unforeseen, serious threat of the 1917 unrestricted U Boat campaign against British, Allied, and neutral merchant ships, by implementing customised layered defence systems. The backstop enabling all other layers to function was the Grand Fleet, based initially in Scapa Flow, consisting of dreadnought-type battleships to form the long-range line of battle. They had initially a screen of armoured cruisers to report the composition, position, course, and speed of the enemy prior to a battle. Destroyer flotillas provided anti-U Boat protection for the fleet, and once battle commenced, to protect against a torpedo attack while delivering such an attack against the enemy's heavy warships. The Battle Cruiser Force / Fleet layer provided high speed reconnaissance with their light cruisers and supporting battle cruisers.

At the commencement of hostilities there were German Cruiser Squadrons and individual cruisers operating against British and Allied maritime trade, the largest of these forces being the East Asiatic Squadron. The Admiralty positioned cruisers and battle cruisers at critical locations to counter possible German moves.⁵⁹² As the various German threats were eliminated, the most powerful and useful warships were returned to home waters. The Harwich-based force layer was composed of fast, modern light cruisers and the latest destroyers that would endeavour to shadow any German force to facilitate a Grand Fleet interception. This was supported by the pre-dreadnought battleships of the Channel Fleet. The composition of these forces also reflected the timing of their integration. For example, a German military raid against the East Coast would be shadowed and reported by the Harwich Force to enable interception by the Grand Fleet. In August 1914, all overseas submarines capable of observational patrols in the Heligoland Bight were stationed in Harwich, and as more overseas submarines were commissioned, further flotillas were established in the Tees, at Blyth and at Dundee. The disposition of new warships was determined by the Admiralty on a basis of where they were needed and where they were most effective, for example, in 1917 the shortage of destroyers needed for anti-U Boat screening of the Grand Fleet battleships, had to be considered against the critical need for convoy escorts. As the war progressed, obsolete warships were de-commissioned, for example the Grand Fleet's superiority in battleships, allowed the Admiralty to detach the older dreadnought battleships to the Nore,

⁵⁹² G Bennett, *Coronel and the Falklands*, (London: Pan, 1962).

enabling the obsolete pre-dreadnought battleships to be paid off and their large crews being available to man the increasing number of anti-U Boat warships.

This dissertation has examined how thousands of moored contact mines laid were effective at sinking U Boats and surface warships, thus becoming an important layer. Offensive minefields on the Heligoland Bight also curtailed the potential exercises and sorties of the High Sea Fleet and delayed U Boat operations. The Dover Barrage, Belgium Barrage, Northern Barrage, when patrolled by surface warships and submarines were all important layers in defeating the U Boat campaign. Defensive minefield such as off the east coast, were defensive layers protecting the passage of merchant ships and convoys. The German navy spent enormous resources in mine sweeping, and the support of minesweepers became a major task of the heavy warships of the High Seas Fleet. The first influence sea mines laid in October 1918 and would have become a very powerful addition to these layers.

This dissertation has examined how the rapid technological wartime developments that strengthened all offensive and defensive layers. As this dissertation has shown, the Admiralty was quick to take implement the technology of Wireless Telegraphy. The interception of German wireless telegraphy signals was very important throughout the war, as the staff in the Admiralty Room 40 were able to break the German codes and learn of their intentions. Direction Finding of signals enabled the position of warships and U Boats to be determined within at worst a 50-mile tolerance. Tactical, often short-term, benefits were obtained in anti-U Boat warfare by plotting their Wireless Telegraphy transmissions, enabling counterattacks, and re-routing convoys. Code breaking and traffic analysis provided immediate warning of German plans, particularly sorties by the High Seas Fleet, enabling the Admiralty and Commanders-in-Chief to pre-dispose their layered forces to counter each threat. It should be mentioned however, that at Jutland the subsequent messages sent to Jellicoe were misleading. The successful anti-U Boat warfare was also highly dependent of technology developments, for example at the beginning of the First World War, everything relied upon visual sighting of the surfaced U Boat or of its periscope. Hydrophones were developed to detect the noise of a submerged U Boat, and then refined further to provide directional data. Weapons were initially ramming, mines and the ineffective towed explosive charge. Later depth charges were developed with hydrostatic fuses.

Research for this dissertation highlight that the different strands of naval intelligence were very important enabling component in all layer defence systems. Pre-1914 a principal source of

naval intelligence was from the Naval Attaché stationed in the British Embassy in Berlin.⁵⁹³ The Attaché had high-level contacts with senior German naval officers, contacts with attaches from other countries, and even occasional conversations with the Kaiser. Information was also obtained from British Consular officials, particularly those working in German ports. There were occasional spying activities and a few agents working within German organisations. Strategic benefits were obtained from captured documents and interrogation of prisoners of war, for example on German weapons developments and location of their defensive minefields. Beyond these at the diplomatic level, naval intelligence supplied the translation of the Zimmerman telegram, that was the final component to bring the United States into the war.⁵⁹⁴

The immediate pre-war senior officers' War Courses were important for layered defence. The War Course helped ensure that the senior officers, including squadron commanders, would react to potential situations in a consistent uniform manner. Strategic and tactical scenarios were examined during the courses and relevant results disseminated to the fleet. Ideas and political consequences were explored. These assisted the Admiralty in strategic issues and assisted the Command-in-Chief Grand Fleet in the preparation of Battle Orders. The War Course also made senior officers aware of new technologies and how they were applied operationally. The creation of the Staff Course also provided the Admirals with the specialist staff for efficient operations. Command and control of the Grand Fleet was difficult due to its size and poor communication systems available. During typical North Sea weather, it was difficult for the Commander-in-Chief to see everything when the fleet was deployed in a single line. At the Battle of Jutland, the poor visibility and the enormous volume of funnel smoke resulted in Admiral Jellicoe being unable to see much of his fleet let alone the position and course of the High Seas Fleet. It should be noted that for surface warships within sight of each other, tactical signals by lamp and flags were generally more efficient than coding and decoding messages sent by wireless telegraphy. War operations, and particularly failures as occurred at the battles of Dogger Bank and Jutland, highlighted the importance of clear, unambiguous tactical signals. Admiral Jellicoe issued printed instructions called "Grand Fleet Battle Orders" as to how the fleet would manoeuvre and engage the enemy in different circumstances. There was debate at the time and afterwards as to the independence squadron commanders had to take advantage of changing battle situations that were out-of-

⁵⁹³ M S Seligmann, *Spies in Uniform. British Military & Naval Intelligence on the Eve of the First World War* (Oxford: OUP, 2007).

⁵⁹⁴ P Beesly, *Room 40, British Naval Intelligence 1914-18*.

sight of the C-in-C. When Admiral Beatty became C-in-C these were shortened and referred to as Instructions to give guidance to the squadron commanders while adhering to the broad central command of the C-in-C. From 1917 these instructions included the roles that submarines had to follow in support of a fleet action.

All the layered defence systems depended on a very large and efficient infrastructure in providing ammunition, stores, and fuel, particularly for the Grand Fleet while based at Scapa Flow in the Orkney Islands far from the established naval bases and without a direct railway link. A further essential support organisation and infrastructure was established for warship maintenance, docking and refits and repairs, in the Cromarty Firth and later at the new naval base at Rosyth. Shipbuilding, and the priorities for different ship types, was also a vital layer. These were established and developed by the Admiralty to meet the changing strategic requirements.

The naval war was dominated by the British economic blockade of German trade, and the German unrestricted U Boat campaign against British and Allied trade. Both were questionable under existing International Laws. British policy was primarily to exert diplomatic pressure and use their control of coal supplies to obtain the co-operation of European neutral countries, whereas German policy was simply to use force. British on-going diplomatic relations with America was more subtle and responsive than the equivalent German diplomacy. Britain hurt the neutral countries financially, but Germany cost the lives of their mariners. The interactions of these respective policies led to Allied victory.

Post War Questions Committee

After the war, the Admiralty began an analysis of the experience of naval warfare and the roles and capabilities of different warship types. The Post War Questions Committee was established under the chairmanship of Vice Admiral R F Phillimore with experienced officers.⁵⁹⁵ The first three clauses of the Terms of Reference were:

1. To consider in the light of experience of the war, the military uses of and values of the different types of war vessels.
2. To report which types of vessels (including aircraft) should compose the principal Fleet on mobilisation for war, and in what proportion they should be provided, with the reasons for the necessity of each type. Regard should be had to the fact that considerations of construction and maintenance demand that the number of different

⁵⁹⁵ Papers of Adm. R F Phillimore, Documents 6515, Imperial War Museum.

types should be kept as small as possible, and the possibility of fitting ships for alternative purposes should be considered.

3. To consider and to advise as to the main naval requirements of each type, e.g. speed, endurance, armament, protection, displacement, special fittings, equipment, etc. giving reasons for each requirement . . . ⁵⁹⁶

All warship types were considered including Battleship, Battle Cruiser, Light Cruiser and Convoy Cruiser, Fleet Aircraft Carrier, Flotilla Leader and Destroyer, Submarine, and CMB and DCB Boats. Consideration was to be given to Armament, Machinery and Fuel. Based upon wartime experience and knowledge of technology developments, the committee recommended which types of warships and their capabilities were needed for the various defence layers in the post war era. Regarding Submarines, Rear Admiral S S Hall, the wartime Commodore (S), and experienced submarine commanding officers, gave evidence and were asked specific questions. As a result, the Committee recommended that sketch designs be prepared for: (1) A Submarine providing some of the qualities of the H and R designs, (2) An improved L class, (3) A Submarine minelayer, (4) An improved K Class, and (5) A Cruiser Submarine.⁵⁹⁷ These recommendations led first to the designing and building of diesel-electric powered cruiser-type submarines with enhanced endurance. During the 1930s, most were stationed in the Far East as a deterrent against Japanese aggression, to provide an offensive layer while awaiting the arrival of a British battle fleet. The S Class and the T Class patrol submarines were built, together with the smaller U Class and V Class submarines. Specialist submarines were also built capable of carrying and laying large numbers of mines. Throughout the Second World War, the submarines were deployed extensively in the North Sea, Arctic, Mediterranean, and Far East. Successful attacks were made on enemy surface warships and U Boats, and unlike the First World War, Royal Navy submarines attacked enemy merchant ships without warning. Further wartime technology and tactical developments also increased rapidly and were implemented successfully in offensive and defensive layers.

Nuclear powered submarines armed with intercontinental and cruise missiles provide further layers. A typical Battle Group is centred around a strike aircraft carrier or amphibious landing vessels. Aircraft and helicopters provide long-range attack capability armed with high-accuracy smart bombs and anti-ship missiles. Escorting warships are armed with anti-ship

⁵⁹⁶ 'Post War Q Committee Evidence', ADM 116/2060, TNA.

⁵⁹⁷ 'Final Report of the Post War Questions Committee', ADM 1/8586/70, TNA.

and anti-aircraft missile systems together with an array of electronic warfare systems. The latest drone technology is also being deployed. The ship types and weapons with different capabilities are integrate into effective layered defence systems.

In summary, this dissertation has established that layered defence and offence systems were implemented in all aspects of naval warfare in the First World War, with the ability of submarines to operate close observation blockade off German North Sea naval bases, enabling the other warship types to be freed from this task and employed in much more effective layers. Between the World Wars, there were progressive developments in warship designs, weapon systems, detection systems, and communications. The layered defence systems were also progressed to integrate these developments. Layered defence systems continue to be developed and are implemented today. The Royal Navy aircraft strike and amphibious warfare groups are now organised to fight in the manner that the Royal Navy wanted to fight in World War One; to use sea-power to project force where the enemy is vulnerable and use this superiority to make amphibious landings.

Appendix 1: Charts

Chart 1: German routes through the Heligoland Bight Minefields.

Naval Staff Monograph, Home Waters Part 9, May-July 1917, ADM 275/14, TNA.
Op. p32.

Chart 2: German Blockade Zone.

Naval Staff Monograph, Home Waters Part 8, Dec 1916-April 1917, ADM 275/13, TNA.
Op. p174.

Chart 3: Scandinavian Convoy Routes.

Naval Staff Monograph, Home Waters Part 8, Dec 1916-April 1917, ADM 275/13, TNA.
Op. p184.

Chart 4: Routes for British, Allied and neutral merchant ships proceeding independently.

Naval Staff Monograph, Home Waters Part 8, Dec 1916-April 1917, ADM 275/13, TNA.
Op. p174.

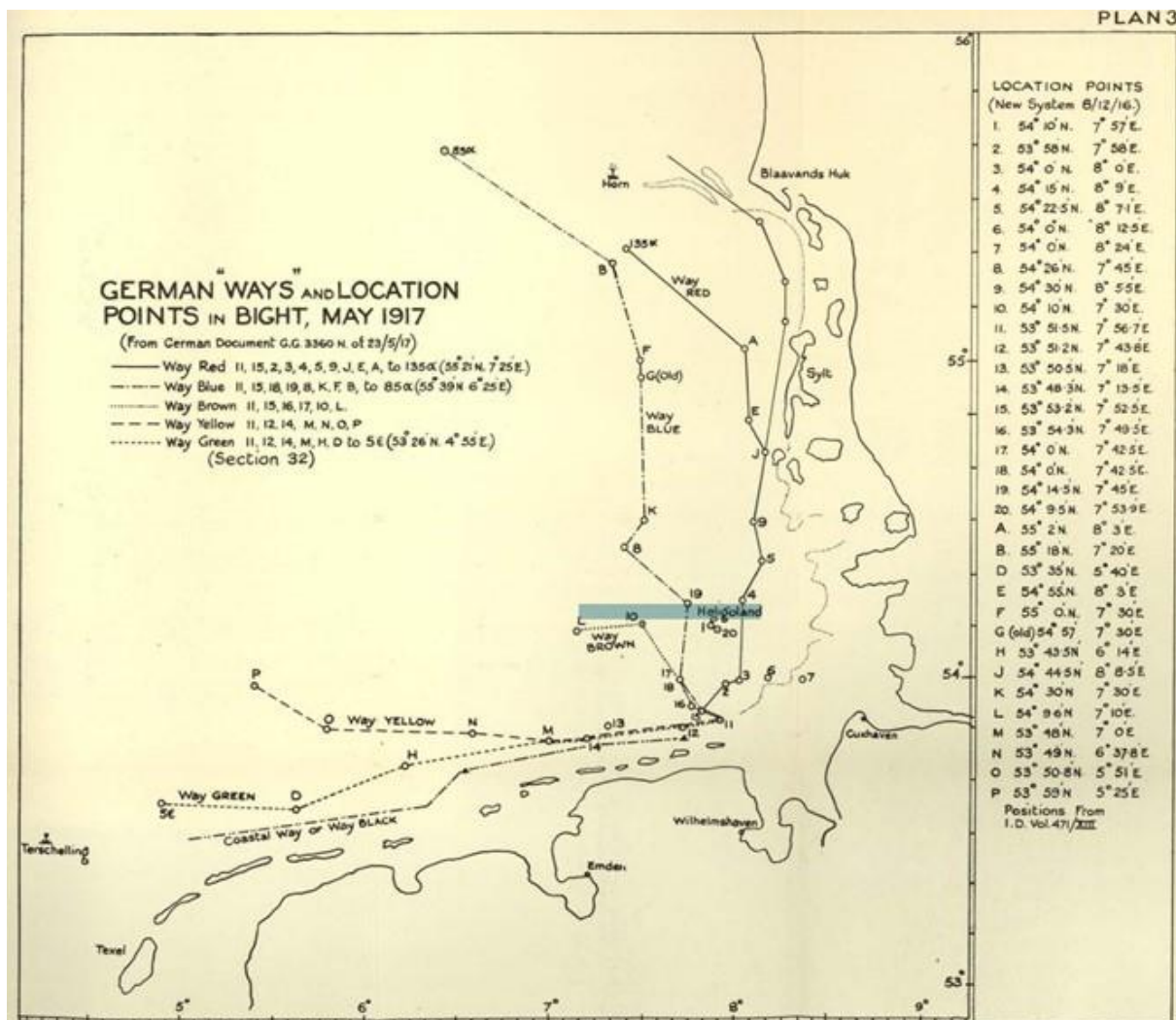
Chart 5: Submarine patrol areas in the North Sea and off the Scandinavian coasts.

Secret Pack of C-in-C Grand Fleet 1917-1918, Vol 46, ADM 137/1926, TNA, f 692.

Chart 6: British Submarine Patrol Areas during Operation BB against German U Boats.

Naval Staff Monograph, Home Waters Part 9, May-July 1917, ADM 275/14, TNA.
Appendix.

Chart 1: German routes through the Heligoland Bight Minefields

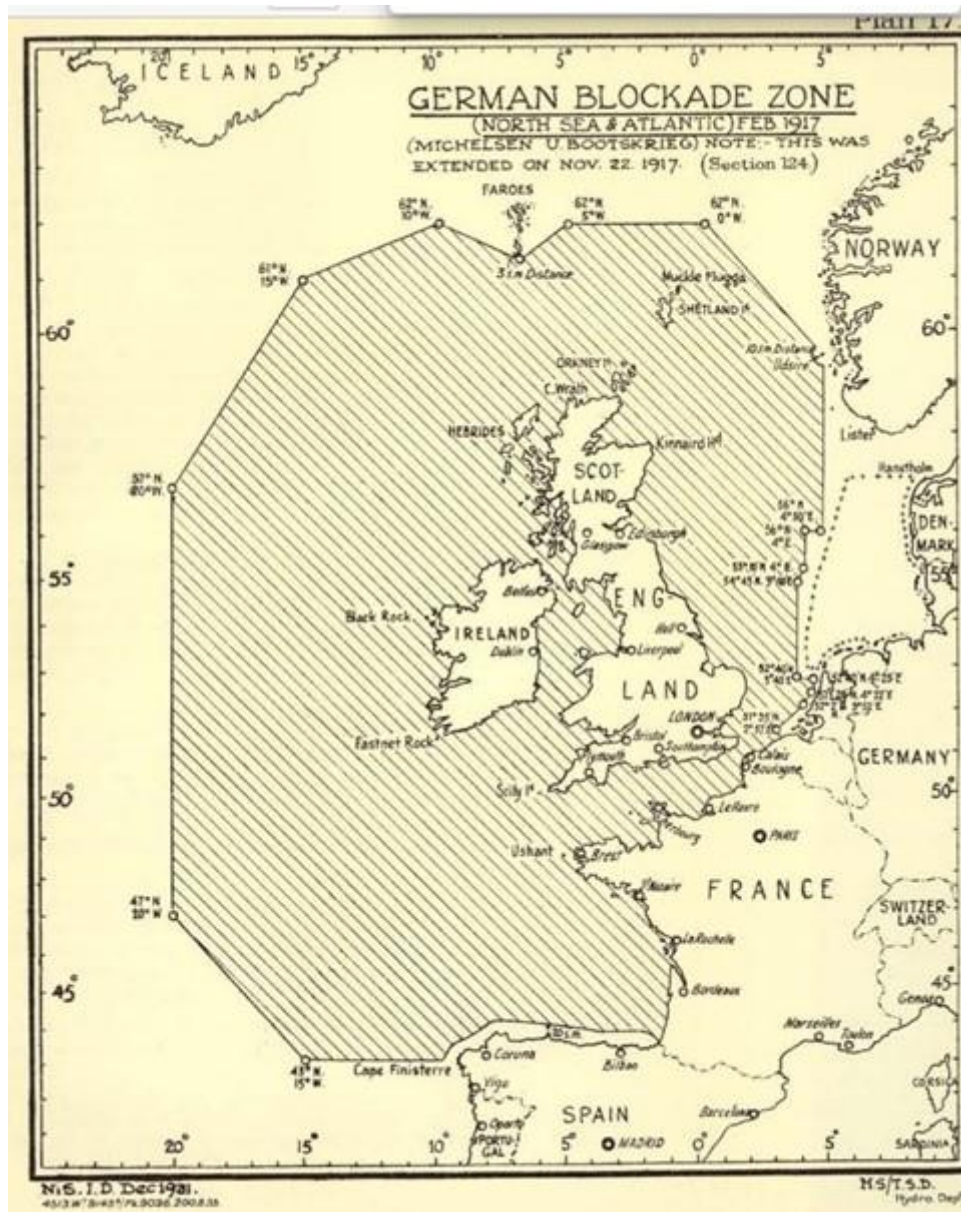


The German Navy regularly swept routes through the Heligoland Bight minefields. Buoys were laid to assist accurate navigation by departing and arriving U Boats and surface warships.

British Naval Intelligence was aware of these routes by wireless telegraphy interception and by direct observations of German minesweeping by British submarines. British minelaying submarines often laid new mines within the recently swept routes.

British layered defence systems contained the German High Seas Fleet within their North Sea naval bases. British submarines were an “enabling technology” that allowed the capabilities of the other warship types to be integrated into these systems.

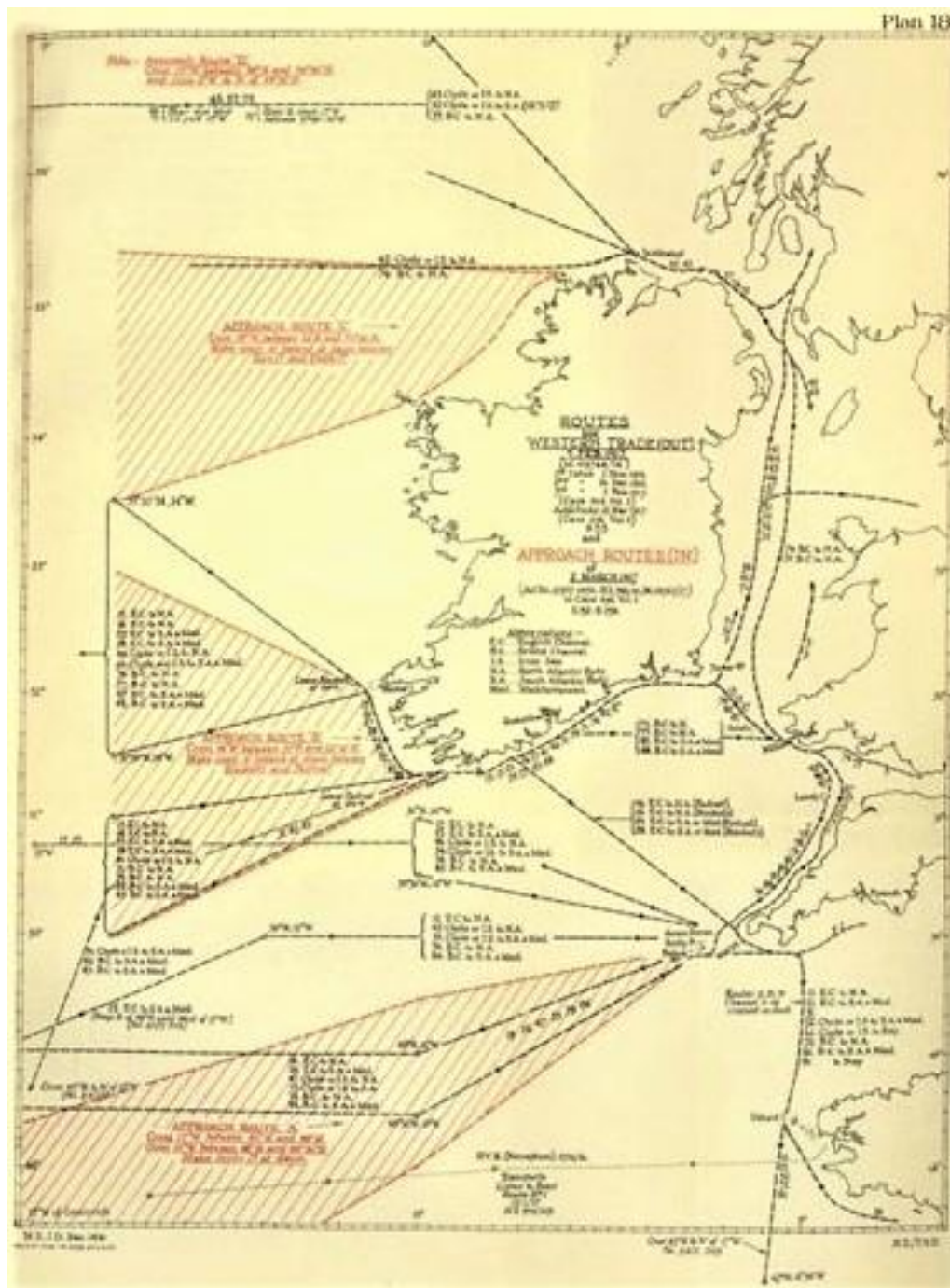
Chart 2: German Blockade Zone.



Issued in 1917, all British, Allied and neutral merchant ships were liable to be attacked and sunk without prior warning while in the German Blockade Zone.

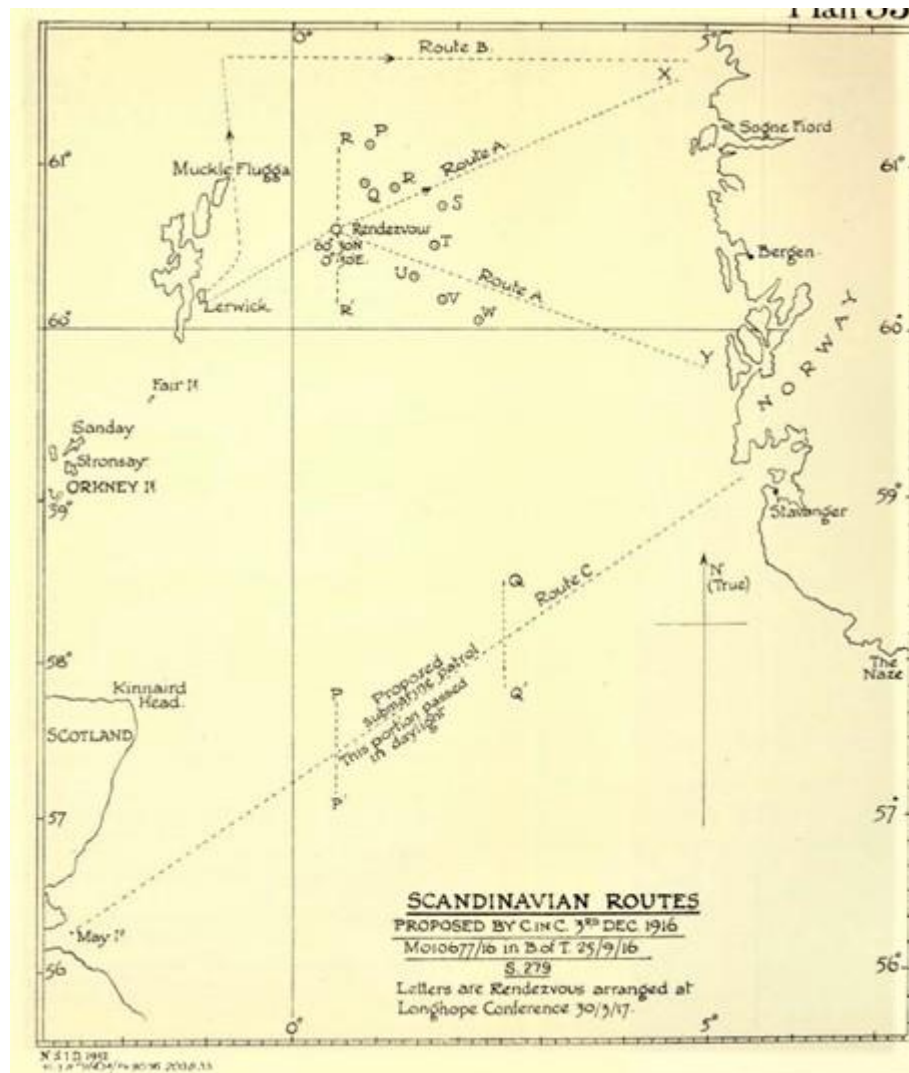
The U Boats achieved initial success, but were defeated by the implementation of escorted convoys, the development of depth charges and hydrophone detection equipment. Overall, the extensive, flexible British layered defence systems, defeated the U Boat unrestricted campaign.

Chart 3: Routes for British, Allied and Neutral merchant ships proceeding independently



The Admiralty specified the routes to be taken by British, Allied and neutral merchant ships. The layered defence system included wireless telegraphy naval intelligence, and U Boat hunting groups. A few British submarines were deployed in pinch-points where the routes converged off the coast of Ireland. This policy was unsuccessful, being replaced by escorted convoys.

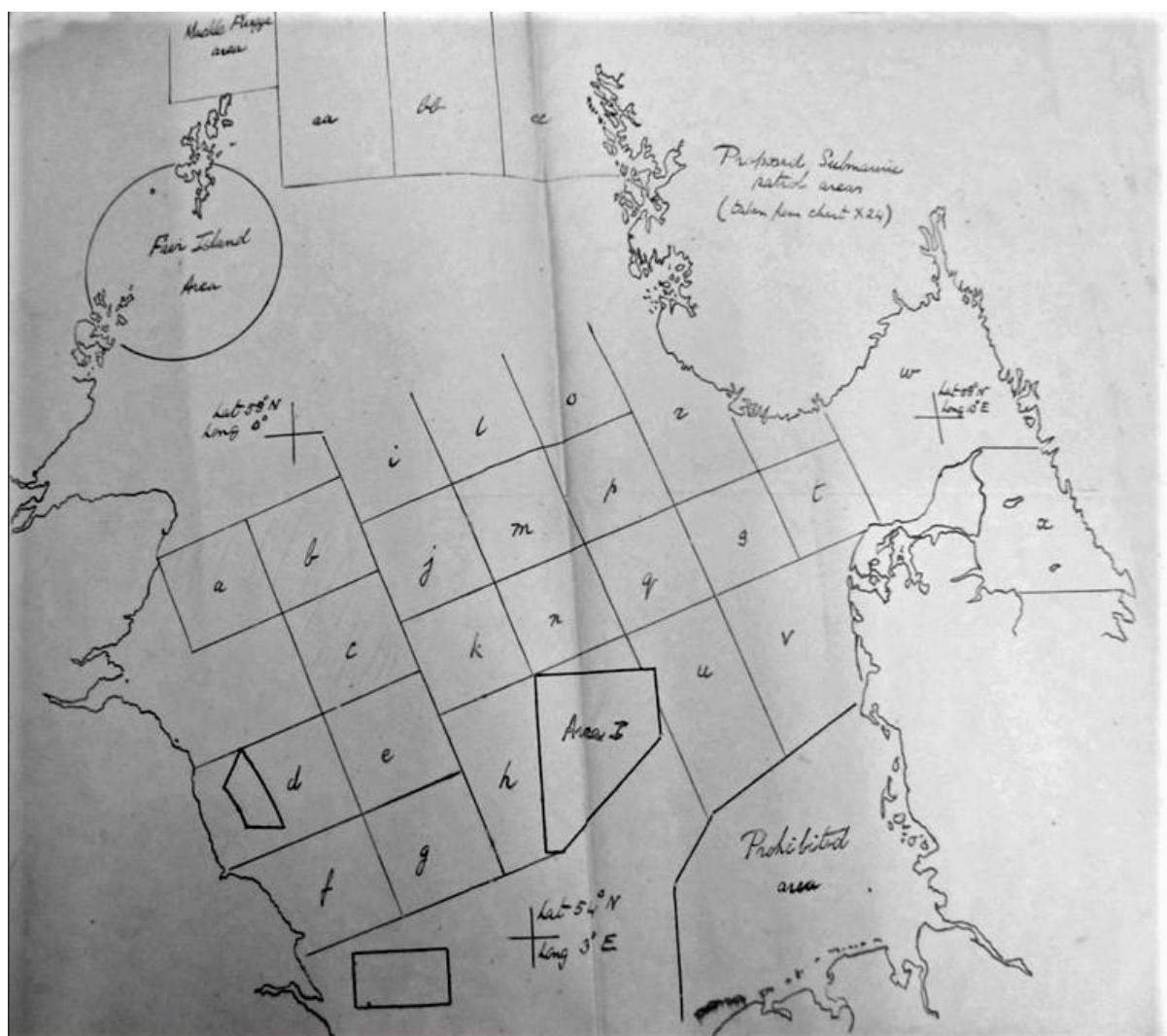
Chart 4: Scandinavian Convoy Routes



Heavy losses of British and Scandinavian merchant ships to U Boat attack, led to the starting of escorted convoys. Merchant ships would load or discharge cargo in English and Scottish East Coast ports. Convoys were formed and escorted to Lerwick, from where convoys were formed that proceeded to the Norwegian West Coast. Later Scandinavian convoys were formed in the Firth of Forth and proceeded to the Norwegian coast in the vicinity of Stavanger. This shorter route was closer to the German Naval bases but was more efficient.

In addition to the convoy escort vessels, the layered defence system included naval intelligence, patrolling submarines, a patrolling squadron of heavy surface warships, and the support of the Grand Fleet.

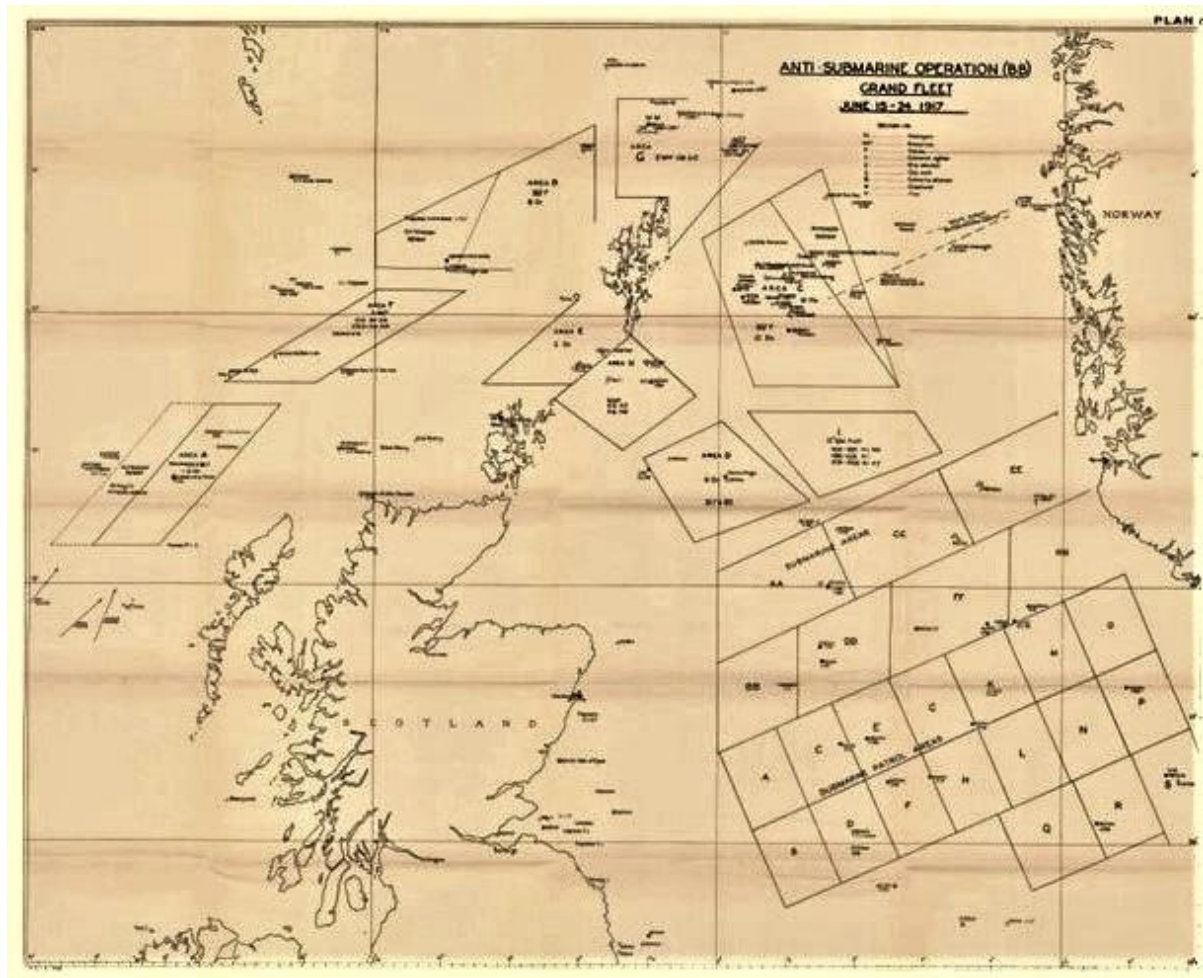
Chart 5: Submarine patrol areas in the North Sea and off the Scandinavian coasts



The British Submarine Patrol Areas, notified by a letter code, were used to attack U Boats. Areas occupied by a submarine depended on the current naval intelligence of the routes taken by departing and returning U Boats. The submarines would first report the position, numbers and types, course and speed of sorties of any German surface warships and then attack. The submarines could attack returning German surface warships and then report them. Note the "Prohibited" area of the heavily mined Heligoland Bight, albeit only British minelaying submarines normally entered this area.

The submarines were a crucial layer in the defence system, including wireless telegraphy intelligence, patrolling surface warships, and the potential of the Grand Fleet being in position on time for a major fleet action.

Chart 6: British Submarine Patrol Areas during Operation BB against German U Boats



Submarine patrol areas were extended during anti-U Boat Operation BB. This was conceived as an offensive operation, rather than the perceived defensive operations around convoys. Areas were designated for submarines, for anti-U Boat trawlers, and for anti-U Boat destroyers. The concept was that when U Boats knew of the presence of submarines, they would proceed submerged thus exhausting their batteries. The U Boats were then forced to proceed on the surface, they would become easier targets for the trawlers and destroyers. The submarines, trawlers and destroyers were located in clearly defined layers.

The results in terms of U Boats sunk was poor, although it might have delayed U Boats arriving at the operating areas in the south-west and north-west approaches off Ireland.

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