REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
04/05/2017	Master's Thesis	SEP 2016-APR2107

4. TITLE AND SUBTITLE
The Aircraft Carrier's Relevancy in Future Conflicts

5a. CONTRACT NUMBER
N/A

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
Nowak, Edward J., Lieutenant Commander, 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)

10. SPONSOR/MONITOR'S ACRONYM(S)

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

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The United States is committed to the super carrier for at least the next 50 years, so the debate should transition from an if towards more of a how the super carrier can remain relevant. The American super carrier would most likely not survive a conflict with a near-peer competitor under current modes of operation/employment. This paper contends that the super carrier needs to evolve a combination of its airwing, doctrine, and/or tactics in order to remain relevant in future conflicts.

15. SUBJECT TERMS
Aircraft Carrier, Relevancy, Future, Anti-Access/Area Denial, Air Wing, Carrier Strike Group

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			USMC Command and Staff College
					19b. TELEPHONE NUMBER *(Include area code)*
Unclass	Unclass	Unclass	UU	36	(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: The Aircraft Carrier's Relevancy in Future Conflicts

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

AUTHOR: Lieutenant Commander Edward J. Nowak

AY 16-17

Mentor and Oral Defense Committee Member: Anne Louise Antonoff
Approved:
Date: 4/5/17

Oral Defense Committee Member: CDR USN Russell Burton
Approved:
Date: 05 APR 17

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.

Table of Contents

Illustrations

Page

Executive Summary

Title: The Aircraft Carrier's Relevancy in Future Conflicts

Author: Lieutenant Commander Edward Nowak, United States Navy

Thesis: Advanced A2/AD capabilities have raised concerns for the American super carrier. The carrier would most likely not survive a conflict with a near-peer competitor with its current tactics, doctrine, and air wing. The super carrier needs to continue to evolve a combination of its airwing, doctrine, and/or tactics in order to remain relevant in future conflicts.

Discussion: Today's skeptics of the super carrier, a single asset worth billions of dollars and thousands of lives, point to the risk of sending such a singularly high asset into the vicinity of modern, near-peer A2/AD weaponry. Such systems, say the critics, can easily target and neutralize the carrier and therefore render it irrelevant. The anti-carrier argument holds that the United States should replace the super carrier with existing amphibious ships and/or a higher number of smaller carriers. The pro-carrier argument holds that any decrease in size creates an exponential decrease in capability, viewing the super carrier as the superior in both fiscal and warfighting terms. The United States is committed to the super carrier for at least the next 50 years the construction of the *USS Ford*, so the debate should transition from an *if* towards more of a *how* the super carrier can remain relevant. First, the Navy must examine the air wing and procure new manned and unmanned aircraft with highly increase range and capabilities. Second, the Navy must reevaluate the validity of current carrier doctrine and explore other mission sets. Lastly, the Navy must evaluate carrier tactics regardless of air wing capability or doctrinal missions to decrease risk.

Conclusion: The super carrier is the superior solution irrespective of threat. Any alternative's cost savings result in an exponential decrease in capability. The super carrier has the ability to remain relevant against the ever advancing A2/AD threat, but *must* adapt to do so. Leadership must be willing to inject innovation into the air wing, doctrine, and/or tactics. It is the adaptability of the aircraft carrier that has allowed it to survive thus far, and will be required to survive in the future.

Acknowledgements

I would like to recognize the efforts of the people who enabled this paper. I would like to first thank Dr. Anne Louise Antonoff, Assistant Associate Professor of Military History at the Marine Corps University, my mentor through this process. Her sage, vast guidance was essential in crafting this paper and I thank her for all of her time spent on her mentorship. I would also like to thank Commander Russell Evens, USN for his additional guidance regarding my paper. Lastly, I would like to thank my loving, supporting family. The thanks I have for the patience and understanding they have displayed this past year could never be adequately displayed within the confines of this page.

REPORT DOCUMENTATION PAGE		FORM APPROVED - - - OMB NO. 0704-0188	
PUBLIC REPORTING BURDEN FOR THIS COLLECTION OF INFORMATION IS ESTIMATED TO AVERAGE 1 HOUR PER RESPONSE, INCLUDING THE TIME FOR REVIEWING INSTRUCTIONS, SEARCHING EXISTING DATA SOURCES, GATHERING AND MAINTAINING THE DATA NEEDED, AND COMPLETING AND REVIEWING THE COLLECTION OF INFORMATION. SEND COMMENTS REGARDING THIS BURDEN ESTIMATE OR ANY OTHER ASPECT OF THIS COLLECTION OF INFORMATION, INCLUDING SUGGESTIONS FOR REDUCING THIS BURDEN, TO WASHINGTON HEADQUARTERS SERVICES, DIRECTORATE FOR INFORMATION OPERATIONS AND REPORTS, 1215 JEFFERSON DAVIS HIGHWAY, SUITE 1204, ARLINGTON, VA 22202-4302, AND TO THE OFFICE OF MANAGEMENT AND BUDGET, PAPERWORK REDUCTION PROJECT (0704-0188) WASHINGTON, DC 20503			
1. AGENCY USE ONLY (*LEAVE BLANK)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED STUDENT RESEARCH PAPER	
4. TITLE AND SUBTITLE THE AIRCRAFT CARRIER'S RELEVANCY IN FUTURE CONFLICTS		5. FUNDING NUMBERS N/A	
6. AUTHOR(S) Lieutenant Commander Edward Nowak			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC COMMAND AND STAFF COLLEGE 2076 SOUTH STREET, MCCDC, QUANTICO, VA 22134-5068		8. PERFORMING ORGANIZATION REPORT NUMBER NONE	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) SAME AS #7.		10. SPONSORING/MONITORING AGENCY REPORT NUMBER: NONE	
11. SUPPLEMENTARY NOTES NONE			
12A. DISTRIBUTION/AVAILABILITY STATEMENT NO RESTRICTIONS		12B. DISTRIBUTION CODE N/A	

ABSTRACT *(MAXIMUM 200 WORDS)*

Today's skeptics of the super carrier, a single asset worth billions of dollars and thousands of lives, point to the risk of sending such a singularly high asset into the vicinity of modern, near-peer A2/AD weaponry. Such systems, say the critics, can easily target and neutralize the carrier and therefore render it irrelevant. The anti-carrier argument holds that the United States should replace the super carrier with existing amphibious ships and/or a higher number of smaller carriers. The pro-carrier argument holds that any decrease in size creates an exponential decrease in capability, viewing the super carrier as the superior in both fiscal and warfighting terms. The United States is committed to the super carrier for at least the next 50 years, so the debate should transition from an *if* towards more of a *how* the super carrier can remain relevant. The American super carrier would most likely not survive a conflict with a near-peer competitor under current modes of operation/employment. This paper contends that the super carrier needs to evolve a combination of its airwing, doctrine, and/or tactics in order to remain relevant in future conflicts.

14. SUBJECT TERMS (KEY WORDS ON WHICH TO PERFORM SEARCH) Aircraft Carrier, Relevancy, Future, Anti-Access/Area Denial, Air Wing, Carrier Strike Group		15. NUMBER OF PAGES: 16. PRICE CODE: N/A	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE: UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT

Introduction

The super carrier most Americans are familiar with today emerged in the 1950's and has enjoyed over 60 years as the most dominant and capable naval asset not only in the United States but also the world over. Much as nuclear weaponry once threatened its viability; however, the rapid advancement of (A2/AD) capabilities by adversaries—specifically missile capabilities—has called into question the validity of deploying such a singularly costly asset, worth billions of dollars and thousands of lives, in the face of increasing danger.

Numerous suggestions—both for and against the carrier—have been put forward across a wide range of methodology and logic. The question is not *if* carriers need to change in order to remain effective in future conflicts and environments, but *how* to do so. Numerous theories exist that cover nearly every aspect of the carrier. Some ideas, such as augmenting the carrier fleet with amphibious ships or replacing super carriers with a higher number of small carriers, look good at first glance, but have flaws in their logic that make them unviable options for implementation. The aircraft carrier must—and has the ability to—evolve through new aircraft, doctrine, and/or tactics in order to stay ahead of the rising A2/AD threat. Luckily for the carrier, adaptation and skepticism are issues the carrier has had to deal with from the start.

The History of the Aircraft Carrier Debate

Controversy has plagued the carrier since the British introduced the world's first aircraft carrier—the *HMS Argus* in 1918. The American aircraft carrier, a shining example of innovation during the Interwar Period, quickly surpassed the battleship as the capital ship of the United States Navy and has ruled the fleet ever since. Doubts nevertheless surfaced at once over the then unproven and theoretical utility of carriers. World War II gave the carrier the chance to

prove its worth as a strike element and played a pivotal role in the Pacific Theater. The carrier debate, however, would resurface before World War II even ended. The "modern" debate can be divided into the three categories: "strategic and hydrogen bomb" challenge (1942-1965), "early anti-access" (1965-1980), and "modern" (1995-present).[1]

While carrier aviation served the Navy well in World War II, the Army Air Corps viewed it as inferior to land-based aviation and competition for funding. One of the main anti-carrier advocates of the time was Major Alexander de Seversky, one of the founders of strategic bombing doctrine. He argued that ground-based aircraft had superior range and payload capacity and that a carrier would have to position itself deep in hostile waters to be effective. Additionally, he argued that naval aircraft would never be able to carry something so large as an atomic bomb.[2] de Seversky's criticisms didn't consider the innovations occurring with the carrier, and proponents were quick to identify flaws with his logic. Traditional bombing tactics were ineffective against naval forces. Even slow ships could evade major bombing runs. Carrier aviation, however, was effective against ships as well as providing an area defense capability.[3] Additionally, the Navy sought and eventually developed a new class of carrier capable of utilizing jet aircraft, which had better range and payload compared to their propeller-driven predecessors.

The main argument against carriers with the advent of the hydrogen bomb was that the blast radius of the hydrogen bomb was wide enough to destroy an entire carrier group even if the bomb didn't hit directly or if the group was dispersed.[4] Carrier advocates were quick to respond by noting that not only were land forces more vulnerable to a hydrogen bomb than a carrier, but they were also vulnerable to a wider range of threats than a carrier was. This counterargument

was basic but as universally applicable today as it was back then at providing the fundamental reason for the existence of the carrier.

The "early anti-access" years brought a new set of arguments against the carrier. Carrier detractors argued that inexpensive anti-access systems could hold off a carrier and fast attack submarines could eliminate a carrier along with its escorts.[5] Additionally, missiles were a cheaper offensive option that could take the role of the carrier. Combat experience would prove the effectiveness carrier aviation would provide in Korea and Vietnam. By the end of the Vietnam War, U.S. naval aviation could fulfill almost any mission of the U.S. Air Force, from precision strikes to nuclear attack.[6] Carrier aviation, however, did not need the hardy fire support that land-based aviation needed to project its power and, according to Secretary of Defense Robert McNamara in 1966, "although the investment to procure these ships is substantial, our experience in Vietnam and recent study results indicate that total costs to procure, support, and defend overseas land based tactical air forces are comparable to total costs of carrier task forces of equal capability."[7] Innovations in aircraft design and the carrier strike group CSG (the solution to air and submarine threats) further allowed carriers to have a key role in the U.S. Naval service.

The Modern Aircraft Carrier Debate

The "modern" debate regarding carriers breaks down into three arguments: 1) carriers are getting too expensive and are increasingly vulnerable to advanced anti-access/area denial (A2/AD) capabilities, 2) aircraft carriers were unnecessary against low-end adversaries and did not account for a peer-like competitor, and 3) A2/AD systems such as China's DF-21D Anti-Ship Ballistic Missile have no effective defense and are a serious threat to the carrier.[8] Through these criticisms, the carrier continues to show its relevance. Following September 11th, carrier

aircraft from the *Carl Vinson*, *Enterprise*, and *Kitty Hawk* provided 72 percent of combat sorties in the early stages of Operation Enduring Freedom when Central Asian airbases were unavailable. In 2014, the *Bush* CSG was the only asset able to project air power against ISIS in Syria for 54 days.[9]

While highly relevant in conflicts today, the carrier has been operating in an uncontested environment against non-state actors and low-end competitors for over two decades. The concern over how today's carriers compete against a competent, peer-like competitor—and its corresponding A2/AD threats—is valid. The A2/AD analysis later in this essay will concentrate on China, as it a perfect example of a rising peer-like competitor with ever-advancing A2/AD capabilities. China—along with Russia—is also one of the United States' more likely future adversaries. First, however, the argument that the super carrier should be replaced with either amphibious ships and/or a larger number of smaller carriers should be examined.

Proposed Alternatives to the Super Carrier

The argument that the current fleet of carriers be augmented or replaced with existing amphibious assault ships acting as aircraft carriers is a popular one. Some maintain that the United States has 19, not 11, aircraft carriers when one factors in the amphibious assault class ships. A point of contention is that the US amphibious ships are comparable to—and would be called—aircraft carriers in any other navy. The *USS America*, with a 45,000-ton displacement, is approximately the same size as the *Charles De Gaulle* (France) and the *Vikramaditya* (India), although a bit smaller than the *Admiral Kuzetsov* (Russia) or her Chinese sister, the *Liaoning*.[10] Additionally, the *America* is considerably larger than recent aircraft-carrying ships constructed for the Korean, Japanese, and Australian navies.[11]

Advocates for amphibs are quick to cite Operation Odyssey Dawn in Libya as a success story where the *USS Kearsarge* filled in for the lack of carriers in the vicinity.[12] While normally fitted with just four to six Harrier jets, amphibs can be outfitted with as many as 30 F-35Bs if it is stripped of its helicopter component.[13] Advocates also note that missions like Operation Odyssey Dawn can be accomplished at a fraction of the price of a super carrier. *Nimitz* class carriers cost about $4.5 billion dollars to build and the *Ford* has already surpassed $13 billion dollars. Meanwhile the *Wasp* class ships cost about $750 million dollars.[14] Advocates compound that monetary fact with the notion that increasing adversarial long strike and A2/AD capabilities are slowly eroding the effectiveness of carriers and paving the way for amphibs to take over as the new capital ship, just as the carrier had done to the battleship. Were it still 1945, this argument might bear some truth—in reality—the very argument that amphib advocates make in support of their views may be the single biggest reason why amphibs *cannot* replace carriers.

At first view, a 45,000 ton "flattop" with two dozen jet aircraft aboard certainly looks like an aircraft carrier. An aircraft carrier is much more, however, than a ship that has the ability to launch and recover aircraft. It must be a self-contained combat system, able to operate far from land-based support and fulfill a variety of missions in a contested environment.[15] Even if the carrier's ability to perform in such a way is currently threatened, the amphib is even more vulnerable than the carrier for the same reasons.

The F-35B, the sole fixed-wing asset of amphibious ships, represents an increase in range and payload over the older AV-8 Harrier. These advances, along with increases in connectivity, sensing, and stealth are all good things, but they do not elevate the F-35B into the class of carrier-based aircraft.[16] The range and endurance of the F-35B are still short enough that it would require the amphib to get closer to the fight, and therefore closer to enemy strike and

A2/AD capabilities, than any carrier would need to do. Moreover, in order to operate as a self-contained unit, the carrier employs several other platforms that amphibious ships do not (and currently cannot) have.

To conduct coordinated operations, counter enemy aircraft, and direct targets hundreds of miles away, strike aircraft require situational awareness and command and control. The Airborne Early Warning (AEW) aircraft E-2 Hawkeye—four of which are assigned to the average aircraft carrier—provide these capabilities.[17] Strike aircraft also operate in hostile environments and require the need for countering enemy defenses. The F-18G Growler, which recently replaced the EA-6B Prowler on carriers, fills the role of electronic warfare. The aircraft carrier has additional requirements for vertical replenishment, medical evacuation, combat search and rescue, anti-surface warfare, maritime interdiction, close air support, intelligence, surveillance and reconnaissance, anti-submarine warfare, and special warfare support.[18] The MH-60S/R helicopters on the carrier fill these roles. The importance of the anti-submarine warfare capabilities provided by the MH-60Rs cannot be overstated given a submarine's attack abilities and the growing proliferation of submarines by enemy forces.

Amphibious ships have no organic, airborne early warning platforms or electronic warfare platforms. Amphib ships do have a certain ability to accomplish vertical replenishment, medical evacuation, combat search and rescue, and maritime interdiction with their current configuration of various helicopters; however, they lack the ability to organically conduct anti-surface warfare, close air support, intelligence, surveillance and reconnaissance, anti-submarine warfare, or special warfare support. However, if the amphib were reconfigured to maximize the number of F-35Bs embarked, the amphib would lose the majority of the helicopter component, effectively stripping it of the missions it was once capable of accomplishing. To make room for

the F-35Bs, the only helicopters that would likely remain embarked are three to four MH-60S helicopters. While the MH-60 is technically capable of filling the majority of the roles, its primary mission while on an amphib is search and rescue (SAR). In order for the F-35Bs to take off and land, a SAR-capable MH-60S must be airborne at all times within close proximity of the ship. This means that if the helicopters are fulfilling some role other than SAR, then the F-35Bs aren't flying, which means that power is not being projected and the amphib is a wasted asset.

In addition to a lack of diverse aircraft incapable of completing the prerequisite mission sets for a formidable strike, the structure and design of amphibious ships severely undermines the increased mission capability these ships would assume in order to replace an aircraft carrier. The decision to use nuclear power was driven not by projected fuel costs, but by logistics, storage, and performance capability. Staying with conventional power instead of switching to nuclear power does save the Navy approximately 40%.[19] With nuclear power, however, the aircraft carrier and its air wing do not need to compete for space on the ship to store fuel. Nearly all of the three million gallons of fuel onboard a *Nimitz* class carrier goes towards the air wing. By contrast, an amphib—which is half the size of a carrier and conventionally powered—can only carry a little over 375,000 gallons of aviation fuel. A conventional ship also necessitates smoke stacks and other internal design considerations that severely diminish space aboard for other stores such as ammunitions and food stores. This constraint increases the demand for logistical replenishment. The small size of amphibs calls into question their ability to generate the same number of sorties as an aircraft carrier.[20] The increased demand for logistical replenishment takes away from time needed to generate sorties, further exacerbating the concern.

Many of the concerns related to the amphibs—except for nuclear power—also apply to the argument that "super" carriers should be replaced by a higher number of smaller carriers.

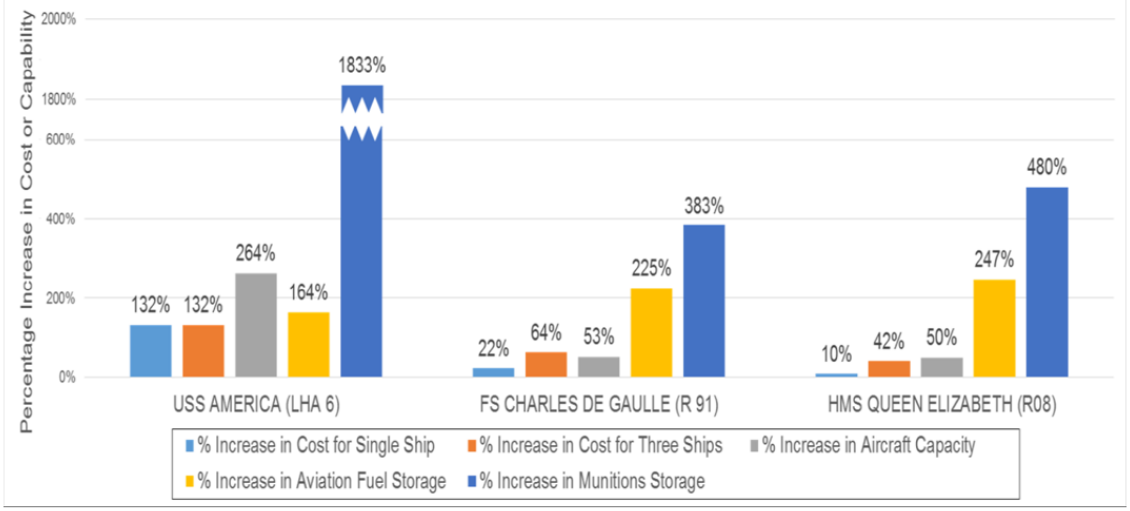
The RAND Corporation—one proponent of the strategy—stated in their 2015 survey *The U.S.-CHINA Military Scorecard* that "the U.S. Navy, for its part, could spread risk and increase flexibility by moving to smaller carriers, as well as save resources."[21] They also suggest that smaller carriers would increase flexibility and save resources and money. These arguments seem to fall apart for most of the same reasons as the amphibious ship argument.

While the argument that a higher number of carriers would reduce the risk of any one carrier seems to make sense on the surface, it isn't actually supported in the RAND survey.[22] In fact, the smaller size of the carriers immediately presents a counterargument. In order to achieve necessary baseline defensive requirements, as well as meet a comparable sortie generation rate, a number of these smaller carriers would have to work in such proximity of each other that the targeting issue for the enemy is effectively nullified.[23] Additionally, the large flat flight deck of a carrier presents a distinct top-down radar signature that many over the horizon radars would likely be able to detect, regardless of size.[24]

Then there is the issue of cost. The fact that a smaller carrier costs lesser than a bigger carrier is a fact, backed by science and common sense. This argument—like all the others—breaks down once one scratches the surface. "Steel and air" are cheap; combat systems, however, are expensive.[25] Every carrier needs escorts, and the increased number of escorts needed—coupled with the higher amount of said smaller carriers—consumes most, if not all, of any savings. Additionally, and more importantly, the cost versus capabilities line is not linear. Analysis in the late 1990's by the Navy concluded that a medium-sized nuclear carrier, with an air wing of 55 aircraft, would cost 87-92% of what it costs to build a *Ford* class carrier; however, monthly sortie generation would fall nearly 50% over a traditional air wing with a notional air wing of 75 aircraft.[26]

The stark contrast between cost and capabilities is embodied in Figure 1. The *Ford* class carrier is 22% more expensive than a ship such as a modernized *Charles de Gaulle* that incorporated the electromagnetic aircraft launch system (EMALS), yet is able to carry 53% more aircraft, 225% more aviation fuel, and 383% more munitions.

Figure 1: Cost versus Capacity analysis for Ford class carrier versus alternate ship designs.



Source: Hudson Institute, *Sharpening the Spear*, Figure 18: Comparison of Ford Class (CVN 80) with Alternate Ship Designs, p. 87.

Switching to conventional power instead of nuclear power does save money. However—for the same reasons mentioned in the amphibious argument—it comes at the severe cost of internal shipboard storage. The *Ford* class magazine is 23 times larger than any amphibious ship in the U.S. Navy inventory.[27] To refer to the old adage, it does seem that—in this case—one truly gets a bigger bang for their buck.

The Super Carrier's Main Threat Analysis

If a super carrier is as a financially sensible ship as shown, what can be done to mitigate risk, defend, and properly utilize such a valuable and costly asset? Before answering this question, the actual A2/AD threats posed by a peer-like competitor need to be examined further in order to propose what the carrier can do to combat them. China's A2/AD capabilities can be

categorized in terms of short (200 nm), medium (600 nm), and long range (600+) threats. Within the short range, China is equipped with approximately 40 Russian-built S-300 SAM batteries and 60 HQ-9 models, which together form what the U.S. Department of Defense has deemed one of the largest forces of advanced SAM systems in the world.[28] Additionally, once China receives the upgraded S-400, it will be able to able to target out to 215 nm, fully encompassing its exclusive economic zone (EEZ).[29] In addition to SAMs, China operates over 100 surface combatants (destroyers, frigates, fast-attack craft, etc.) capable of carrying the anti-ship cruise missile (ASCM) YJ-83 with a range of 65 nm.[30] China's Kilo class submarines are outfitted with the SS-N-27 Sizzler, an ASCM with a range of 160nm and a terminal phase altitude of five to ten meters. This results in detection at approximately 18 nm and less than 1 minute to respond.[31]

In addition to more conventional threats, China is also embracing other technologies. China is in possession of over 100 Israeli-built Harpy UAVs. With a range of 215 nm and a 32kg warhead, China utilizes them as anti-radiation missiles that loiter within the EEZ.[32] A payload of that size would hardly do any significant damage to a ship the size of the carrier, but if China implements a swarm tactic with UAVs, it would be both hard to defend and might be capable of achieving a "mission kill".

China's medium threats include a variety of platforms that can reach the East and South China Seas, as well as areas of Japan and the Philippines. For example, the J-10A/S fighter jet, capable of delivering the 65 nm-range YJ-83, has a combat radius in excess of 540 nm.[33] This brings the J-10A/S's effective reach to 600 nm, which presents a key problem—notably the disparity between A2/AD threats and the average air wing combat radius—that will be discussed at length in a future section. China is also developing UAVs capable of assisting in over-the-

horizon targeting for ASCMs and anti-ship ballistic missiles (ASBM). These capabilities increase when one factors the Paracel and Spratly Islands into the equation. China's medium range threat could be considerably extended if it were to militarize these highly-contested islands with SAM sites or any other military capability.

China's A2/AD threats wane as they exceed 600 nm. This does not mean, however, that it does not have any capabilities. While most of China's land-based aircraft can only reach this distance through aerial refueling, there are some exceptions that cause concern. China has approximately 250 Su-27 Flankers and J-11s, and over 100 Su-30MKK/2 Flankers.[34] All of these aircraft possess a combat radius over 750 nm, which presents a severe advantage over the current average air wing combat radius. Two fifth-generation fighters, the J-20 and the J-31, are also in development. Coupled with any potential long-range ASCM, these fighters may have an effective radius of 1,200 nm; 1,000 nm for the jet, 200 nm for the missile.[35]

There are other systems such as the DF-21D ASBM, which is by far the most referenced and most feared platform capable of targeting a carrier. Specifications on the DF-21D vary, but the ASBM can purportedly travel at Mach-10, possesses a cluster warhead designed to incapacitate a carrier flight deck, and is capable of striking slow moving targets from a distance of 810 nm with an accuracy circle of 20 meters.[36]

It is easy to see why this situation worries those among the defense establishment concerned with the risks towards carriers. Given such examples of advanced A2/AD capabilities of a peer-like competitor, is the super carrier—a singularly massively expensive asset—a sensible and capable platform in future conflicts? The short answer is…yes. The road to future success for the carrier, however, has reached a doctrinal fork. If the carrier is to remain not only a viable option but *the* premier, dominant source of naval power projection, and the envy of

every other navy, then the carrier must, above all, drastically improve the aircraft that comprise the carrier wing. If the air wing is not overhauled, then the doctrinal mission of the carrier must change from power projection and strike to a number of other possible mission sets.

How The Air Wing Can Evolve

Starting in the Interwar Period, innovations in technologies and procedures spawned an evolutionary history for naval aircraft that has been intertwined with the history of the carrier itself. Captain J.M. Reeves, the Commanding Officer of the *USS Langley* in 1926, used the knowledge he learned from the "Fleet Problems" simulations at the Naval War College to increase the number of aircraft onboard a carrier from 12 to 42. He also dramatically reduced launch and recovery cycles and developed the safe and efficient maneuvering of aircraft on a crowded flight deck.[37] The Navy eventually engineered—through constant research and development—the F6F Hellcat and F4U Corsair, the first naval aircraft able to handily defeat Japanese aircraft.[38] From there, carrier air wings would continue to evolve in order to defeat enemies abroad and quiet critics—who argued that naval aircraft would never be as useful as land-based aircraft—at home. The carrier air wing for the *USS Langley* in 1922 was 30 aircraft with an average range of 140 nm and a payload of 610 lbs.[39] The Navy, through more "Fleet Problems", recognized that mass was critical to naval aviation success and the USS Lexington carrier air wing grew to 70 aircraft with an average range of 258 nm and a payload of 371 lbs.[40] Combat experience in World War II confirmed the need for mass, range and payload, which resulted in the *Essex* class carrier air wing having 90 aircraft with an average range of 758 nm and a payload of 1,800 lbs.[41]

The dawn of the nuclear age and jet propulsion saw the carrier air wing lightly reduce its numbers, but dramatically increase abilities. The *Forrestal* class carrier—the world's

first super carrier—was designed for one specific purpose: to launch and recover aircraft large enough to carry a heavy load of ordnance a long distance.[42] The *USS Forrestal* carried 46 aircraft with an average range of 1,210 nm and a payload of 4,522 lbs.[43] The Vietnam War and the Cold War would see the average carrier air wing stabilize at around 80 aircraft with an average payload of 13,754 lbs., approximately three times the amount of the air wing from the 1950s. The average range of aircraft decreased to 732 nm during this time; however, the Navy was insightful enough to extend ranges with massive organic tankers such as the A-3 Skywarrior, which was able to extend the range of 10 aircraft to 1,800 miles.[44]

Ironically, the end of the Cold War began the Navy's retreat from the tenets of mass, range, and payload at a time when A2/AD capabilities were advancing and proliferating rapidly. The *Nimitz* class air wing currently has approximately 60 aircraft with an average payload of 12,040 lbs. and an average range of 496 nm, numbers not seen since the 1930s.[45] This can be attributed to two main events: the cancellation of the A-12 and the rise of the F-18. The A-12 was designed to be 70 feet from wingtip to wingtip and 36 feet long and 80,000 pounds fully loaded. It would have possessed a payload of 6,000 lbs. internally and a combat radius of 1,000 nm.[46] The A-12, however, was cancelled in 1991 and the Navy would permanently lose its deep-strike capability. Around the same time (1987) the F/A -18C Hornet was introduced to naval aviation. The Hornet was popular for many reasons; it was cheap, reliable, efficient, and stable—having one of the world's first fly by wire systems. It was designed to fill multiple roles on the carrier and, as the old adage goes, it became a "jack of all trades, master of none." While the Hornet's nine stations could carry 13,700 lbs. of either fuel, munitions, or equipment, it fell critically short on range. The Hornet's combat range has been cited at as 366 nm for air to air and 415 nm for attack.[47] This was initially acceptable, but the retirement of the A-3 only 4 years

later has severely limited range since then. The F/A-18 E/F has only slightly better range of approximately 500 miles. As a tanker, an F/A-18 E/F can extend 4 Hornets out to 1,000 miles.[48] While a step in the right direction, these ranges pale in comparison to the days of the A-3s.

In the face of increased A2/AD capabilities, the Navy has signed on to another aircraft with a minimal range increase, if any at all, the F-35C. At its inception, the aircraft was to have a range of 730 nm, already well short of A2/AD threats and of legacy aircraft. By 2010, estimates for the combat radius of the F-35 had dropped to 550 nm, 50 more nm than the F/A-18 E/F.[49] The problem with this reoccurring theme should be apparent when overlaid with the current A2/AD problem. The current and future composition of carrier air wings at an average range of 600 nm means that a carrier must enter the purported range of the DF-21D "carrier killer" for 400 nm before being combat effective.

There are ways in which the Navy could restore its deep-strike capabilities through new programs such as a resurgence of A-12-like programs, or the total acceptance of the unmanned combat aerial vehicles (UCAV). The A-12 program is the more conventional route, with the wheel being refined, not re-invented. The Navy has produced aircraft with ranges exceeding 1,000 miles with sufficient payload capacity in the past and it could do so again in the future if the Navy decided to produce a deep-strike aircraft. The inherent problem with such a platform in an age of A2/AD threats is that the physiological toll on a pilot due to the length of the mission driven by ever-advancing stand-off distances, and/or the need to loiter on-station to find mobile or time critical targets, makes the likelihood of such a platform unlikely to ever materialize.[50]

The realistic future and possible savior for the air wing and the carrier itself lies in the form of unmanned systems, specifically the X-47B. The X-47B boasts a range of 2,100 nm with an internal payload capacity of 4,500 lbs.[51] The advanced capabilities such a platform could

bring to a carrier air wing are numerous ranging from intelligence, surveillance and reconnaissance (ISR) to aerial refueling, to deep-strike. Testing for the X-47B has gone relatively well. The X-47B made its first catapult launch in 2012, first carrier landing in 2013, completed combined operations with manned aircraft in 2014, and completed the first fully autonomous aerial refueling operation in 2015.[52]

Multiple possible future air wing configurations exist, from the status quo to such injected variables as F/A-18 E/F quantities, F-35B quantities, and X-47B quantities (and roles). The most of audacious of them, however, claims to solve the issues of air wing range and fiscal austerity in one fell swoop. One proposal in the report *RETREAT FROM RANGE: The Rise and Fall of Carrier Aviation* calls for cancelling the F-35B program and extending F/A-18 Super Hornet production to cover the gap until the X-47B comes online. Cancelling the F-35B would save $85 million per aircraft and the Navy would eventually be able to purchase two squadrons of 12 Super Hornets (in addition to the two Super Hornet squadrons already present) to replace the two squadrons of 10 F-35Cs and purchase six squadrons of UCAVs with 16 aircraft apiece (12 strikers and four tankers) and still have money left over.

The X-47B has a possible Achilles heel, however: the institutional organization and mindset of the U.S. Navy. The technology to use a drone for ISR or tanking at a minimum has existed for years. The Navy, however, has concluded its UCAV testing with the execution of the recent aerial refueling test. It may be because Navy leadership is uncertain of what becomes of the pilot and what it means for promotion, having a "real men fly planes and command air wings and get promoted by others who do" mindset.[53] Recent public statements of tactical naval aviation admirals, who make up 26 percent of unrestricted line flag officers, do not appear to consider unmanned aircraft operating from the carrier deck in any other role than surveillance or

"spotter" for the carrier and its air wing.[54] If the Navy fails to make the necessary upgrades to its future air wings then it must seriously reconsider the mission of the carrier itself if the carrier is to survive.

Doctrine/Tactical Adaptation of the Aircraft Carrier

In the current realm, while the carrier may not be able to hold its own against a peer-like enemy, the countries with those capabilities are—for now—few. The carrier could—in theory—continue to operate as is against the vast majority of potential adversaries, as it contains more airpower and firepower than the entire air force of many nations. The carrier may also be the ship best suited to counter the tactics—such as swarm attacks—that lesser capable forces are adopting.[55] However, if A2/AD capabilities advance and proliferate at the current rate, the likelihood of these missions for the carrier will surely diminish.[56] What missions then could a carrier fulfill in the future?

The carrier could return to one of its original missions as the "eyes of the fleet" and resume a form of reconnaissance role or command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) as it is called today. The carrier air wing would be comprised of mainly UCAS systems such as the X-47B as well as any number of drones designed to either conduct C4ISR and/or create a network infrastructure which would allow the carrier to communicate with other assets in the case of a global positioning system (GPS) failure. The long range of the UCAS system would have increased maneuverability and operate at a distance in which the risk more appropriately matches the task.[57]

Alternatively, the carrier could be used as a mothership of sorts for other ships such as submarines or littoral combat ships (LCS). By design, most logistical and maintenance functions

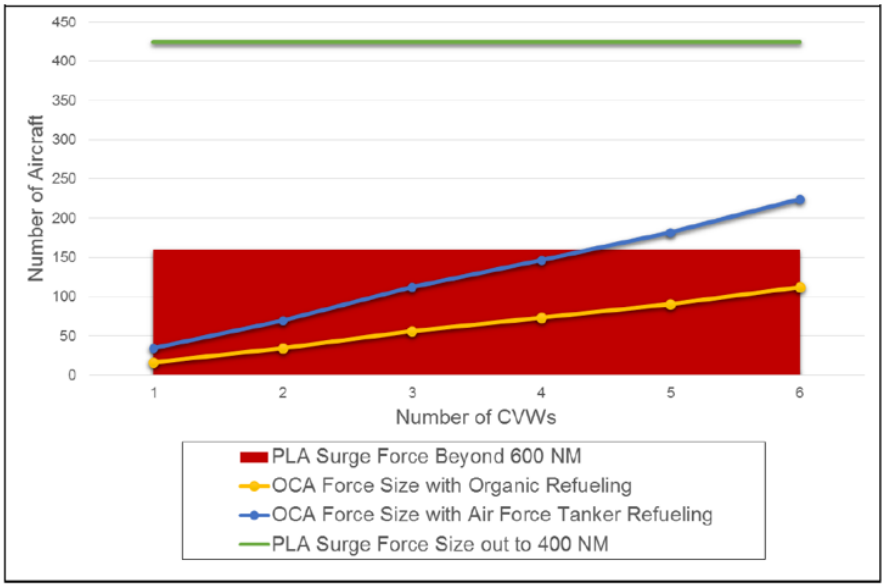
have been removed from the LCS, which therefore requires a fair amount of external support. If LCSs were to enter a high threat area where there are no bases and regular logistical ships would be at excessive risk, then a carrier might be the solution.[58] With tremendous amount of fuel and ammunition capacity, high speeds, and defense capabilities, the carrier may be perfectly suited to execute expeditious at replenishments at sea with an LCS or any other ship.[59] Furthermore, accepting a mothership role does not exclude the possibility of also acting in a C4ISR role as well. The carrier could certainly execute a C4ISR mission with its UCAS system while simultaneously acting as a mothership. In fact, it makes sense that the two missions would mutually benefit from each other.

Ultimately, even if the carrier air wing evolves and/or the mission changes, the tactical employment of the carrier must evolve. Given the range of naval aircraft and the fact that 80 percent of the world's population and capitals are located within 200 nm of a coastline, Navy planners prefer to operate a carrier 50-100 nm from an enemy coastline.[60] The days of a carrier mulling about continuously at those distances are dwindling and already unacceptably risky against a peer-like competitor. Two of the proposed future tactics are the pulsing of combat power and integrated multi-CSG operations.

Pulsing combat power is fundamentally a type of "hit and run" tactic. A CSG would operate at the edge of an enemy's A2/AD range, utilizing long range weapons against targets and repositioning in emissions control (emcon) to another operating area.[61] Repositioning constantly would cause the enemy to greatly increase its search area, consuming ISR resources while also eroding enemy strike capabilities by operating at range.[62] While carriers could implement this tactic with current air wings, improving air wing range as aforementioned would certainly increase the effectiveness.

One constant concern from a peer-like competitor is the ability to surge and overwhelm a carrier, or any asset for that matter. Integrated multi-CSG operations is an attempt to solve that problem. Multiple (anywhere from 2-6) CSGs would simultaneously attack a target, amassing an amount of power projection that could match the enemy's. Figure 2 below shows that it would require 4-5 CSGs with Air Force refueling to match the PLA capabilities at a range of 600 nm. This tactic is completely plausible with some doctrinal augmentation for command and control, but would only be used as an initial attack and require a decisive single battle mindset.

Figure 2: Comparisons of U.S. CVW and PLA Surge Force Generation Capacity



Source: Hudson Institute, *Sharpening the Spear*, Figure 8: Comparisons of U.S. CVW and PLA Surge Force Generation Capacity, p 44.

The main constraint in this tactic is logistics. It would drain virtually the complete logistical capacity of the Navy (to include Military Sealift Command) to refuel 5 CSGs 3,000 nm from an advanced base.[63]

The De-evolution of the Carrier Strike Group

Evolutions in aircraft, doctrine, and tactics, have all offered a different solution to the same problem of how to utilize the carrier in the future against a peer-like competitor. The true

answer may lie with a combination of all the above. The world becomes more complex every day, and the carrier needs to shift from the cookie cutter CSG structure it deploys with. A nominal CSG consists of one nuclear-powered aircraft carrier, six large multi-mission surface combatants (cruisers and destroyers), and two attack submarines. With the disappearance of the Soviet Navy, and with no open ocean threats to carriers evident on the horizon, naval planners concluded that they could reduce the number of carrier escorts to three combatants (all with AEGIS) and one submarine without appreciably raising the risk to the carriers.[64] Using that structure as a minimum benchmark, the CSG should be able to expand as necessary based on mission, anticipated threats, and enemy capability.

If a carrier were assigned a foreign humanitarian assistance (FHA) mission, it would require minimal escort support depending on the theater the mission is in. A FHA mission in the United States of the Caribbean, for example, would require less escort capability than a FHA mission in the PACOM AOR, China's back yard. In a conflict against a low-end to moderate competitor, the Navy could continue to deploy CSG structures comparable to the nominal set established in the Cold War. As conflict escalates and enemy capabilities increase, the CSG—and ultimately the Navy as a whole—needs to be ready for multiple different, unusual and simultaneous carrier missions with correspondingly different escorts and air wing capabilities.

A conflict with a peer-like competitor (China) would certainly cause many of the United States assets to shift into the PACOM AOR, and CSGs would be no different. With the majority of carriers in PACOM, there are ample opportunities for CSGs to diversify their mission sets to aid in the fight. A CSG could be assigned to "no man's land", the area in between two adversarial A2/AD capabilities. The carrier would perform C4ISR missions and be assigned a relatively minimal escort CSG. The air wing would be mainly comprised of long range UCAS

systems capable of covering vast swaths of ocean with a smaller contingent of manned aircraft for defensive and search and rescue purposes.

Closer to the threat environment, carriers could fulfill a variety of roles. Multiple CSGs within the AOR could rotate through assignments ranging from a "mothership", supporting amphibious assets, to C4ISR missions, to combined operations with other CSGs to execute a power pulse attack. The air wing would have a degree of modularity, tailored to the carrier's mission. Surrounding the carrier, the CSG would, in effect, disaggregate. While CSGs would not disappear, the rigid unit assignments within the CSG would. The combined CSG assets (cruisers, destroyers, submarines, etc.) for the participating carriers would be distributed to the carrier based on mission and threat level. For example, a carrier assigned to being a mothership might get close to the minimum CSG allotment while the carriers executing the pulse attack would receive the lion's share of the escorts.

This interoperability and fluidity may sound radical; however, only when compared to how carriers have operated over the past 20 years. This concept has roots in doctrine laid out by Rear Admiral Fredrick Sherman, who modified the *Standard Cruising Instructions for Carrier Task Forces* in 1943. In the doctrine, Sherman allows for carrier to operate air patrols and scouting missions while the other carrier stood ready to conduct strikes, with the two carriers rotating between the "duty carrier" and the strike carrier.[65] Most notably, it also calls for multiple carriers in a task force to separate during air attacks with each carrier taking with it "those cruisers and destroyers that can form screens in the shortest possible time".[66] According to Sherman, escorts had the ability to be requirement driven instead of being permanently assigned to a particular carrier. While escort "pick-up games" were possible in WWII, the complexity of the current warfare requires a degree of coordination. Any coordinated effort

between a carrier and its escorts today would necessitate a level of prior coordination through exercises or work up cycles.

Task Force 77 provides a more recent example of the possibilities of carriers operating together. Until its disestablishment in the 2000s, CTF 77 was the task force responsible for carrier operations in 7th Fleet. The task force was operating as many as three to four carriers simultaneously during the Vietnam War.[67] CTF 77 also commanded the multi-carrier Battle Force Zulu in the North Arabian Sea during Operation Desert Storm. The day after the operation commenced, the *USS Midway* and the *USS Ranger* in the Persian Gulf, the *USS Theodore Roosevelt* en route to the Gulf, and the *USS John F. Kennedy, USS Saratoga,* and *USS America* in the Red Sea all executed a combined 228 combat aircraft sorties.[68] The Navy may need merely to expand upon past experiences—not wholly reinvent the wheel—to make such a shift in operations a reality.

CONCLUSION

The United States super carrier has enjoyed its due glory as a capital ship for nearly 60 years. The debate as to the carrier's relevancy places that prestige in question and threatens the carrier to the fate of the battleship, the ship that succumbed to the carrier's primacy. Perhaps where the debate hits a snag is the concern whether a carrier can survive as *a capital ship*. The answer very well be, "Does it *need* to?" Not every option offered in this essay arguably need be executed before a prior "softening of the beach" by missiles launched from submarines or land-based bombers. There is talk of making the submarine the new capital ship of the Navy. The entire construct of a capital ship in the current environment, however, may be very well an irrelevant concept. With the evolving A2/AD threat, every ship is vulnerable to some degree, and it is going to take the entire fleet networked together, executing together to achieve its goals.

The carrier has prided itself on being "the tip of the spear." The question that everyone should ask themselves is, "Is it enough to be the power behind the spear once the tip has pierced through enemy defenses?"

The aircraft carrier is the superior solution for future conflicts. While the debate rages on as to the viability of the super carrier, one thing is for certain. Any aircraft carrier has advantages over a land base. A slow-moving object is definitionally harder to target than a stationary object. The age of the super carrier may be currently under debate but the age of the runway is most certainly over. As to whether or not the super carrier is relevant in the future; the data indicate that there is no other ship remotely as capable as the super carrier, neither amphibious ships nor smaller carriers in smaller numbers.

The super carriers are going to be around for at least another 50 years with the commissioning of the *USS Ford*. The Navy has to find a way to utilize the super carrier in the evolving A2/AD environment. Whether it be through aircraft, technologies, doctrine, or a combination thereof, the Navy simply must adapt to the changing times. It is something the carrier has done since its inception, and it something it must continue to accomplish. To "quote" Charles Darwin in a phrase often attributed to, but not actually said by him, "It is not the strongest of the species that survives… It is the one that is most adaptable to change."[69]

Bibliography

Cancian, Mark. "What Does the Future Hold for the U.S. Navy's Aircraft Carriers?" *World Politics Review (19446284)* (February 10, 2016): 1-4. http://seach.ebscohost.com/

Cropsey, Seth, Bryan McGrath, and Timothy A. Walton. "Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict." *Hudson Institute Policy Study* (2015): http://www.hudson.org/research/11731-sharpening-the-spear-the-carrier-the-joint-force-and-high-end-conflict.

Hammes, T.X. "Technologies Converge and Power Diffuses: The Evolution of Small, Smart, and Cheap Weapons." *CATO INSTITUTE POLICY ANALYSIS NO.* 786 (2016): https://www.cato.org/publications/policy-analysis/technologies-converge-power-diffuses-evolution-small-smart-cheap

Hendrix, Jerry. "Retreat From Range: The Rise and Fall of Carrier Aviation." *Center for a New American Security* (2015): https://www.cnas.org/publications/reports/retreat-from-range-the-rise-and-fall-of-carrier-aviation.

Hone, Thomas. "Replacing Battleships with Aircraft Carriers in the Pacific in World War II." *Naval War College Review* 66, no. 1 (Winter, 2013): 56-76. https://www.usnwc.edu/getattachment/9fe423c2-9276-41c7-be29-04260b8a04c3/Replacing-Battleships-with-Aircraft-Carriers-in-th.aspx.

Jacobs, Keith. "THE FUTURE CARRIER AIR WING: MIX OF MANNED AND UNMANNED AIRCRAFT." *Naval Forces* 29, no. 1 (February 2008): 26-35. http://seach.ebscohost.com/

Krepinevich, Andrew. "WAR LIKE NO OTHER: Maritime Competition in a Mature Precision-Strike Regime." *Center for Strategic and Budgetary Assessments* (2015): http://csbaonline.org/research/publications/war-like-no-other-maritime-competition-in-a-mature-precision-strike-regime

Krepinevich, Andrew, Barry Watts and Robert Work. "Meeting the Anti-Access and Area-Denial Challenge." *Center for Strategic and Budgetary Assessments* (2003): http://csbaonline.org/research/publications/a2ad-anti-access-area-denial.

Rubel, Robert C. "THE FUTURE OF AIRCRAFT CARRIERS." *Naval War College Review* 64, no. 4 (September 2011): 12-27. http://seach.ebscohost.com/

Sayler, Kelley. "RED ALERT: The Growing Threat to U.S. Aircraft Carriers." *Center for a New American Security* (2016):

https://www.cnas.org/publications/reports/retreat-from-range-the-rise-and-fall-of-carrier-aviation.

Stillion, John, and Bryan Clark. "WHAT IT TAKES TO WIN: Succeeding in 21st Century Battle Network Competitions." *Center for a New American Security* (2015): http://csbaonline.org/research/publications/what-it-takes-to-win-succeeding-in-21st-century-battle-network-competitions

[1] Seth Cropsey, Bryan McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, D.C.: Hudson Institute, 2015), 14. http://www.hudson.org/research/11731-sharpening-the-spear-the-carrier-the-joint-force-and-high-end-conflict.
[2] Ibid., 14.
[3] Ibid., 16.
[4] Ibid., 18.
[5] Ibid., 19.
[6] Ibid., 20.
[7] Ibid., 21.
[8] Ibid., 24-26.
[9] Ibid., 26.
[10] Robert Farley, "Does the US Navy have 10 or 19 Aircraft Carriers?," *TheDiplomat.com,* April 17, 2014, http://thediplomat.com/2014/04/does-the-us-navy-have-10-or-19-aircraft-carriers/.
[11] Ibid.
[12] Nick Ottens, "Amphibs Versus Carriers: Which Has the Future?," *AtlanticSentinel.com*, July 29, 2011, http://atlanticsentinel.com/2011/07/amphibs-vs-carriers-which-has-the-future/.
[13] Ibid.
[14] Ibid.
[15] Bryan McGrath, "Not Every Flattop Is an Aircraft Carrier," *realcleardefense.com*, May 20, 2014, http://www.realcleardefense.com/articles/2014/05/20/not_every_flattop_is_an_aircraft_carrier_107238.html.
[16] Robert Rubel, "The Future of Aircraft Carriers," *Naval War College Review* 64, no. 4 (Autumn, 2011): 21, https://www.usnwc.edu/getattachment/87bcd2ff-c7b6-4715-b2ed-05df6e416b3b/The-Future-of-Aircraft-Carriers.aspx.
[17] Bryan McGrath, "Not Every Flattop Is an Aircraft Carrier," *realcleardefense.com*, May 20, 2014, http://www.realcleardefense.com/articles/2014/05/20/not_every_flattop_is_an_aircraft_carrier_107238.html.
[18] Ibid.
[19] Seth Cropsey, Bryan McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, D.C.: Hudson Institute, 2015), 87. http://www.hudson.org/research/11731-sharpening-the-spear-the-carrier-the-joint-force-and-high-end-conflict.
[20] Ibid., 86.
[21] Eric Heginbotham et al., *The U.S.-CHINA Military Scorecard* (Santa Monica, CA: RAND Corporation, 2015), 348. http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR392/RAND_RR392.pdf.
[22] Should America embrace Timothy Walton, "Should America Embrace Smaller Aircraft Carriers?," *nationalinterest.org*, October 04, 2015, http://nationalinterest.org/feature/should-america-embrace-smaller-aircraft-carriers-14001?page=show.
[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] Seth Cropsey, Bryan McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, D.C.: Hudson Institute, 2015), 86. http://www.hudson.org/research/11731-sharpening-the-spear-the-carrier-the-joint-force-and-high-end-conflict.
[27] Ibid., 87.
[28] Kelley Sayler, *RED ALERT: The Growing Threat to U.S. Aircraft Carriers* (Washington, D.C.: Center for a New American Security, 2016), 3. https://www.cnas.org/publications/reports/red-alert-the-growing-threat-to-u-s-aircraft-carriers
[29] Ibid.,3.
[30] Ibid., 3.
[31] Ibid., 3.
[32] Ibid., 3.
[33] Ibid., 4.
[34] Ibid., 6.
[35] Ibid., 6.

[36] Ibid., 6.
[37] Thomas C. Hone and Mark D. Mandeles, "Interwar Innovation in Three Navies: U.S. Navy, Royal Navy, Imperial Japanese Navy," *Naval War College Review* 318, no. 2 (Spring 1987): 75, https://www.usnwc.edu/Publications/Naval-War-College-Review/ArchivedIssues/1980s/1987-Spring.aspx.
[38] Ibid., 78.
[39] Jerry Hendrix, *RETREAT FROM RANGE: The Rise and Fall of Carrier Aviation*, (Center for a New American Security, 2015), 11, https://www.cnas.org/publications/reports/retreat-from-range-the-rise-and-fall-of-carrier-aviation.
[40] Ibid., 15.
[41] Ibid., 19.
[42] Ibid., 23.
[43] Ibid., 27.
[44] Ibid., 34.
[45] Ibid., 39.
[46] Ibid., 43.
[47] Ibid., 41.
[48] Ibid., 46.
[49] Ibid., 48.
[50] Ibid., 52.
[51] "X-47B UCAS," *northropgrumman.com*, http://www.northropgrumman.com/Capabilities/X47BUCAS/Documents/UCAS-D_Data_Sheet.pdf
[52] Ibid.
[53] Steve Blank, "THE THREAT IS HERE, IT'S JUST DISTRIBUTED UNEVENLY: A2/AD AND THE AIRCRAFT CARRIER," *War On the Rocks*, July 28, 2016, https://warontherocks.com/2016/07/the-threat-is-here-its-just-distributed-unevenly-a2ad-and-the-aircraft-carrier/.
[54] Jerry Hendrix, *RETREAT FROM RANGE: The Rise and Fall of Carrier Aviation*, (Center for a New American Security, 2015), 53, https://www.cnas.org/publications/reports/retreat-from-range-the-rise-and-fall-of-carrier-aviation.
[55] Robert Rubel, "The Future of Aircraft Carriers," *Naval War College Review* 64, no. 4 (Autumn, 2011): 23, https://www.usnwc.edu/getattachment/87bcd2ff-c7b6-4715-b2ed-05df6e416b3b/The-Future-of-Aircraft-Carriers.aspx.
[56] Ibid., 23.
[57] Ibid., 24.
[58] Ibid., 24.
[59] Ibid., 24.
[60] Andrew Krepinevich, Barry Watts and Robert Work, *Meeting the Anti-Access and Area-Denial Challenge* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2003), 30,33, http://csbaonline.org/research/publications/a2ad-anti-access-area-denial.
[61] Seth Cropsey, Bryan McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict* (Washington, D.C.: Hudson Institute, 2015), 53, http://www.hudson.org/research/11731-sharpening-the-spear-the-carrier-the-joint-force-and-high-end-conflict.
[62] Ibid., 53.
[63] Ibid., 46.
[64] Andrew Krepinevich, Barry Watts and Robert Work, *Meeting the Anti-Access and Area-Denial Challenge* (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2003), 41, http://csbaonline.org/research/publications/a2ad-anti-access-area-denial.
[65] Thomas Hone, "Replacing Battleships with Aircraft Carriers in the Pacific in World War II,' *Naval War College Review* 66, no. 1 (Winter, 2013): 61, https://www.usnwc.edu/getattachment/9fe423c2-9276-41c7-be29-04260b8a04c3/Replacing-Battleships-with-Aircraft-Carriers-in-th.aspx
[66] Ibid., 62.
[67] "Task Force 77 (United States Navy)," *Wikipedia*, last modified 19 December, 2016, https://en.wikipedia.org/wiki/Task_Force_77_(United_States_Navy).
[68] Ibid.
[69] "Six Things Darwin Never Said-and One He Did," *Darwin Correspondence Project*, 2017, https://www.darwinproject.ac.uk/people/about-darwin/six-things-darwin-never-said#quote1.