# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| **1. REPORT DATE** *(DD-MM-YYYY)* | **2. REPORT TYPE** | **3. DATES COVERED** *(From - To)* |
|---|---|---|
| 20-07-2014 | Master of Military Studies Research Paper | September 2014 - April 2015 |

**4. TITLE AND SUBTITLE**
The Future of Amphibious Operations in the Face of the Precision Guided Munition

**5a. CONTRACT NUMBER**
N/A

**5b. GRANT NUMBER**
N/A

**5c. PROGRAM ELEMENT NUMBER**
N/A

**6. AUTHOR(S)**
Graham, Erik A., LCDR, USN

**5d. PROJECT NUMBER**
N/A

**5e. TASK NUMBER**
N/A

**5f. WORK UNIT NUMBER**
N/A

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
USMC Command and Staff College
Marine Corps University
2076 South Street
Quantico, VA 22134-5068

**8. PERFORMING ORGANIZATION REPORT NUMBER**
N/A

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
N/A

**10. SPONSOR/MONITOR'S ACRONYM(S)**
N/A

**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**
N/A

**12. DISTRIBUTION / AVAILABILITY STATEMENT**
Approved for public release; distribution is unlimited.

**13. SUPPLEMENTARY NOTES**
N/A

**14. ABSTRACT**

The threat of the precision guided munition specifically the anti-ship cruise missile has unnecessarily caused the Navy and Marine Corps to call for a change in the way amphibious operations are conducted. The need for a 65 nautical mile stand-off from the beach head and connectors to facilitate the movement ashore is an unnecessary fiscal strain and concedes vital battlespace which allows the enemy to win the A2/AD fight. The United States Navy and Marine Corps have a doctrinally sound amphibious capability. A capability which has been developed and perfected over decades and successfully applied in training and in combat. That capability must not be lost to the most recent overly inflated alarmist threat. This capability is unnecessary, assumes more risk than the ASCM threat offers, and is fiscally untenable in the face of today's budget cuts.

**15. SUBJECT TERMS**
Amphibious, Expeditionary Force-21; Air-Sea Battle; Anti-Ship Cruise Missile; Precision Guided Munition

| **16. SECURITY CLASSIFICATION OF:** | | | **17. LIMITATION OF ABSTRACT** | **18. NUMBER OF PAGES** | **19a. NAME OF RESPONSIBLE PERSON** |
|---|---|---|---|---|---|
| **a. REPORT** | **b. ABSTRACT** | **c. THIS PAGE** | | | Marine Corps University/Command a |
| Unclass | Unclass | Unclass | UU | 70 | **19b. TELEPHONE NUMBER** *(include area code)* (703) 784-3330 (Admin Office) |

*United States Marine Corps*
*Command and Staff College*
*Marine Corps University*
*2076 South Street*
*Marine Corps Combat Development Command*
*Quantico, Virginia 22134-5068*

MASTER OF MILITARY STUDIES

---

**TITLE: Amphibious Warfare in the Face of the Precision Guided Munition**

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF MILITARY STUDIES

**AUTHOR:** Lieutenant Commander Erik A. Graham, USN

AY 14-15

---

Mentor and Oral Defense Committee Member: Dr. Richard DiNardo

Approved: Richard J. DiNardo

Date: 28 April 2015

Oral Defense Committee Member: DR CHRISTOPHER S. STONE

Approved:

Date: 28 APRIL 2015

*United States Marine Corps*
*Command and Staff College*
*Marine Corps University*
*2076 South Street*
*Marine Corps Combat Development Command*
*Quantico, Virginia 22134-5068*

MASTER OF MILITARY STUDIES

---

**TITLE: Amphibious Warfare in the Face of the Precision Guided Munition**

SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF MILITARY STUDIES

**AUTHOR:** Lieutenant Commander Erik A. Graham, USN

AY 14-15

---

Mentor and Oral Defense Committee Member: Dr. Richard DiNardo

Approved: _____

Date: _____

Oral Defense Committee Member: _____

Approved: _____

Date: _____

## Executive Summary

**Title:** The Future of Amphibious Operations in the Face of the Precision Guided Munition

**Author:** Lieutenant Commander Erik A. Graham, United States Navy

**Thesis:** The threat of the precision guided munition specifically the anti-ship cruise missile has unnecessarily caused the Navy and Marine Corps to call for a change in the way amphibious operations are conducted. The need for a 65 nautical mile stand-off from the beach head and connectors to facilitate the movement ashore is an unnecessary fiscal strain and concedes vital battlespace which allows the enemy to win the A2/AD fight.

**Discussion:** Decades ago, the advancement of the machine gun, armor, and artillery were touted to be the end of the amphibious assault. Today, it's the anti-ship cruise missile. The current response to the ASCM is develop the capability to be able to launch the amphibious landing craft from beyond 65 nm. This study will provide a realistic threat and risk assessment of the effectiveness of the precision guided munition against an amphibious assault. Specifically, this study will concentrate on the ASCM in its application to deny amphibious operations and power projection from the sea. This assessment will be based on most likely threats organized by type of precision guided munitions. Each threat will be analyzed based on technical ability required to launch, command and control required, launch platform, targeting, guidance, and operational effectiveness. All of this in how it relates to the current state of amphibious capabilities within the Navy and Marine Corps. Finally, this study will provide an assessment of current amphibious capabilities and provide a realistic recommendation for the way ahead for amphibious operations and the unnecessary, self-imposed 65 nautical mile stand-off requirement as stated in Expeditionary Force 21.

**Conclusion:** The United States Navy and Marine Corps have a doctrinally sound amphibious capability. A capability which has been developed and perfected over decades and successfully applied in training and in combat. That capability must not be lost to the most recent overly inflated alarmist threat. This capability is unnecessary, assumes more risk than the ASCM threat offers, and is fiscally untenable in the face of today's budget cuts.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

## *Preface*

The current threat of the Anti-Ship Cruise Missile to naval operations is a real and powerful instrument in A2/AD. This threat must be recognized and respected yet mitigated and managed at the same time. If not, the United States Navy and the United States Marine Corps will be unable to continue to command and project power from the seas. To simply push the Amphibious Ready Group out past 65 nautical miles away from land does nothing to mitigate the threat but does everything to complicate the problem and the amphibious operation. My thesis refutes the requirement for the 65 nm stand off and the fiscally irresponsible request for new connectors and technology in order to launch the landing force from that distance. Instead, we must mitigate the threat without conceding battlespace through innovation in doctrine, techniques, procedures and future technologies.

First and foremost, I would like to thank the Marine Corps University's Command and Staff College for allowing me the opportunity to share the halls with such a professional and talented cadre of staff and students. I am truly humbled to be among some of the brightest military officers past and present. I would like to sincerely thank my mentor, Dr. Richard DiNardo for his mentorship and professional academic guidance throughout the writing process. Additionally, my military and faculty advisors Lt Col Winston Gould and Dr. James Joyner have been profoundly patient and supportive throughout the academic year and have my utmost professional and personal respect.

## Table of Contents

The ability to project power from the sea has been the foundation of the Marine Corps and the fundamental reason for their existence and relevancy. This ability has been threatened in recent years by the mass production, proliferation, and increased sophistication of the capabilities of precision guided munitions (PGM). PGMs have proliferated beyond the world's military powers such as China, Russia, India, and Iran. The capabilities of employing these lethal weapons by non-state actors has become a reality and was displayed by Hezbollah in 2006 when a C-802 anti-ship cruise missile (ASCM) struck the Israeli ship *Hanit* ten nautical miles off the coast of Lebanon. This sent shock waves through navies world-wide and sent them scrambling to re-evaluate their ASCM defense capabilities. It also made the United States Navy begin to question the current state of amphibious operations and whether current tactics should be revised in light of this proliferated threat. They did and they were successful in convincing the Marine Corps of the need for the capability for assault waves to be launched from a distance of 65 nautical miles from the shore. This was highlighted in the Marine Corps Capstone Concept Expeditionary Force 21 (EF-21). The United States cannot concede this battlespace and it cannot concede the ability to quickly and efficiently project power from the littorals. Even before the disaster at Gallipoli, it seems every generation has forecasted the end of amphibious operations. Lord Horatio Nelson once said that "a ship's a fool to fight a fort."[1] In 1949, General Omar Bradley said "I predict that large-scale amphibious operations will never occur again."[2] Approximately one year later one of the most daring, large-scale amphibious assaults was executed at Inchon, Korea. The end of amphibious landings has been forecasted just as long as they have been around. The reasons have varied from the advancement in weaponry, to include machine guns, armor, artillery, and even nuclear weapons.[3] Now critics are clamoring about the

advances in precision guided munitions. Specifically the ASCM and how they would inflict an unsustainable casualty rate if an amphibious force came within their effective range envelope.

In today's interconnected global markets, the sea lanes of communication must be open and free trade must not be inhibited or disrupted. Additionally, the United States government through the United States Navy and the United States Marine Corps, must be able present the unbridled and unrestricted ability to conduct amphibious operations and project power from the sea at will. There cannot be any stipulations on this ability. Finally, evacuation operations and other operations from the sea must not be delayed, disrupted, or prohibited for any reason even in the face of a non-state actor possessing a rudimentary ASCM capability.

To accomplish this the United States must maintain a relevant, technologically superior fleet of ships capable of projecting power from the sea. This includes the ability to dominate the littorals in order to conduct large-scale amphibious assaults or simply the freedom to navigate uncontested. To concede this littoral battlespace is to concede a critical piece of diplomacy. The threat of PGMs in the littorals indeed must be mitigated but the answer is not as simple as to launch the amphibious assault at 65 nm in order to protect amphibious ships. In fact, more risk is assumed than mitigated by launching an amphibious assault further from the beach. Additionally, a stand-off of 65 nm still puts amphibious ships well within the threat ring of a good majority of the world's ASCMs.

To counter A2/AD the Navy and her sister services have developed a strategy called the Air-Sea Battle concept. The future amphibious assault must be conducted utilizing a phased approach of risk and incorporated within the Air-Sea Battle concept, which is now being called the Joint Concept for Access and Maneuver in the Global Commons (JAM-GC). The JAM-GC revision is scheduled to be released by the end of 2015. The precision guided munition is a

threat but not enough of a threat to concede the ability to conduct an amphibious landing and allow the enemy complete A2/AD success. The threat must be managed and a certain amount of risk must be assumed in order to continue to command the seas and deny the enemy their A2/AD capabilities.

**Anti-Access (A2) and Area-Denial (AD)**

Anti-Access is an "action intended to slow deployment of friendly forces into a theater or cause forces to operate from distances farther from the locus of conflict than they would otherwise prefer. A2 affects movement to a theater".[4] Area-Denial is an "action intended to impede friendly operations within areas where an adversary cannot or will not prevent access. AD affects maneuver within a theater".[5]

"Air-Sea Battle relies on tightly coordinated operations across domains (air, land, maritime, undersea, space and cyberspace) to defeat A2/AD capabilities, such as a submarine striking air defenses in support of Air Force bombers, Air Force stealth fighters destroying a radar site to prevent cruise missile attacks on Navy ships, or a Navy cryptologic technician (CT) confusing a radar system to allow an Air Force UAV to attack an enemy command center".[6] ASB relies on joint interoperability in order to prepare the battlespace so all forces have freedom of maneuver in all theaters of the world. "No domain can be completely ceded to the adversary. Each domain can be used to impact and deny access to the others, so to cede one domain to an adversary invites the eventual loss of the other interdependent domains".[7] This includes our

ability to project power ashore from Navy ships in the form of the Marine Air/Ground Task Force.

> "Hybrid threats faced today demand multiple, joint effects for all types of operations to negate the asymmetric force of A2/AD capabilities. Any amphibious assault will most likely be preceded by a large effort to shape the battle space through joint effects. Shaping will have taken place in the form of global strike and interdiction, hitting command and control, integrated air defense, fixed enemy positions, and critical surface-to-surface and surface-to-air missile nodes. The Air Force will conduct offensive cyber attacks on critical command-and-control centers of gravity in an attempt to peel back the layers of A2/AD, further facilitating the approaching amphibious operation. Once the assault is under way, the Air Force and Navy will provide joint suppression of enemy air defenses and offensive counter-air capability, providing essential firepower to overcome the A2/AD obstacles of maneuver for the combined Marine force".[8]

## Types of Precision Guided Munitions

**Precision Guided Mortar Rounds -** The GRAN laser guided mortar round was developed by the Russians and used extensively in Afghanistan with positive results. The target is "painted" with a coded laser beam and the rounds are guided with highly effective accuracy from a forward observer.[9] The only with problem utilizing a laser designator from a land borne system against a waterborne target would be the possible reflection and scattering of the beam due to the water, wave height, and sea spray. Therefore, the laser designator could only realistically be employed within a mile from shore.

The GPS guided mortar round was most recently used by Hamas against the Israelis in November of 2014. The highly accurate mortar rounds were reportedly smuggled in by Hamas from Libya during the most recent civil war. The lethality and accuracy of this weapon is exceptional but its use against a seaborne threat is mitigated by two things: mobility and the sea. GPS guided munitions are developed for and most accurate on stationary targets. Additionally, it is very difficult to get a targeting quality coordinate in the middle of the ocean. Therefore the

basic nature of amphibious operations would mitigate the use of the GPS guided mortar round.

**Precision Guided Artillery Rounds -** Several countries developed the laser-guided artillery round. The Russians developed the 30F39 Krasnopol in the mid 1980s and have experienced successful operational deployment of the round. The concept is similar to most laser-guided munitions.[10] The effectiveness is limited by weather, target obscuration, and line-of-sight of the laser-designating observer.

The U.S. developed the M982 Excalibur round jointly with Sweden and is compatible with several international militaries' artillery systems. The GPS-guided artillery round operates much like a JDAM. The round is guided onto the target utilizing GPS for increased accuracy. Testing with the U.S. Army and Marine Corps in Iraq and Afghanistan have confirmed the increased accuracy (5m CEP) and a 40% increase in maximum effective range of a standard artillery round. The Excalibur has been upgraded with the ability for GPS and Laser Spot Tracker (LST) which enables the round to be fired at moving targets or in the event of GPS jamming.[11]

All of the above PGMs are most certainly a threat to any military operation. But as they relate to the amphibious assault, the most significant threat to Navy ships and Marines from going ashore is the anti-ship cruise missile (ASCM). The ASCM in an A2/AD role is the single cause for the Navy and Marine Corps' call for the capability to launch the assault wave from beyond 65 nautical miles.

**Anti-Ship Cruise Missiles** "A standard cruise missile can be described as an unmanned, self-propelled, winged, non-recoverable aerial vehicle designed to destroy a surface target".[12] The

evolution and development of precision guided munitions has ultimately lead the technology to the anti-ship cruise missile. From its inception and application in the form of the "bug" during World War I, the precision guided munition was arguably always meant to be the cruise missile. Yes, PGMs have mostly been launched from manned aircraft but one of the fundamental qualities of a PGM is to limit the risk to personnel. The anti-ship cruise missile is everything the PGM was intended to be: highly accurate, deadly, and limits the risk to friendly forces.

Unlike other types of PGMs, the anti-ship cruise missile (ASCM) over the course of its history was developed with varying types of technology in order to find its target. A brief description and evaluation of the most common and most successful seeker types is appropriate in order to evaluate the ASCM threat. This information can be referenced in Appendix 1 of this document.

A brief description and analysis of some of the most common seeker and guidance types have been included at the end of the thesis as an appendix. Additionally, a general overview of some of the current and future missile defense systems and tactics utilized in an integrated missile and air defense are also included as an appendix. While the aforementioned topics are germane to this topic, it is preferred to have them as a ready reference in support of the thesis.

**The Most Dangerous Cruise and Ballistic Missiles**

**DF-21/CSS-5 Mods 1-5**. This Chinese produced anti-ship ballistic missile (ASBM) also known as the 'carrier killer' has the potential of causing a paradigm shift in respect to past employment of aircraft carriers. The Chinese have advertised the DF-21 to have a maximum range of over 1300 nm, a terminal speed of mach 10, the ability for the warhead to maneuver upon re-entry, and a possible IR, optical, active radar seeker or a combination of the three. Some reports

indicate initial testing against land targets have been successful. As of yet, it is assessed that a successful operational test against a maneuvering seaborne target has yet to be accomplished.[13] That being said, the DF-21 plays significantly into Chinese A2/AD strategy in the Pacific Rim and a deterrence to potential U.S. intervention in the region.


**Figure 1: Chinese test of DF-21 on carrier size target in Gobi Desert (Image courtesy of chinatimes.com)**

While the DF-21 has been touted as a 'game changer' by some analysts, the fact of the matter is that the DF-21 requires an extensive targeting and support network in order to successfully detect, track, and target an moving aircraft carrier at sea.[14] Additionally, those integrated systems are susceptible to jamming, spoofing, or cyber attack at multiple points of the targeting chain. The U.S. has also been experimenting with different types of defenses against the DF-21 in its terminal phase to include electronic defense, obscurants, and in the future directed energy weapons. The DF-21 can be defeated at several points in its targeting chain.[15]

Russia and China are the only potential adversaries possessing the technical and tactical

ability to field an ASBM. DF-21 is China's deterrent to the U.S. Carrier Strike Group. China uses the DF-21 to deter the use of aircraft carriers in the Pacific Region. Yet, China is deterred from using the DF-21 by the U.S.'s nuclear capabilities as China still does not possess a secure second strike capability and would have to carefully consider the repercussions of a launch against an aircraft carrier.[16] The DF-21 while a significant threat to aircraft carriers and the projection of power from the sea it is by no means a weapons system that cannot be defended against. **3M-54 Klub/SS-N-27A** "**Sizzler**"**.**This Russian produced sea-skimming ASCM can be fired from surface or subsurface platforms. The Sizzler has a range of approximately 186 nm, utilizes inertial navigation and pre-launch targeting data, active radar seeker during its terminal phase, and carries a 450 kg warhead. What makes this missile so deadly is the speed at its terminal phase. At approximately 40 nm from its intended target, the SS-N-27 reaches supersonic speeds of Mach 3 and is capable of conducting high G terminal maneuvers to defeat a target's defensive systems.[17]

The export version currently offered on the international arms market is particularly troublesome because it is housed in an innocuously looking container found on most merchant ships. The control and launching controls are also conveniently located within the box. Potentially, these could be placed on civilian container ships to deceive its intended target.[18]

The Sizzler is a formidable missile system yet it does have weaknesses. In order to maximize the range at which it is delivered it must rely on third party targeting and an integrated command and control system. This targeting chain can be detected and defeated through

jamming, spoofing, and countermeasures. Also, this missile has been known to have significant issues with quality control and inconsistent operational tests by Russia and India.[19] The Sizzler has proliferated to China, India, Algeria, Vietnam, and it is suspected Malaysia and Iran have purchased some variants.[20]

**K-300P Bastion-P (SSC-5 'Stooge').** This is a Russian produced mobile Coastal Defense Cruise Missile (CDCM) system based off the SS-N-26 (Strobile). The missile has a maximum range of 180 nm, utilizes INS for its midcourse phase, a cruise speed of Mach 2.6, and the option of a high (50,000 ft) and low (30,000-60,000 ft) altitude flight path. It has a 200 kg high explosive warhead, an active/passive radar seeker, and is highly survivable even in the most complex jamming environments. In this regard, this arguably might be the most formidable CDCM threat to amphibious operations based on the ability to mass fires, its high degree of mobility, and survivability against some of the best missile defense systems.[21]

However, every system has vulnerabilities. The key to defeat this weapons system will be to disrupt and destroy the Bastion-P's command and control through shaping operations and battlespace preparation prior to conducting the amphibious operation. Additionally, the system is highly mobile but can be easily identified by ISR (Intelligence, Surveillance, and Reconnaissance) assets such as UAVs, satellites, and other imagery systems. The Bastion-P is easier to identify than the Club-K due to its military appearance, relatively large support vehicle footprint, reliance on third party targeting, and short active standby time of 3-5 days.

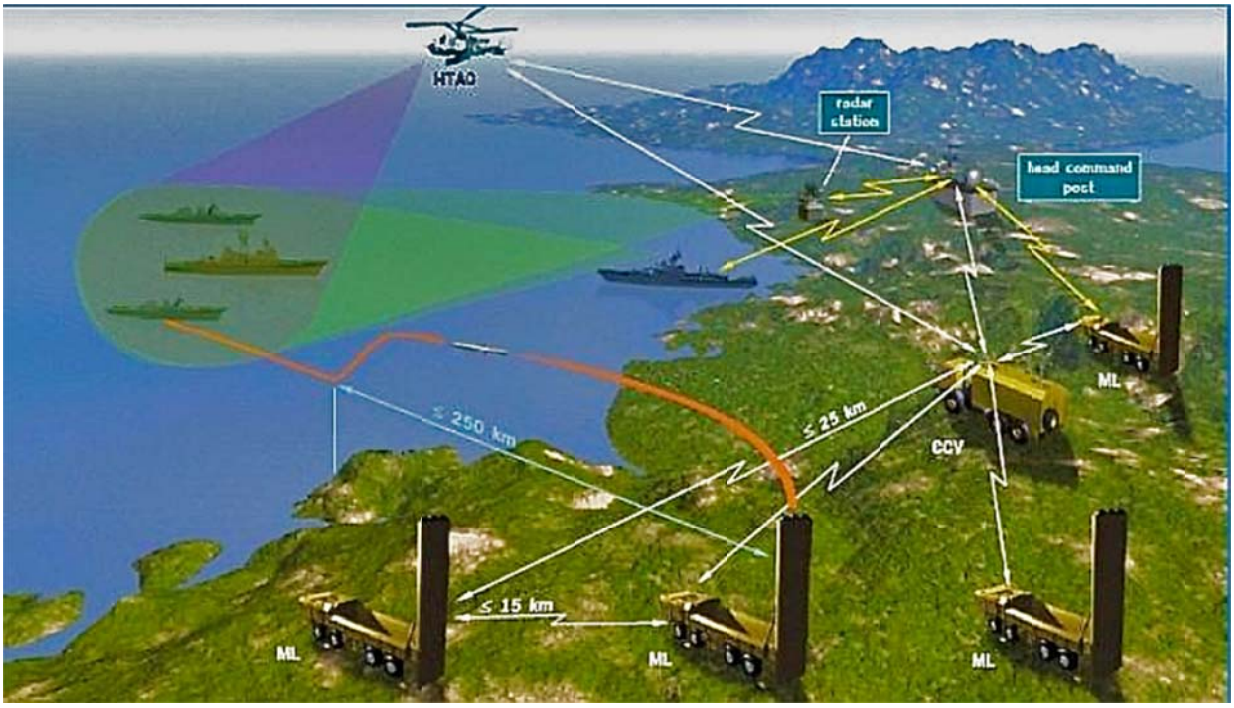


Figure 2: The command and control structure of the Bastion Missile System.

image courtesy of defense-arab.com

**BrahMos/Yakhont/Oniks.** This missile was developed by India and Russia in a joint venture based off the SS-N-26 "Strobile" missile. It is an air, land, surface, and subsurface launched supersonic, sea skimming missile reaching a terminal speed of Mach 2.8. A hypersonic version, Brahmos 2 is reported to be able to reach speeds of Mach 7 and will be the fastest cruise missile in production.[22] The missile's guidance relies on INS for its midcourse and an active radar seeker and satellite input for terminal guidance. This missile is a significant threat due to its high speed and ability to conduct high G maneuvers in its terminal phase.[23]

This missile can be defeated in similar ways the previous missile systems can be defeated. Disrupt or destroy the command and control structure, spoof or electronically jam the third party targeting, and employ electronic countermeasures and integrated missile defense systems found in any Amphibious Readiness Group or Carrier Strike Group.

While the above missiles present the most significant threat to the amphibious assault and if launched in great numbers on varying axis or even on a single line of bearing could prove to be

very lethal. Yet, the above missiles have not been assessed as operationally effective in a combat environment, proliferated in great numbers beyond China, Russia, and India, and able to be fired en masse.

However, the most proliferated missiles while not being the fastest, most maneuverable, or the most technologically deceptive have been proven in a combat environment, proliferated throughout the international community, and relatively inexpensive and easy to use. That presents more of a threat than a single or even a half dozen highly advanced missiles such as the BrahMos or "Stooge".

**Most Proliferated Cruise Missiles**

**C-802/YJ-82/Noor.** There are different variants of the YJ-8 or C-802. It was originally developed by the Chinese and exported to Algeria, Bangladesh, Indonesia, Iran, Pakistan, Myanmar, Thailand, and Syria. The Iranians reverse engineered the YJ-8 and began producing an indigenous version called the Noor. Subsequently, the Chinese upgraded the C-802 to the supersonic version called the C-803. The C-802 can be launched from air, surface, subsurface, and land based launching systems. It is a subsonic (.9 Mach), sea skimming, active seeker with a maximum range of 40-75 nm.[24]

**Exocet.** The Exocet is a sea-skimming, subsonic, active seeker with a maximum effective range of 27-120 nm (depending on variant). The missile was developed approximately 30 years ago and has been proliferated to Argentina, Brunei, Bulgaria, Brazil, Cameroon, Chile, Colombia, Cyprus, Ecuador, Egypt, France, Germany, Greece, Indonesia, India, Iran, Kuwait, Libya, Malaysia, Morocco, Oman, Pakistan, Peru, Qatar, South Africa, South Korea, Thailand, Tunisia, Turkey, Vietnam, UAE, and Uruguay. It has been proven to be a capable missile by its use during the Falklands War and during the Iran/Iraq war when it struck the USS Stark.[25]

**How it affects amphibious operations**

When using the term ASCM as it relates to the future of amphibious operations I will use the C-802 and Exocet as the most likely and most dangerous threat. This assumption is based on its level of proliferation, success rate in operational tests and in battle, the regions of the world it is most commonly found coupled with the areas the U.S. is most likely to conduct an opposed amphibious operation, and finally the ability to mass fires due to its relative low cost and ease of employment. This is not to minimize the previously detailed 'most dangerous' missile systems. Rather, due to their complexity of launch requirements, command and control, unproven operational and battlefield performance, and relatively low proliferation they are more of an outlier when it comes to their utilization as an A2/AD threat.

Precision guided munitions in the form of the ASCM are the biggest threat to an opposed amphibious operation. An ASCM launched from a Transporter-Erector-Launcher (TEL) site presents the biggest threat due to mobility and the potential for the TEL to be camouflaged within the terrain or disguised as something benign within an urban environment. Yet, the ASCM's biggest threat comes from the ability to launch them en masse in order to saturate the defensive systems of its target. Even the most advanced missile defense systems can be over-saturated. Missiles, if engaged individually could be defeated but if an overwhelming volume were to be launched simultaneously, enough could penetrate and find their intended target.

That being said, the days of hundreds of ships anchored off the coast of a country in support of an amphibious operation are potentially gone. Especially in a hostile environment against an enemy possessing a large number of ASCMs and able to launch them on multiple axises. Therefore, it has never been more critical in the history of amphibious warfare to

prepare the battlespace prior to the commencement of amphibious operations and maintain that secure environment once prepared. This secure environment is essential not only for the amphibious ships carrying the assault force, but for the logistical support required once Marines are ashore, and in preparation of redeployment.

The amphibious landing site is going to be shaped and prepared prior to commencement of the amphibious assault. The shaping of the battlespace has to be conducted utilizing every warfare area in a very structured, layered, and stepped approach in order to dismantle the A2/AD defenses pre-invasion. The steps will utilize warfare areas which possess the least risk to personnel and equipment. As the threat decreases and the battlespace is shaped, the use of manned vehicles and riskier operations will be conducted culminating in the Marine stepping onto the opposed beach head.

**Networked, Integrated, Attack-in-Depth to Disrupt, Destroy, and Defeat (NIA/D3)**

"The ASB Concept's solution to the A2/AD challenge in the global commons is to develop networked, integrated forces capable of attack-in-depth (NIA) operations requires the application of cross-domain operations across all the interdependent war fighting domains (air, maritime, land, space, and cyberspace to disrupt, destroy, and defeat (D3) A2/AD capabilities and provide maximum operational advantage to friendly joint and coalition forces."[26]

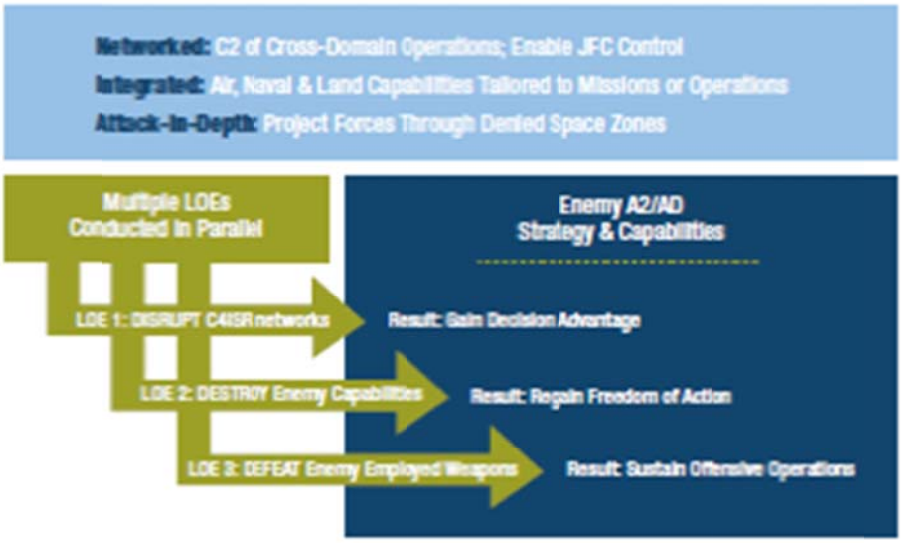


**Figure 1. Components of ASB's Conceptual Design "NIA/D2"**

image courtesy of Air-Sea Battle Concept

**Cyber Attack.** Cyber operations will be employed in order to shut down air defense systems so carrier based aircraft can strike pre-determined A2/AD systems. The cyber domain will be used to provide misinformation, confuse, and frustrate command and control and senior leadership. Cyber warfare will be used to shut down civil communications and potentially the entire cyber network of the target country. Cyber warfare has emerged as one of the premier supportive warfare areas to battlefield shaping operations.

**Electronic Warfare.** In order to shape the battlespace, air and surface units will be used to electronically jam and deny the opposing force the use of the electromagnetic spectrum. Air and surface search and fire control radars will be denied the ability to provide CDCM sites third party targeting data. Cell phone towers will be shut down in order to minimize the most basic forms of command and control. Even the use of commercial navigation radars would be saturated to the point they would be useless in support of targeting.

**SOF Insertion.** Special operating forces would be inserted to conduct clandestine operations, disrupt lines of communication, anti-mining, conduct beach surveys, or other battlespace shaping. The method of insertion could be via submarine, air, or via special warfare boats. The insertion of SOF and subsequent operations could be overt or covert in order to conceal the location of the planned amphibious operation.

**Unmanned Aerial Vehicles.** UAVs will provide current situational awareness of beachhead defenses, the disposition of ASCM sites, movement of TELs, and real time battle damage assessment from ongoing shaping operations. UAVs are difficult to detect due to their small radar cross section and relatively low altitude and can provide targeting quality coordinates to ships and aircraft preparing to shape the battlespace with surface to surface and air to surface fires.

**Strike.** Once targets have been identified and confirmed, Tomahawk Land Attack Cruise Missiles would be used to conduct stand-off strikes on critical A2/AD command and control, ASCM, CDCM, and SAM sites, and associated supporting infrastructure. Once these targets have been suppressed, disrupted, and or destroyed, carrier air strikes could commence and provide greater detailed strike capability to include real-time and on call targets of opportunity not identified by UAVs, satellites, and intelligence.

**Naval Surface Fire Support.** Once the battlespace has been prepped by cyber operations, UAVs, TLAMs, and air strikes, cruisers and destroyers would provide surface to surface fires immediately prior to launching Marines ashore. This on call fire support directed by Tactical Action Control Parties would provide immediate suppression and disruption of key A2/AD defenses. Additionally, the platforms conducting NSFS could also provide an integrated air and missile defense for the amphibious landing.

**Post Launch Missile Defense**

These are just some of the capabilities a commander would have to shape the battlespace for an amphibious landing. In the event an enemy's CDCM or ASCM weapon systems survive the battlespace preparation phase, the naval landing force has a myriad of defenses to counter the post launch ASCM threat. Individually these systems have proven to be successful in defending against an inbound missile. When these systems are used in a layered defense, the result is effective against most CDCM and ASCM missiles. A listing and brief description of in use and in development missile defense systems composing an integrated and layered defense can be found and reviewed in Appendix 2.

Phased shaping of the battlespace, an active, integrated, layered missile defense against a pre and post launch of an ASCM, ASBM, or CDCM, and an active A2/AD strategy will allow for the amphibious force to position its high water mark wherever it best suits the amphibious commander. There is no denying that a certain level of risk must be assumed in the face of the ASCM threat. However, those risks can be mitigated and minimized well beyond and they far outweigh the risks of launching an amphibious assault 65 nm away from the beach. Pushing the landing force further from land does nothing to counter the ASCM threat. If anything, it increases the potency of the threat by adding complexity and unnecessary risk to the ARG and/or CSG commander.

**The Dangers of 65 Nautical Mile Stand-Off**

**Navigation:** The simple fact of having to navigate 65 nm leaves a boat wave susceptible to poor visibility, navigation errors, inclement weather, high sea state, mechanical failure, hydrography, tidal range, and many more unrealized factors. To have an LCU boat wave travel over 65 nm at an average speed of 10 knots would take about 5-6 hours to negotiate. Therefore,

a roundtrip of a single boat wave could take over 10-12 hours. If not timed correctly, it would be impossible to avoid night operations. Conducting amphibious operations at night would only intensify the risk and increase the confusion of operating beyond 65 nm from shore. The lack of cultural lighting on the beach and limited lighting of the amphibious force would only further obfuscate the operation and create further risk of fratricide to units returning to force.

If LCACs were used the transit time would be cut in half. However, LCACs have an operating limit of a sea state of three or less (4 foot wave height).[27] LCACs would take 2-3 hours to negotiate the 65nm transit but their load capacity is much less than that of an LCU. So, half the equipment in half the time with an LCAC or double the equipment in twice the time with an LCU. It is essentially the same. Command and Control of the amphibious force would be compounded with the requirement for over-the-horizon communications which are inherently prone to equipment malfunction, atmospheric interference, adversary interception and jamming, and complexity of communication plan.

**Logistics:** Additionally, the increase in fuel requirements would be a factor that would be a cost transferred back to the amphibious ship and then back to the oiler and ultimately requiring more logistical movements in theater. More logistical movements to a theater would mean by aerial delivery to a local permissive port. If a local port was not available to receive or distribute fuel then the fuel would need to be delivered from the closest permissive port facility. Either way, it would require an increased OPTEMPO of an oiler already in theater and/or an additional oiler from a stateside rotation.

**Fast Attack Craft (FAC) or Fast Inshore Attack Craft (FIAC):** FAC are civilian produced small craft militarized with crew served weapons, rockets, and possess a small scale mine laying capability. FIAC are produced for military purposes and are outfitted with cruise

served weapons, rockets, and/or mines, and in some cases are capable of launching ASCMs such as the C-802. The FAC or FIAC threat would be potentially devastating during the boat wave's transit to shore loaded with Marines and equipment. The LCAC and LCU possess little self-defense capability. FAC or FIAC are high speed craft with a low radar cross section and blend in to civilian shipping which makes them difficult to detect, track, and engage. The FAC or FIAC would be able to swarm the poorly defended amphibious vehicles with little opposition especially when forced to negotiate a 5-6 hour, 65 nm transit.

**Mines:** The most affordable, effective, and easiest way to shut down a sea lane. The defending nation could deliver these low cost waterborne IEDs via commercial boats, FAC or FIAC, submarine, or aircraft. A boat wave encountering a mined waterway would face devastating results. The shorter distance an amphibious vehicle has to travel the less time that has to be spent hunting and clearing mines, and less of an area susceptible to mining.

**ASCM Range:** A 65 nautical mile standoff will not insure the safety of the amphibious force from the ASCM threat. Most ASCMs can be delivered from land, air, surface, or subsurface units. These threats (especially in a compressed battlespace such as the Arabian Gulf) can be well within that 65nm threat envelope regardless of an ARG's distance from shore. If the 65nm stand off mindset would be applied to the Arabian Gulf then ships would cease to operate in that region and the entire Gulf would be conceded to the threat. This is obviously unrealistic and currently not being applied to forces operating in the Arabian Gulf.

**Loss of a Navy Ship**

The loss of a Navy ship would have significant negative effects to the Navy's confidence, the country's resolve, and the U.S.'s reputation of decades of uncontested power projection from the sea. Yet, a zero defect mentality cannot exist in today's naval environment. With the

development and proliferation of more sophisticated ASCMs the high seas and littorals have become a more dangerous place. This doesn't mean navies should cease going to sea. On the contrary, navies should assume the elevated risk, mitigate it by developing technologies and doctrine to counter the threat, and command the seas.

Pushing the amphibious force further out to sea only confounds the amphibious operation and concedes battlespace to the enemy. This conceded battlespace allows the enemy more freedom of movement, which gives them more battlespace to manipulate, and more opportunity to detect, disrupt, and destroy the amphibious force. Additionally, pushing the amphibious force out further increases the vulnerability to other threats such as submarines, large conventional warships, and small boat attack, all the while still within the threat of the ASCM (the original reason for the 65nm stand off). This ends up being a threat multiplier for the ARG commander and increases the complexity of the amphibious assault. This ultimately creates more uncertainty, confusion, and stress. The ASCM must not scare the U.S. into assuming more risk. That being said, the loss of a Navy ship does not have to be necessary nor is it inevitable in the face of the advanced ASCM.

If a ship is lost to an ASCM during an amphibious operation, then the ship was lost because the offensive was not taken to the extent necessary to secure the battlespace. The ship was not lost due to assuming too much risk and not observing a necessary stand-off distance. If the amphibious landing is important enough to risk ships and Marines then it is important enough to aggressively prepare the battlespace and spend some political liability. If it is determined that the amphibious assault is in the nation's best interest and must be conducted to secure those interests then the joint force must spare no expense insuring the safety of the landing force. This aggressive offensive may result in collateral damage and possibly negative images of the U.S. for

the enemy's Information Operations (IO) campaign. The loss of an IO campaign due to collateral damage is more acceptable than the loss of a ship and her crew due to risk aversion and the inability to aggressively take the offensive.

**Conclusion**

EF-21 is too risk averse and potentially leads the Marine Corps down a path to request for unnecessary and costly assets for an unnecessary capability based on an overly inflated and misunderstood threat. The ASCM is this generation's threat to dismiss the amphibious assault. Much like the machine gun, artillery, and advancements in armor were to previous generations. Yet, instead of conceding the ability to project power from the littorals in the form of the amphibious assault, military leaders devised new technologies, created innovative tactics, and improved doctrine and training. They used the widespread belief that amphibious operations were too costly and too dangerous against those that bought into that perceived paradigm shift. Those innovative leaders did not concede the battlespace, they assumed a measured risk, and denied the enemy their ability to wield their A2/AD defense.

The future of the Navy and Marine Corps team is not simply to defend itself against the A2/AD threat whether in the form of mines, FAC or FIAC, ASCMs, or ASBMs. The approach should be to aggressively mitigate those threats, specifically the ASCM, by aggressively preparing the battlespace, shaping the environment in which the amphibious force operates, countering the threat, and commanding the seas both open ocean and littorals. Simply extending the stand-off range and increasing the distance the assault wave must travel, increases susceptibility to mines, FAC or FIAC attack, poor weather conditions, increased logistical strain, and navigation hazards. This stand off approach towards the future amphibious strategy is the antithesis of innovative, questionably negligent, risk averse, and unnecessarily alarmist. The

answer is not pushing the landing force further out to sea, conceding battlespace, and relinquishing domination of the littorals. The answer is to utilize current amphibious force's capabilities while developing innovative technologies to counter current and future threats to the amphibious assault. Funding is required to research and develop a state-of-the-art amphibious force but not for the development of a capability that takes the amphibious force further away from the fight. No amount of preparation can insure the complete safety of an Amphibious Ready Group from the ASCM threat. However, the integration of current defense systems and the application of the Air-Sea Battle's (JAM-GC) NIA/D3 concept to phased shaping operations will allow for the amphibious capability to continue to exist and for the Marine Corps to maintain their relevancy and its Naval roots. Simply, the Navy shall command the seas, close the beach quickly, dispense the amphibious assault without haste, and limit the enemy's window of opportunity to employ any surviving A2/AD assets in protest to the landing.

## ENDNOTES

[1] James, Holmes. "Anti-Access and the 'Fortress-Fleet'" The Diplomat. September 10, 2012. http://thediplomat.com/2012/09/anti-access-and-the-fortress-fleet/.
[2] George, James L., and Christopher Jehn, eds. The U.S. Marine Corps: The View from the Late 1980s. Alexandria, Va.: Center for Naval Analyses, 1988.
[3] Friedman, Brett. "No, the Amphibious Assault Isn't Dead." War on the Rocks. June 12, 2014. Accessed March 21, 2015.
[4] "Air-Sea Battle - Service Collaboration to Address Area Access and Area Denial Challenges." May 1, 2013. Accessed January 19, 2015. http://www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf
[5] ibid.
[6] ibid.
[7] ibid.
[8] ibid.
[9] Grau, Lester W. "The High-Precision Tulip: Development and Combat Employment of the Soviet Laser-Guided Mortar Round." Journal of Slavic Military Studies 18, no. 4 (2005): 717-722.
[10] Williams, Walter. "Threat Update Krasnopol--A Laser-Guided Projectile for Tube Artillery." Foreign Military Studies Office Publications. Accessed March 21, 2015. http://fas.org/man/dod-101/sys/land/row/krasnopol.htm.
[11] "Excalibur XM982 Precision Engagement Projectiles." May 1, 2007. Accessed January 19, 2015. http://www.dote.osd.mil/pub/reports/FY2007/pdf
[12] Heidenrich, John. "The Cruise Missile Threat and Its Proliferation." Marshal.org. October 11, 2006. Accessed March 21, 2015.
[13] Erickson, Andrew S. Chinese Anti-ship Ballistic Missile (ASBM) Development: Drivers, Trajectories, and Strategies. Washington, D. C.: Jamestown Foundation, 2013.
[14] Kazianis, Harry. "China's Most Dangerous Missile (So Far)." War on the Rocks. October 23, 2013. http://warontherocks.com/2014/07/chinas-most-dangerous-missile-so-far/.
[15] O'Rourke, Ronald. "China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress." Congressional Research Service. 2014. https://fas.org/sgp/crs/row/RL33153.pdf.
[16] ibid.
[17] "Defense Updates: Russian Novator 3M-54 Klub / Kalibr / SS-N-27 Missile Complex." Defense Updates. February 11, 2013. http://defenseupdates.blogspot.com/2013/02/russian-novator-3m-54-klub-kalibr-ss-n.html.
[18] ibid.
[19] "Return to Sender: India Rejects Kilo/Klub Sub Missile Upgrades." Defense Industry Daily RSS News. January 14, 2008. http://www.defenseindustrydaily.com/return-to-sender-india-rejects-kiloklub-sub-missile-upgrades-04581/.
[20] "3M-54 Klub." Wikipedia. February 10, 2015. Accessed March 21, 2015.

[21] De Larrinaga, Nicholas, Peter Felstead, and Bruce Jones. "Russia Parades Bastion-P in Crimea." IHS Jane's 360. May 1, 2014. http://www.janes.com/article/37829/russia-parades-bastion-p-in-crimea.
[22] Endres, Gunter. "BrahMos Tested to the Limit." IHS Jane's 360. November 4, 2014. http://www.janes.com/article/45334/brahmos-tested-to-the-limit-id14d1.
[23] Simko, Tom. "India's BrahMos Aerospace in New Missile Race." Indian Defence Review. February 24, 2014. http://www.indiandefencereview.com/spotlights/indias-brahmos-aerospace-in-new-missile-race/.
[24] "C-802." Wikipedia. http://en.wikipedia.org/wiki/C-802.
[25] "Exocet MM40 Block 3 New Generation Long Range Anti-ship Missile System." MBDA Systems. http://www.mbda-systems.com/mediagallery/files/exocet-mm40-block3_datasheet-1424428284.pdf.
[26] Air-Sea Battle - Service Collaboration to Address Area Access and Area Denial Challenges." May 1, 2013: 4-5. Accessed January 19, 2015. http://www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf
[27] "Chapter 8 - LCAC Operations in Extreme Environmental Conditions." In *Employment of Landing Craft Air Curshion (LCAC)*. Washington, DC: Dept. of the Navy, Office of Chief of Naval Operations and Headquarters, U.S. Marine Corps, 1997.
[27] Vitaliy O. Pradun, "From Bottle Rockets to Lightning Bolts: China's Missile-centric Strategy and PLA Strategy against Military Intervention," Naval War College Review, 64.2 (Spring 2011): 7-38.
[28]"Iran Watch." Iran's Long Range Missile Capabilities. July 15, 1998. Accessed April 28, 2015. http://www.iranwatch.org/library/government/united-states/congress/legislation-reports/irans-long-range-missile-capabilities.
[29] "Evolved Seasparrow Missile (ESSM)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/essm/.
[30]"Raytheon." Phalanx Close-In Weapon System (CIWS). Accessed March 20, 2015. http://www.raytheon.com/capabilities/products/phalanx/.
[31]"Standard Missile-6 (SM-6)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/sm-6/.
[32]"Nulka." BAE. 2014. http://www.baesystems.com/product/BAES_020585/nulka.
[33]"7th Fleet Tests Innovative Missile Defense System." Navy. June 26, 2014. http://www.navy.mil/submit/display.asp?story_id=81918.
[34]Jean, Grace. "USN's Prototype Laser Weapon in Operational Use in Gulf." IHS Jane's 360. December 11, 2014. http://www.janes.com/article/46929/usn-s-prototype-laser-weapon-in-operational-use-in-gulf.

## Appendix One

### Seeker Types

The first ASCM was radio controlled but there are many different types of guidance employed on ASCM's. The seeker types include active radar guidance, semi-active radar guidance, passive homing, anti-radiation, command to line-of-sight, beam riding, infrared, laser, wire guidance, inertial, and satellite. Only the most common and most lethal will be reviewed and considered in this thesis.

**Infrared** homing or "heatseeker" is a passive weapon guidance system. It simply relies on the infrared radiation emitted from a target. This infrared radiation can be from engine exhaust of an aircraft or ship and an engine compartment or auxiliary machinery on a ship. This is the most common type of seeker and arguably the easiest to defeat. To defeat this seeker, the IR seeker must be distracted and be provided a larger heat signature. This can be done with flares, infrared countermeasures (IRCM), or an obscurant that either masks or lessens the heat signature of the target so the missile will lock on to stronger heat signatures in the target area. The missile that relies solely on IR guidance cannot discern between friend or foe and the potential for blind impact (hitting an unintended target) is high.[xxviii]

**Laser-guided** seeker technology has been used for several decades and is still in use today. The target is "illuminated" with a laser and the incoming missile will detect the beam and "ride" the beam to the designated target. The laser-guided missile can be defeated several ways. Smoke, fog, water vapor, laser detection systems can all be used and are relatively effective and inexpensive.

**Semi-Active** seekers are the most popular methods for the terminal guidance of cruise missiles. Semi-Active homing relies on the RF energy from an external source whether it be sea, air, or shore based. The external source illuminates the target and the missile receives the reflected RF energy and processes the signal with an onboard computer. It will then make the necessary corrections for intercept.

The positive qualities of a semi-active seeker is that the missile itself does not emit an RF signature that can be detected by onboard systems. The third party can illuminate the target from an off axis stand off distance potentially out of range of the target's weapons systems. The negative aspect is that the missile requires a third party to provide terminal guidance and therefore must be within communication or line of sight. This could be problematic in the sense the third party could be targeted and electronically jammed or destroyed. As a result, the missile would be unable to reach its target.[xxix]

**Active** seekers work very similarly to Semi-Active seekers except the missile transmits and receives its own RF energy from onboard systems. These missiles are often called "fire and forget" missiles since they do not require any further guidance or information from external sources. The positive aspect of the active seeker is that everything it requires to reach its target is onboard the missile. It does not require third party targeting, Missiles typically have a small radar cross section and ability to fly at low altitudes making it difficult to detect without a sophisticated radar suite designed for missile defense. The negative aspect of an active seeker is

that it can be detected by a ship's electronic warfare suite, jammed, and distracted. Additionally, since the missile has more transmitting, processing, and receiving electronic equipment onboard makes it heavier and requiring more fuel. This ultimately leads to a decreased in maximum range and more importantly to militaries on a budget; a higher cost.[xxx]

**Passive** seekers are similar to active seekers in that they require no external source or input. Passive seekers rely on a source emitted by the target to give course corrections for intercept to target. The positive aspect of passive seekers are the same as the active seeker in that it requires no input from outside sensors. More importantly it is not as easily detected by electronic warfare systems since it does not transmit an RF signal. The negative aspect is that it requires a source of emission to detect from the target. If the target ceases or obscures the transmission of whatever the passive seeker is using to home then the missile loses track and is defeated.[xxxi]

## Appendix Two

**Minimum Effective Range:** Cruise missiles have a minimum range at which a target must be in order for the missile to be in the proper flight profile and seeker has time to turn on.[xxxii] If the ASCM threat is known for a particular area in which amphibious operations are to be conducted the amphibious force could remain within that minimum distance to defeat that particular missile. While this would certainly not be the only defense but if coupled with other more robust missile defenses this could further mitigate the ASCM threat.

**ESSM:** The Evolved Sea Sparrow Missisle system is an international cooperative missile program within NATO by the United States, Australia, Belgium, Canada, Denmark, Germany, Greece, Norway, Spain, Turkey, and the Netherlands. The ESSM is an all weather, medium range, high speed, highly maneuverable, semi-active radar homing missile capable of defeating low altitude, high G maneuvering, high velocitiy, ASCMs.[xxxiii] This missile system is anticipated to be expanded, developed, and will be operationally relevant for the long term.

**SSDS:** Surface Ship Defense System is a LAN based system that integrates a ships's sensors and weapons system that provides automated detect, track, and engagement of an inbound threat. This allows for a quicker response time against low-flying, high velocity threats which are usually detected at a shorter range. This is vital in order to give the quicker reaction time and decompresses the commander's decision making time.

**RAM:** The Rolling Airframe Missile is a supersonic missile deployed on most U.S. carriers and amphibious ships. It provides a defense capability to defeat ASCMs, low flying threats, and helicopters.

**CIWS:** Close in Weapons System is an operationally proven very short range, anti-ship missile weapon system. CIWS is a self-contained system that can detect, track, evaluate, and engage inbound threats.[xxxiv] CIWS has been proven to be operationally successful against inbound threats to include the engagement of FAC or FIAC in defense of the amphibious assault wave.

**SeaRAM:** Is a new and evolving technology which incorporates the CIWS tracking system with the RAM missile system. This system will take advantage of the effectiveness of the computing and radar suite of CIWS and the longer range and more capable intercept abilities of the RAM.

**SM-2/SM-6:** The Navy's standard missile has different variants with varying degrees of sophistication geared towards varying degrees of sophisticated threats. The SM-2 and the future fielding of the SM-6 are capable missiles used to intercept ASCMs and aircraft. These missiles provide a competent defense against most ASCMs that could threaten the amphibious assault.[xxxv]

**NULKA/CHAFF:** NULKA is an active "soft kill" missile decoy system. When integrated with a ship's "hard kill" defense system, NULKA provides a layered defense capability that can defeat some of the world's most capable missiles by radiating a large radar cross section, seducing the incoming missile away from the ship.[xxxvi]

**Battlespace Obscurants:** Pandarra Fog is a carbon-fiber cloud that absorbs and diffuses the RF energy from a missiles seeker head. This confuses the missile and obscures the target. It can be

generated from most platforms of ships and is relatively effective against active, passive, semi-active and optical sight seeker heads.[xxxvii]

**LaWS:** This is a directed energy weapon system that integrates with CIWS to defend against UAVs, FAC/FIAC, and other air and seaborne threats. The future state of this system will be to provide ships with a cost-effective alternative to missiles and traditional ordnance used for missile defense.[xxxviii]

## Bibliography

"3M-54 Klub." Wikipedia. http://en.wikipedia.org/wiki/3M-54_Klub.

"7th Fleet Tests Innovative Missile Defense System." Navy. June 26, 2014. http://www.navy.mil/ submit/display.asp?story_id=81918.

"Air-Sea Battle - Service Collaboration to Address Area Access and Area Denial Challenges." May 1, 2013. http://www.defense.gov/pubs/ASB-ConceptImplementation-Summary-May-2013.pdf.

"C-802." Wikipedia. http://en.wikipedia.org/wiki/C-802

De Larrinaga, Nicholas, Peter Felstead, and Bruce Jones. "Russia Parades Bastion-P in Crimea." IHS Jane's 360. May 1, 2014. http://www.janes.com/article/37829/russia-parades-bastion-p-in-crimea.

"Defense Updates: Russian Novator 3M-54 Klub / Kalibr / SS-N-27 Missile Complex." Defense Updates. February 11, 2013. http://defenseupdates.blogspot.com/2013/02/russian-novator-3m-54-klub-kalibr-ss-n.html.

Endres, Gunter. "BrahMos Tested to the Limit." IHS Jane's 360. November 4, 2014. http://www.janes.com/article/45334/brahmos-tested-to-the-limit-id14d1.

Erickson, Andrew S. Chinese Anti-ship Ballistic Missile (ASBM) Development: Drivers, Trajectories, and Strategies. Washington, D. C.: Jamestown Foundation, 2013.

"Evolved Seasparrow Missile (ESSM)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/essm/.

"Excalibur XM982 Precision Engagement Projectiles." May 1, 2007. Accessed January 19, 2015. http://www.dote.osd.mil/pub/reports/FY2007/pdf.

"Exocet MM40 Block 3 New Generation Long Range Anti-ship Missile System." MBDA Systems. http://www.mbda-systems.com/mediagallery/files/exocet-mm40-block3_datasheet-1424428284.pdf.

Friedman, Brett. "No, the Amphibious Assault Isn't Dead." War on the Rocks. June 12, 2014. http://warontherocks.com/2014/06/no-the-amphibious-assault-isnt-dead/#_.

George, James L. The U.S. Marine Corps: The View from the Late 1980s. Alexandria, VA: Center for Naval Analyses, 1988.

Grau, Lester W. "The High-precision Tulip: Development and Combat Employment of the Soviet Laser-Guided Mortar Round." The Journal of Slavic Military Studies 18, no. 4 (2005): 717-22.

Heidenrich, John. "The Cruise Missile Threat and Its Proliferation." George C Marshall Institute. August 1, 2013. http://marshall.org/missile-defense/the-cruise-missile-threat-and-its-proliferation/.

"Iran Watch." Iran's Long Range Missile Capabilities. July 15, 1998. Accessed April 28, 2015. http://www.iranwatch.org/library/government/united-states/congress/legislation-reports/irans-long-range-missile-capabilities.

James, Holmes. "Anti-Access and the 'Fortress-Fleet'" The Diplomat. September 10, 2012. http://thediplomat.com/2012/09/anti-access-and-the-fortress-fleet/.

Jean, Grace. "USN's Prototype Laser Weapon in Operational Use in Gulf." IHS Jane's 360. December 11, 2014. http://www.janes.com/article/46929/usn-s-prototype-laser-weapon-in-operational-use-in-gulf.

Kazianis, Harry. "China's Most Dangerous Missile (So Far)." War on the Rocks. October 23, 2013. http://warontherocks.com/2014/07/chinas-most-dangerous-missile-so-far/.

Kopp, Carlo. "Active and Semi Active Radar Missile Guidance." Air Power Australia. 2005. http://www.ausairpower.net/TE-Radar-AAMs.html.

Kopp, Carlo. "Heat-Seeking Missile Guidance." Heat-Seeking Missile Guidance. 2005. http://www.ausairpower.net/TE-IR-Guidance.html.

"LCAC Operations in Extreme Environmental Conditions - Chapter 8 " In Employment of Landing Craft Air Curshion (LCAC). Washington, DC: Dept. of the Navy, Office of Chief of Naval Operations and Headquarters, U.S. Marine Corps, 1997.

O'Rourke, Ronald. "China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress." Congressional Research Service. 2014. https://fas.org/sgp/crs/row/RL33153.pdf.

"Phalanx Close-In Weapon System (CIWS)." Raytheon. http://www.raytheon.com/capabilities/products/phalanx/.

"Return to Sender: India Rejects Kilo/Klub Sub Missile Upgrades." Defense Industry Daily RSS News. January 14, 2008. http://www.defenseindustrydaily.com/return-to-sender-india-rejects-kiloklub-sub-missile-upgrades-04581/.

"Standard Missile-6 (SM-6)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/sm-6/.

Vitaliy O. Pradun, “From Bottle Rockets to Lightning Bolts: China’s Missile-centric Strategy and PLA Strategy against Military Intervention,” Naval War College Review, 64.2 (Spring 2011): 7-38.

Williams, Walter. "Threat Update Krasnopol--A Laser-Guided Projectile for Tube Artillery." Federation Of American Scientists. http://fas.org/man/dod-101/sys/land/row/krasnopol.htm.

[xxviii] Kopp, Carlo. "Heat-Seeking Missile Guidance." Heat-Seeking Missile Guidance. 2005. http://www.ausairpower.net/TE-IR-Guidance.html.
[xxix] Kopp, Carlo. "Active and Semi Active Radar Missile Guidance." Air Power Australia. 2005. http://www.ausairpower.net/TE-Radar-AAMs.html.
[xxx] ibid.

[xxxi] Vitaliy O. Pradun, “From Bottle Rockets to Lightning Bolts: China’s Missile-centric Strategy and PLA Strategy against Military Intervention,” Naval War College Review, 64.2 (Spring 2011): 7-38.

[xxxii] "Iran Watch." Iran's Long Range Missile Capabilities. July 15, 1998. Accessed April 28, 2015. http://www.iranwatch.org/library/government/united-states/congress/legislation-reports/irans-long-range-missile-capabilities.

[xxxiii] "Evolved Seasparrow Missile (ESSM)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/essm/.

[xxxiv]"Raytheon." Phalanx Close-In Weapon System (CIWS). Accessed March 20, 2015. http://www.raytheon.com/capabilities/products/phalanx/.

[xxxv] "Standard Missile-6 (SM-6)." Raytheon. 2015. http://www.raytheon.com/capabilities/products/sm-6/.

[xxxvi] "Nulka." BAE. 2014. http://www.baesystems.com/product/BAES_020585/nulka.

[xxxvii] "7th Fleet Tests Innovative Missile Defense System." Navy. June 26, 2014. http://www.navy.mil/submit/display.asp?story_id=81918.

[xxxviii] Jean, Grace. "USN's Prototype Laser Weapon in Operational Use in Gulf." IHS Jane's 360. December 11, 2014. http://www.janes.com/article/46929/usn-s-prototype-laser-weapon-in-operational-use-in-gulf.