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The ASW Threat in the Littoral

by

Douglas E. Heady
Lieutenant Commander, United States Navy

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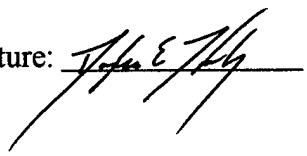
The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature: 

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ABSTRACT

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U.S. Navy doctrine relies heavily on the ability to operate forward in the littoral regions to support the projection of power from the sea to influence events ashore. Forward deployed naval forces are often called upon to establish the critical connection between peacetime operations and conflict. As existing and potential adversaries exploit technological advances, the Navy's freedom of action will be challenged. As these adversaries acquire better weapons, U.S. forces become more vulnerable.

Perhaps the greatest recipient of these technological advances is the submarine. They are a low-cost, high impact weapons. Advances in propulsion systems, sensors and armament are small submarines very lethal. Combine this with the inherent difficulties in conducting ASW operations in the littoral and the submarine creates major difficulties in sea control operations. To complicate the issue, U.S. forces have down played the importance of ASW in recent years.

It is critical for the Navy to focus efforts in the ASW arena. Efforts are under way to improve capabilities with new and improved platforms and sensors. Network-centric ASW, linking sensors, shooters and decision makers may be the wave of the future. In any event, with out sufficient training and integration, ASW in the littoral will be a lost battle.

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U.S. Navy doctrine relies heavily on the ability to operate forward in the littoral regions to support the projection of power from the sea to influence events ashore. Forward deployed naval forces are often called upon to establish the critical connection between peacetime operations and conflict. As existing and potential adversaries exploit technological advances, the Navy's freedom of action will be challenged. As these adversaries acquire better weapons, U.S. forces become more vulnerable.

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Introduction

Since the end of the Cold War, the U.S. Navy has undergone a dramatic shift in the focus of its maritime strategy. Gone are the days of deep water, open ocean fleet engagements. The projection of power from the sea in the littoral to influence events ashore has clearly become the basis of U.S. naval strategy and doctrine. With their forward deployed presence, naval forces are uniquely qualified to provide the critical link "between peacetime operations and the initial requirements of a developing crisis or major regional contingency."[1] Sea control is a mandated requirement in order to accomplish these tasks. The Navy's ability to maintain freedom of action is not expected to be challenged by any potential threat navy in a conventional confrontation. However, existing and potential adversaries are actively increasing their ability to deny this freedom of movement. Naval forces of the future must be structured and trained to quickly and successfully counter an increasingly capable enemy: an enemy who can be expected to employ his forces in an integrated and asymmetric manner. These sea denial threats can consist of ballistic and sea skimming missiles, weapons of mass destruction, air threats, small boats, mines, and of course, small quiet submarines.

Recent technological advances in propulsion, sensors, and armament, combined with the proliferation of these technologies have made the submarine an increasing lethal threat in the littoral regions. This is in part due to the decline of the former Soviet Union's military presence and the resultant reduction in national defense spending. At the same time, the Navy's anti-submarine warfare (ASW) capability is at an all time low. During the Cold War, great amounts of time, effort, and money were expended to counter the formidable Soviet submarine threat and made the Navy the pre-eminent ASW force upon the seas. With the

current focus on fighting in the littoral emphasizing land attack, the Navy's ASW capabilities have atrophied. In the face of the growing submarine threat, ASW can no longer be neglected. This paper reviews the difficulties in operating in the littoral environment and the advances of the submarine threat likely to be encountered there. An analysis of ASW force proposals will be presented followed by recommendations to ensure the Navy can fulfill its sea supremacy role in the future.

Doctrine and Policy

Doctrinally speaking, the littoral is comprised of two parts, the seaward area from the open ocean to the shore, which must be controlled to support operations ashore, and the landward area inland from the shore that can be supported and defended directly from the sea. While it can be argued that the Navy has always fought in the littorals, the focus has shifted "from open ocean warfighting *on* the sea, toward joint operations conducted *from* the sea."[2] This fundamental shift has been driven by maritime requirements in response to supporting a substantial overseas presence in order to promote regional stability, defend United States, Allied and friendly interests in critical regions and rapidly respond to crisis as outlined in the National Security Strategy.[3] Standing naval policy articulates the need to provide credible forward deployed naval forces to ensure the foundations of peacetime stability. These forces are also expected to contribute heavily during transitions from crisis to conflict.[4] These strategic ideas drive the basis and concepts of the Navy's mission and requirements.

The ability to project power ashore from the sea is now the core of the Navy's mission and forward deployed forces are the instruments of that mission. With the reduction of U.S. military installations world wide, these forces have become even more important in

national policy. Through the use of operational maneuver, forward deployed naval forces operating on and from the sea utilize the factors time and space to establish operational and strategic advantages over enemy forces ashore.[5] These initial operations by naval forces may include the insertion of critical ground troops into theater and shape the battlefield for further joint operations. U.S. Marine Corps doctrine as outlined in *Operational Maneuver from the Sea*, "emphasizes using the sea as a secure area from which to conduct ship-to-objective movement."[6] To project this capability, naval forces must obtain and maintain sea control in the littoral to ensure unimpeded freedom of action against an increasingly capable enemy.

Sea Denial

The ability to dictate actions ashore is accomplished "by defeating enemy sea denial efforts and gaining maritime superiority, thus providing unimpeded use of strategic sea lanes and freedom of operations in littoral waters."[7] The sea denial threats that naval forces may face in the littoral are not a new dilemma. Naval forces throughout history have dealt with all of these threats in some form or another, only the specific weapons systems and their lethality have changed. Two fairly recent examples come to mind; first, the employment of submarine forces by both antagonists during the Falkland-Malvinas War in 1982 and second, Iraqi mining operations during Operation *Desert Storm*. The use of submarines by both the Argentinean and British navies had serious operational impact during the Falklands-Malvinas War. The sinking of the Argentinean heavy cruiser *General Belgrano* by the submarine HMS *Conqueror* forced a credible Argentinean surface navy to retreat to its own coastal waters and relinquish any attempts to counter British sea control around the Falkland Islands. Meanwhile, the Argentinean submarine *San Luis*, a small diesel submarine, caused great concern for the British Battle Group Commander, Admiral Woodward. Although the *San*

Luis was not successful in damaging any naval targets or disrupting the amphibious landings, the British expended an enormous amount of time, effort and weapons chasing this elusive submarine. Admiral Woodward realized that a lucky hit disabling his carriers HMS *Invincible* or HMS *Hermes* would seriously jeopardize or end the British effort in retaking the Falklands.[8] That such a modern and powerful naval force was so vulnerable to a relatively minor threat is a telling example of the problems facing naval forces operating in the littoral.

Prior to Operation *Desert Storm* in 1991, Iraqi naval forces mined the northern Arabian Gulf off the coast of Kuwait. Coalition forces failed to interdict these operations or locate the extent of the minefields. Subsequently, two U.S. warships, the USS *Princeton* and the USS *Tripoli* struck and were damaged by mines. When the ground offensive started, the amphibious landing plans were cancelled due to the threat of mines. Again, by employing an unsophisticated weapon, a vastly inferior enemy was able to deny a superior force sea control and essentially dictate the operational battlefield.

These two examples are by no means exceptions, but rather illustrations of the serious dangers that naval forces may face. Joint Vision 2010 warns that technology has created adversaries that have some working knowledge of U.S. military capabilities, the desire to avoid direct confrontation with U.S. military strength, exploit weaknesses and vulnerabilities, and posses the will to do so.[9] By using asymmetric means, the adversary will adopt a strategy oriented towards actions intended to deny, delay, and disrupt naval forces. A weaker enemy will seek to exploit vulnerabilities in order to harass, embarrass, and inflict casualties upon U.S. forces while avoiding a pitched battle and preserving limited assets. Tactics aimed at damaging or disabling naval forces include the employment of sea mines, land launched

tactical and ballistic missiles, small patrol craft and submarines. For a weaker adversary, a single, or a few small successes can ultimately mean victory, particularly in world opinion.

To compound the seriousness of the threat, the adversary is also concentrating and layering defenses. No longer can naval forces concentrate on a single threat. By 2005, Iran is projected to have developed an integrated network of shore-based anti-ship missiles, mines and submarines that could seriously threaten United States access to the Arabian Gulf.[10] While sophisticated information technologies and networked littoral defenses are not yet reality for the majority of potential enemies, they may soon be commonplace. Space and information technologies are rapidly growing fields and the United States no longer possesses the clear advantage. Many other foreign nations and their militaries are exploiting these advances as well. It is estimated that by 2015, over a dozen nations will have deployed space-based imagery systems. For those nations without organic space systems, information and imagery will be and currently is available through commercial means.[11]

Current and future antagonists will continue to search for any means available to exploit weaknesses or vulnerabilities and threaten naval forces operating forward in the littoral. They will strike asymmetrically at forces at sea as well as targeting any forward operating bases or troop and material concentrations that can be reached. Any of these given threats has the ability to restrict freedom of action and thus limits the ability of naval forces to project power ashore. As these sea denial threats become more lethal and capable, U.S. forces become more vulnerable. Although these threats cannot defeat U.S. naval forces, they can delay response time, prolong the conflict, and increase the cost of thwarting aggression. It is imperative to counter these sea denial threats effectively and quickly, utilizing superior

force protection capabilities, power projection, and potent information warfare to establish a decisive impact early in the crisis.[12]

The Threat

Each of these threats can be significant in countering the Navy's sea control and power projection mission. Solutions to these sea denial threats must address the ability to provide for the protection of forward deployed naval forces from peacetime operations through crisis response, and must include the ability to expand this battlespace dominance to provide for a full scale joint force protection. Each of these threats presents their own unique problems for naval forces operating in the littoral. While each threat must be addressed in turn to ensure U.S. naval forces posses the right equipment, training and tactics, only the submarine threat will be addressed at here.

Today, over 40 countries operate submarines[13] and that number is only expected to increase. Many countries see the submarine as a key in their national and military strategies. With its inherent strengths of stealth and lethality, the submarine is a potent threat to defend coastal waters against perceived aggression, deny freedom of action to adversaries and interdict both commercial and military shipping. In the interdiction role, the submarine can have serious consequences. During the Gulf War in 1991, and every other major conflict this century, more than 95% of all equipment, supplies and material have arrived in theater by way of sea.[14] Any successful interdiction operations by an adversary can have an equally devastating effect on maritime operations and the power projection mission as the sinking or disabling of a high-value military unit such as an aircraft carrier or amphibious assault ship would.

Anti-submarine warfare is a warfare area that requires patience and skill and is very asset intensive, often rewarding ASW forces with frustration and failure. A diesel submarine operating on battery power can be nearly undetectable with current acoustic capabilities. These sensors were primarily designed for blue water searches against nuclear powered submarine, taking advantage of the colder, deeper water environment and the benefits that it provides for exploiting sound propagation. ASW in the littoral or more precisely, shallow water (defined as water depths of 100 fathoms or less) ASW is greatly affected by the shallowness of the water, the characteristics of the sea floor, and the proximity to land. The depth of the water limits the size of vessels able to operate in shallow water. Large submarines, particularly the nuclear powered variety, are restricted from very shallow water. Likewise, shallow water limits the maneuverability of surface combatants and may inhibit the use of variable-depth sonars and passive towed arrays. In addition, air launched sonobuoys and torpedoes have minimum water depth requirement that often preclude their use in shallow water.

Acoustic sensor performance is degraded by the tremendous variations and overall unpredictability of the ocean's temperature, salinity, surface conditions, tides, currents, sound absorption and reflection from the characteristics of the bottom and by the background noise, both man-made and natural.[15] The effectiveness of non-acoustic sensors are also degraded; radar by small islands, shipping, fishing vessels, and other small boats and magnetic anomaly detectors by possible wrecks and the closeness of ferrous minerals in the sea bed.

It may seem like the diesel submarine is invincible operating in shallow water, but this is not the case. For decades, anti-diesel tactics have been honed to attack the diesel submarine's vulnerability – the requirement to snorkel in order to recharge its batteries.

Although the diesel is extremely quiet while running on battery power, it can only operate for 2-3 days submerged at slow speeds (3-4 knots) before it has to snorkel and recharge its batteries. If forced to operate at higher speeds, for transits or tactical maneuvers, submerged time is dramatically reduced. Recharging batteries requires the submarine to run its diesel engines while placing a snorkel out of the water to intake air for the engines and release gaseous by-products. The percentage of time spent recharging batteries is know as the discretion rate and can run between 10% and 25% of the operational period of a submarine.[16] The sound radiated from the diesel engine and the thermal and reflective signatures of the snorkel make the submarine highly susceptible to detection.

This vulnerability has been long recognized and recent advances by submarine manufacturers are designed to eliminate it. Air-independent propulsion (AIP) technology is being introduced that will increase underwater endurance to more than two weeks at slow speeds. These designers and builders are refining these designs to make them more attractive, more affordable and more lethal. Closed-cycle diesel engines are essentially identical to normal diesel power plants except the oxygen required for combustion is provided artificially while the submarine is submerged. The Stirling engine, currently the only AIP system in operational use, is similar in that it burns diesel fuel and liquid oxygen (LOX) in a combustion chamber, but it heats helium gas in a heat exchanger which drives the electric producing equipment. The MESMA (Module d'Energie Sous-Marin Autonome) system uses a combusted combination of ethanol and LOX to generate heat in a conventional steam turbine assembly, much like the design of a nuclear powered submarine.[17] Fuel cell technology is the most promising, but it currently is the most expensive and least developed.

Its process, essentially the reverse of electrolysis, noiselessly produces direct electrical current by mixing hydrogen and oxygen in water.[18]

Although AIP will greatly increase the submerged endurance capability of many submarines, these technologies are not the ultimate solution. While the susceptibility of detection due to exposed snorkels is extremely low for AIP driven submarines, there are drawbacks to each system. The closed-cycle diesel presents the identical loud acoustic signature as a snorkeling submarine. The Stirling engine and MESMA AIP systems, although significantly quieter, still have detectable acoustic signatures. All of these systems are also limited by the supply of oxygen on board.

The increased endurance AIP provides is of obvious operational benefit, but AIP driven submarines are limited in the factors of speed and maneuverability. Operating speeds are still low, typically 4-5 knots. Even the most efficient system, the fuel cell, is only capable of sustaining 8 knots.[19] Additional maneuvering causes draws on battery power, further reducing submerged endurance. Still, the overall benefits are substantial and the growth of the technology continues unabated. Currently, submarine designers and builders in no less than five countries (Germany, France, Spain, Russia and Sweden) are actively marketing AIP for both new construction submarines and as modular re-fits into existing fleet boats. In addition to the three AIP equipped *Gotland* class submarines currently in operation in Sweden, several additional foreign navies have ordered AIP. Pakistan is expected to take delivery of the first of three AIP driven *Agosta* class submarines in 2000-2001.[20]

While AIP provides a distinct advantage over regular diesel-electric submarines, advances in other areas are being pursued. Advances in hull designs, weapons

improvements, and computer technology are also being exploited. Advances in submarine designs for shallow water operations include X-shaped rudder configuration for operating on the ocean floor, providing for a very significant tactical advantage. A torpedo that can be launched while a submarine is sitting on the sea bed is already in production and is being actively exported.[21] Sophisticated computer aided combat management systems and improved sensors are being integrated, creating very potent platforms. As can be seen, battling battery driven submarines in shallow water is a very serious dilemma. Between the environment and new technologies, detection and prosecution is extremely difficult. These technical advances have made the submarine more lethal, and hence, made their neutralization even more critical in the littoral.

Counter-Threat

It was not that long ago that ASW was the Navy's number one warfare priority, intended to combat the Soviet Union's formidable submarine force. Since the end of the Cold War and the Navy's subsequent focus on land attack, its ASW capability has suffered from years of neglect. Tremendous effort has been placed in the areas of precision strike weapons and anti-air warfare as well as in command, control, communications, computers, intelligence, surveillance and reconnaissance capabilities. This shift in force capabilities combined with a shrinking budget has eroded the Navy's ASW force strengths and capabilities. ASW proven *Perry* class frigates are being retired at a rapid rate. On the aviation side, the ledger is worse. The S-3B Viking is no longer ASW capable, leaving the carrier with no organic ASW assets other than short ranged helicopters. The P-3 Orion force is at half its force strength of 1990 and is has also changed its mission focus away from ASW toward anti-surface operations and land attack. Even the Navy's own submarine force, by far

the best ASW platform, is being used extensively in the land attack role with Tomahawk cruise missiles. While there have been some advances in ASW capabilities, namely in the area of helicopters, as a whole the Navy's ability to perform effective ASW has been drastically reduced. Combine this with the increased difficulty of conducting ASW in shallow water and the proliferation of technologically advanced submarines places the Navy in a precarious position to conduct battlespace dominance and power projection from the sea.

Current Navy leadership has recognized this shortfall and is attempting to address it. This new ASW strategy is comprised of four major tenets. The first is that ASW is an enduring core competency that the Navy must, and will maintain. The second emphasis is on broadening the focus of ASW operations into the littoral, while not forfeiting open-ocean capabilities. The third major tenet is in the development of new operational concepts that are taking advantage of the rapid growth and power of information technologies. Finally, it is realized that ASW must be a collaborative effort from all naval forces and must be integrated to form the most efficient ASW force.[22]

The most far-reaching vision is the shift to network-centric ASW. This emerging warfighting concept evolves ASW from an asset-based platform-centric warfare to a collaborative-networked one. Network-centric ASW is characterized as a system of sensors, decision-makers, and shooters that are linked together, leading to timely and appropriate decisions and responses, for the purpose of submarine detection, classification, localization and neutralization.[23] This theater-level combat system will include national and theater surveillance assets, surface ships, submarines, aviation assets, ship and shore-based command sites, and other shore support facilities. These elements will all be linked into an ASW information backplane. Designed along same lines as the cooperative anti-air network,

the network-centric ASW will have many of the same benefits. One major difference is that the ASW network will not be an underwater version of the Cooperative Engagement Capability: weapons release will must likely not be automated. The network-centric ASW grid will, instead, allow the operational or operational-tactical commander the ability to mesh integrated sensors and intelligence to best determine courses of action and maximize use of limited assets.

The network-centric hierarchy consists of two major components: the information link and the sensor network. With the rapid explosion in information technologies, the first is becoming reality. Increased use of commercial and military satellites combined with the greater bandwidth capability onboard ships has already greatly increased connectivity. Eventually every ship in the fleet will have immediate access to needed information. The integrated sensor network is a revolutionary concept. Development of entirely new sensors is required. These sensors are being aimed at performance in shallow water. Submarines, sonobuoy fields, ship-mounted sonars and arrays, unmanned underwater vehicles (UUVs), bottom deployed arrays and possibly torpedoes are envisioned to make up this integrated sensor grid. Extensive research is being conducted in the areas of passisve and active arrays for both surface ships and bottom deployment. Futuristic UUVs, deployed from long distances have the advantage of gathering information, detecting, identifying and eliminating threats in high risk areas.[24]

Anti-submarine warfare in the littoral means more than sensors however. The Naval forces of tomorrow must be proper assets to combat the ASW threat in the littoral. As the Navy sails into the 21st century, two platforms are being developed that will be major players in littoral warfare, the "land attack" or "maritime dominance" destroyer (DD-21) and the

newest class of attack submarine (SSN), the *Virginia* class. Designed to replace several classes of aging surface ships, the DD-21 is scheduled to reach the fleet in 2009. The DD-21 provides maximum firepower for projecting power ashore in the land attack role. In keeping with the four operational concepts of dominant maneuver, precision engagement, focused logistics and full dimensional protection, as outlined in Joint Vision 2010[25], DD-21 will protect friendly forces from enemy attack by establishing and maintaining battlespace dominance against missile, air, surface and subsurface threats.[26] This will be accomplished through the use of both organic sensors and DD-21's construction to be fully network-centric compatible.

The new SSN is a touted as a submarine designed for littoral warfare. It is of smaller size, weapons capability, and crew manning than current SSNs. Its smaller size and increased quietness, both acoustic and non-acoustic, is aimed at operating in the littoral. The intent is to have an effective platform to combat the shallowness of the water, and the potential mine, enemy aircraft, and diesel submarine threats expected there. A full array of electronic improvements is scheduled to increase connectivity while retaining covertness. All of these initiatives and proposals are intended to address the need for a credible ASW-capable force in the littoral.

Conclusion

The preceding analysis of anti-submarine warfare in the littoral highlights the importance of the littoral and the difficulties in operating there. The littoral is the most likely arena U.S. forces will see conflict in the future. Achieving and maintaining battlespace supremacy in the littoral is a cornerstone of national military policy and naval strategy to

support joint forces ashore. Naval forces, by their nature of being forward deployed, must be prepared for operations there.

Potential adversaries understand the importance of maintaining freedom of action in the littoral. An adversary's sea-denial efforts aimed at denying, disrupting or delaying U.S. forces can have serious impact on the outcome of a conflict. Realizing an inability to face U.S. forces head on, the adversary can be expected to layer defenses and attack U.S. forces asymmetrically. One of the ways to achieve this goal is with small, quiet submarines.

The submarine is rapidly becoming a weapon of choice. It is a high-impact weapon at an affordable cost. With the rapid advances in technology, submarines are quickly becoming very lethal and very difficult adversaries. The shallowness of the water and the nearness of land complicate the picture and degrade performance of current platforms and sensors. Land-based aircraft, shore-based defensive systems and small missile carrying surface ships all endanger ASW and other forces attempting to establish battlespace dominance.

After years of putting ASW on the back burner, the Navy is finally re-evaluating the dangers and its capabilities to address them. While the current threat is rather minimal, this case will not last. The next few years are critical as the number of potential adversaries acquires submarines and the proliferations of advanced technologies make them more lethal. The U.S. Navy must recognize these dangers and construct a force to adequately counter and defeat these threats.

Recommendations

The picture is not all doom and gloom. While the submarine threat is a dangerous one and will grow substantially more difficult with the advances in technology, it can be

overcome. The U.S. Navy is still the premier ASW force in the world. Although these capabilities have begun to slide in recent years, all is not lost. A shift in focus is required to address the shortfalls and project requirements for the future. Land attack, or power projection ashore cannot be the sole focus of naval doctrine. U.S. forces have become accustomed to having unchallenged control of the sea. This is an assumption that cannot be made. Tomahawk missile shooters, Marine amphibious operations or carrier air strikes can not happen if enemy forces are able to effectively contest U.S. battlespace dominance.

Forces of tomorrow must be structured in a way to provide the necessary striking power yet retain the required capabilities to provide full-dimensional protection. It is understood that these forces must be multi-mission capable, particularly as shrinking defense dollars limit the number of assets available, but it is imperative that these platforms do not prejudice one mission over another. If DD-21, for example, is intended to be the "maritime dominance" destroyer of the future, it must posses the sensors, weapons and capabilities to operate and dominate all areas of the littoral – air, surface and subsurface. It makes poor sense to spend extra millions of dollars on land attack missile upgrades and guns if the ship cannot operate unhindered in the littoral due to a submarine threat.

Efforts must also be stepped up in the areas of sensors and weapons. Current sensors are unfit for use in shallow water. There is promising work in this field, but a concerted attempt to get these technologies to the fleet sooner than later must be undertaken. The same is true for weapons. There are currently no torpedoes in production for the Navy and the ones in the inventory are not ideally suited for shallow water use.

While network-centric ASW may seem to be the answer to the problem in the future, the plan is not utopia. Although the explosion in information technologies is happening at

such a rate that the linking of all decision makers, shooters and advanced sensor grids into a single network may happen relatively soon, it is only half of the equation. Equally capable sensors and platforms – air, surface and subsurface – must be developed and funded. Most overlooked, is it may be impossible to create these sensor grids if the air or sea space is contested. A hostile or potentially hostile adversary is not going to stand idly by while U.S. forces deploy bottom arrays off their coasts. Likewise, an adversary may utilize coastal missiles, air power or surface forces to effectively disrupt U.S. ASW forces.

Finally, the most important aspect of battling submarines in the littorals is training. Courses of action, tactics and equipment must be developed and trained to. Only with adequate and extensive training can operators, regardless of platforms, develop the skills necessary to combat the enemy and win. Too long has ASW been given lip service in fleet exercises while the main effort has been on training in other warfare areas. The most credible ASW force will consist of a fully integrated and highly trained team. All assets must train together to form the most effective force. Submarine threats in the littoral will soon become a major threat to U.S. forces and the U.S. Navy must be ready and trained to meet that threat.

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