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Subcommittee on Seapower and Projection Forces

Introduction:

Chairman Forbes, Ranking Member Courtney, and other distinguished members of the committee. Thank you for the honor of appearing before this committee. I have been asked to address the future of naval aviation and the carrier air wing, with a specific focus on unmanned systems.

This testimony will include four sections. First, I will discuss the evolution of the carrier air wing, from the 1980s until the present, with a specific focus on diversity and range. Second, I will analyze the gaps in the current carrier air wing, with an eye towards the new anti-access threats that the US' contemporary adversaries and potential adversaries pose. Third, I will explain the potential role of unmanned systems in the air wing. Finally, I will present my recommendations to this committee, on the topics of unmanned systems and the air wing as a whole.

Before I begin, I would like to emphasize that none of the points I raise matter without serious consideration of strategy. Since the end of the Cold War, all American attempts at strategy-making have been regionally focused. Low-intensity threats dominated U.S. thinking, with protracted insurgencies becoming the norm, rather than major conflict with states. To emphasize: the last two ground wars the U.S. has fought have been in the same country against the same military. Saddam's surplus Soviet forces and massive conscript army were first overwhelmed by a technologically advanced allied coalition, and then destroyed by a much smaller, primarily American, invasion force just a decade later.

Following this ground invasion, the United States did not face a major regional or global threat. Long-term, protracted insurgencies in Afghanistan and Iraq took their toll, but fighting those enemies did not require a global strategy. Modern American threats are no longer regional. China's interests are globalizing. It presents a direct strategic challenge to the American-led international order, and has confronted US power throughout the Asia-Pacific. Russia exploits the cracks in the European alliance system, and the inability of the US and its allies to adapt to changing situations to seize territory, and has inserted itself into the current Middle Eastern maelstrom as the US has departed. The Islamic Republic of Iran has embarrassed the US on multiple occasions, capturing its sailors, flaunting its sanctions, and attacking its allies under the pretext of righteousness. Finally, a lack of American resolve has allowed Islamist groups to turn the tide against the West. Islamic State now holds territory in the Middle East and along the Southern Mediterranean, allowing it to exploit Europe's soft underbelly in its most vulnerable condition since the height of the Cold War.

These threats, ranging from China at the highest end of the spectrum, to ISIS at the low end, overlap regionally and strategically. Iran and ISIS operate in the same countries, and are engaged in military conflict. Russia has thrown its weight behind Iran and its Syrian proxy, Bashar al-Assad. Moscow has committed a substantial expeditionary force to the conflict in the Levant. Its actions in Eastern Europe intersect with the refugee crisis, fertile ground for ISIS and other terrorist groups to infiltrate the EU. Finally, China and Russia both have interests in

Central Asia and the Pacific, which coincide with Iranian rulers' ambition to monopolize the world's petroleum supply.

The overlap between these threats necessitates a global strategy that is designed to counter the full spectrum of potential enemies. Such an understanding must dictate not only our tactics and operational procedures, but also our weapons systems.

Great maritime powers have always experienced the problems that overlapping threats present. Britain serves as the best example. The Royal Navy in 1807 had to prevent Napoleon's forces from striking across the Channel and making landfall in England, while simultaneously combating the slave trade off the coast of Africa. On the eve of World War One, First Sea Lord Jackie Fisher and First Lord Winston Churchill had to counter the powerful *Kaiserlich Marine* in the North Sea, while defending British shipping around the world against commerce raiders and submarines. Churchill reprised his role at the outbreak of World War Two, countering the dual threat of the German submarine fleet, and Japan's powerful Navy in the Pacific.

In each of the three examples, the Royal Navy diversified the tools at its disposal to respond to both high and low end threats. In the early 19th century, the British constructed powerful first and second-rate ships of the line to preserve their dominance over the French. Neither their strategy nor their shipbuilding stopped here. In addition, the Royal Navy built smaller frigates, and later Baltimore Clippers, to hunt down pirates off the African Coast.

Admiral Fisher's vaunted "scheme" marshalled heavy dreadnought battleships for major fleet engagements against the Germans in the North Sea, along with fast Battlecruisers, which were intended to destroy commerce raiders, despite their different usage during Jutland. Combined with smaller destroyers and other escorts, this mix of ships was designed to engage in major oceanic battles, and protect British shipping internationally. During the Second World War, Churchill created destroyer and light aircraft carrier picket squadrons to confront U-Boats and German commerce raiders, while maintaining the British battleship fleet to counter the *Kriegsmarine* if needed. In each of these cases, the Royal Navy employed high and low end platforms, quite often in the same theater of operations and sometimes against the same enemy, to achieve a diverse set of strategic goals. The multiplicity of current threats to the United States, ranging from the sophisticated and powerful PRC to ISIS' crude tactics, indicates the need for a similar approach today.

Threats have ceased to be regional: they now span continents, hemispheres and traditional US combatant command areas of responsibility. These pose systemic challenges to the American-led liberal international order. Without an understanding of how to deal with these actors, their intentions, and their capabilities, our discussion today on systems and platforms exists only in a closed loop. Without a coherent strategy, discussion of fleet design is an exercise in speculation.

Evolution of the Carrier Air Wing (1980-2016):

Since its earliest days, naval aviation has always been defined by a diversity of platforms. The carrier platform, with the limitations it imposes on fuel usage and weight, has always forced aircraft designers to create a diverse number of platforms. Even in the earliest days of the Second World War, the carrier air wing was comprised of air superiority fighters like the F4F

Wildcat, scout bombers like the SBD Dauntless, and Torpedo Bombers like the TBD Devastator. This delineated structure continued throughout World War II, with platforms specific to certain missions conducting strike, reconnaissance, or air combat as needed.

Two factors have shaped the modern carrier air wing – aerial refueling, and sustainable ISR platforms. Aerial refueling extended the range and flight time of the carrier air wing, allowing it to remain on station longer, and patrol more airspace. This became critically important for long-range interceptors and fighter aircraft, since these platforms could now transcend earlier limitations on range. Truly dedicated air-borne early warning platforms began to enter the fleet in the 1960s, allowing the carrier air wing to monitor even more airspace.

By the 1980s, the modern carrier air wing emerged. Long-range interceptors, multi-role fighters, strike aircraft, ground attack aircraft, electronic warfare platforms, maritime patrol aircraft, aerial refueling platforms, and air-borne early warning platforms ensured the efficacy of the air wing in a variety of situations. The long-range F-14 Tomcat doubled as an air superiority fighter and long-range interceptor, allowing the carrier air wing to intercept threats at range and destroy enemy fighters in dogfights. The multirole F/A-18 Hornet carried a heavy payload, and despite its shorter range, could serve well as a dogfighter if needed, improving fleet air superiority and strike capabilities. The A-6 Intruder platform's heavy payload and effective range provided the carrier with an all-weather strike aircraft. The platform also doubled as an Electronic Warfare airframe, when reconfigured as the EA-6B.

Moving to more low-level platforms, the A-7 Corsair II, derived from the F-8 Crusader fighter aircraft, gave the carrier subsonic attack capability to be used in ship-to-shore actions. Maritime patrol aircraft included the carrier-based S-3 Viking, and the long-range, land-based P-3 Orion, allowing the Navy to defend the carrier against undersea threats and interdict shipping when needed. Variants of the A-6 and the S-3 were used as carrier-based aerial refueling platforms, increasing range and loiter time for all aircraft in the air wing. Finally, the E-2 Hawkeye ensured that the air wing could monitor the skies at all times, allowing for a much more effective sortie rate. The carrier air wing could then conduct its four critical missions: ISR, Strike, Sea Control, and ASW. It could fulfill these missions at long range, against a variety of high end and low-end threats.

This air wing was designed with a specific purpose: countering the threat that the USSR posed to the US' European allies. *The Maritime Strategy* of the 1980s called for the Navy to take pressure off the European Central Front by applying it to the Soviet Union's flanks – the Mediterranean, the northern seas, and the Pacific. The air wing was designed with this goal. The F-14 and F/A-18 could achieve air superiority against limited long-range Russian air cover, while intercepting long-range strike aircraft. The A-6 and A-7 would then exploit this air superiority by striking inland at ground targets. The S-3, when coupled with the surface combatants in a carrier strike group, would help destroy the Soviet submarine fleet. Finally, aerial refueling platforms multiplied the range and endurance of the entire air wing, ensuring long-term patrols and deep strikes into enemy airspace remained possible.

This air wing structure ensured the ability of the carrier platform to respond to multiple gradations of threats. The same flattop had the tools to fight high-end Soviet fighters and

intercept bombers, attack hardened ground installations, and provide consistent air support against low-level threats at a low cost. The diversity of the air wing therefore increased combat power, and made the carrier, and by extension the fleet, more efficient.

Decline in Diversity:

Since the end of the Cold War, the US Navy's carrier air wing has declined in diversity, with multirole platforms replacing mission-specific aircraft. The F-14, A-6, S-3, and A-7 were phased out, with the F/A-18 Hornet and Super Hornet taking over their various missions. Despite the versatility of the platform, the F/A-18 cannot match the range of the platforms it replaced, nor does it provide the same sort of air-to-air capability that the F-14 did. The F-35 attempts to offer the Navy a measure of the A-6's and A-7's strike abilities, but the expensive platform comes with major operational questions. Most important, the Navy currently lacks organic range-extending airframes. It relies on land-based KC-10, KC-130, and KC-135 refueling aircraft. Such an arrangement is viable in peacetime, or when low-level, regional threats are the US' primary concern. However, in combat, such operational assumptions are dubious.

Deficiencies in the Modern Air Wing:

A small number of platforms have replaced the previously diverse carrier air wing. In fact, the current air wing can be narrowed to three platforms: F/A-18 variants, E-2 Hawkeyes, and the newly introduced F-35. These platforms are currently deficient in performing the four major roles of ISR, Strike, Sea Control, and ASW. In addition to these gaps in tactical abilities, there is a major strategic gap in the carrier air wing's ability to defeat Anti-Access/Area Denial (A2AD) systems being employed by such potential adversaries as China, Iran, and Russia.

Current carrier borne ISR missions are carried out by the E-2 Hawkeye. The E-2 carries a large radar system that is used to monitor and coordinate all air and surface surveillance and targeting operations. The Hawkeye has adequate radars to complete its mission, with an 800 nautical mile range. However, its endurance time of six hours limits the time it can remain on station. As the typical carrier air wing only contains one squadron of E-2's, for a total of five birds each, the carrier's ISR capabilities are limited.

The current carrier air wing uses two multipurpose platforms to conduct strike missions – the F/A-18 and the F-35. Although the F-35 is not yet in service, and is not slated to be in large numbers until late 2018, its projected role in the air wing warrants its inclusion in this discussion. The F/A-18's C, E, F, and G variants (the final of which is the carrier's Electronic Warfare platform) can carry a heavy armament, and can perform multiple missions quite effectively. The smaller F/A-18C carries nearly 14,000 pounds of ordinance, whereas its larger Super Hornet cousin can carry nearly 18,000 pounds of weapons. However, the combat radius of both platforms does not exceed 600 nautical miles at most, and in reality is closer to 350-400.

The F/A-18 is not effective for striking over large distances, despite its serviceability when striking shore targets in Afghanistan or Iraq. To overcome this range restriction, the Navy has used two methods. First, "buddy tanking" involves outfitting an F-18 with multiple drop tanks rather than weapons, and using it as an impromptu range-extension platform. This system requires a high percentage of the air wing to be removed from combat during long-range strike

missions. Air Force tankers can be used to increase the range of Navy strike fighters. This is a viable option only if the Air Force has secure bases within range, which is unlikely in the majority of modern combat environments. The EA-18G electronic warfare platform suffers from the same range and endurance difficulties as the F-18 fighter variant.

The F-35 will serve theoretically as a high-tech, stealthy strike platform, complementing the low-tech F/A-18. Its integrated-stealth, fifth-generation technology, internal weapons bays, and informational capabilities should be a major asset to the modern air wing. However, the platform has major liabilities. Its radar profile is still quite large, its internal weapons bays do not contain enough ordinance for a significant strike, and it has multiple potential informational vulnerabilities. Nevertheless, the greatest problem for this high-cost platform is its range. The F-35 is limited to just over 600 nautical miles, giving it only a slight edge over the F-18 it is intended to replace. This small difference does not enable it to conduct deep strike operations any more effectively than an F-18.

The shorter range of the F-18 and F-35 has also made sea control more difficult to achieve. Without a long-range interceptor like the F-14 (which was also armed with specialized, long-range air-to-air missiles to increase its combat radius), the current carrier air wing is much less capable of defeating incoming threats and establishing sea control. Aside from the range limitations on both potential sea control platforms, both the F/A-18 and F-35 are questionable dogfighters. The F/A-18 can challenge any major air-to-air platform, aside from Su-35 variants, making it decently survivable. However, the F-35 has poor aerodynamics, meaning it cannot serve as an effective dogfighter if needed. Fully integrating such an airframe into the air wing in the next decade would decrease the ability of the Navy to control the seas, in addition to the other drawbacks inherent in the F-35 platform.

More broadly, organic stealth capability on the carrier platform may be a very far reach. Stealth aircraft like the F-22 aircraft must be cleaned and serviced every few sorties. Small bits of debris and poor weather conditions on land erode the airframe's stealth. Operational conditions are even worse onboard an aircraft carrier. Salt spray constantly abrades the airframe. The cramped conditions of the hangar deck point to multiple scrapes and bumps. Additionally, the carrier cannot have a built in stealth service facility, as this would take up too much space. Thus, the F-35 is an even less effective aspect of the air wing – it is simply an under-armed, aerodynamically poor attack aircraft with a high radar profile.

The Navy's antisubmarine warfare (ASW) capabilities have declined since the retirement of the S-3 Viking. The Viking's 600+ nautical mile range gave American fleets a potent tool to combat Soviet submarines in the 1980s, protecting the critical flat top from undersea threats. With its retirement, the SH-60 helicopter took over its ASW duties. The resulting range decrease of 200 or more nautical miles (to a maximum 400 nautical mile range) makes the carrier, and by extension the fleet, much more vulnerable to attack from subsurface assets. In addition, aerial refueling is not possible for most helicopters. So the fleet would be just as vulnerable to submarines notwithstanding range-extending platforms.

Although the individual components of the modern air wing are effective, taken as a whole, the carrier air wing is deficient. It is hampered by its short range and small loiter time. Its

multipurpose airframes cannot perform air superiority missions to the level of the most advanced Russian and Chinese fighters. In addition, its major platforms like the F-35 have significant vulnerabilities. A final problem exacerbates all the listed weaknesses in the carrier air wing: a lack of aircraft. The services as a whole have been forced to tie up expensive platforms to cut costs. Because the maintenance costs for the Navy are much higher than for any other service, the Navy must bear a portion of any budget cuts by tying up platforms. This has resulted in the placement of 11 missile-defense *Ticonderoga*-class cruisers into the reserve fleet, along with other major surface combatants. Naval aviation has also experienced the problems that budget cuts impose on the service. For at least the last eight years, the Navy has fielded undersized carrier air wings, numbering at 60 aircraft, or at most 75% of the supercarrier's designed capacity. This smaller number of planes specifically causes one of the problems noted above– the undersized air wing does not field enough E-2 Hawkeye airborne early warning platforms to adequately patrol the airspace around the carrier.

The final problem the carrier air wing encounters today is cost. The carrier platform is expensive, with the newest *Ford*-class coming in at $2.4 billion over budget. However, the costs of the supercarrier are justifiable, as the alternative of a land-based network requires a high expenditure of diplomatic capital and financial resources, and small carriers would have difficulty providing needed combat power to the fleet with sufficient cost savings. Nevertheless, the platforms on the carrier are not efficiently employed in current missions. The 1980s era air wing used the A-6 and the A-7 to strike land targets, with the A-7 performing the majority of close air support missions. Using this cheaper platform for lower-cost missions allowed the more advanced A-6 to be maximized in different combat environments. Today, the F/A-18 performs all interdiction, intercept, and air superiority roles in the air wing. Although it serves well in all three missions, the platform is extremely cost inefficient for strike against organizations like ISIS. Using the F-35 for such strikes will be even more economically inefficient. A large-bore howitzer is unnecessary to protect against a marauding grizzly bear.

Modern Threats:

Unlike during the post-Cold War period, the United States must confront several major state actors on the international stage. The three foremost state threats today are China, Russia, and Iran. Each adversary has its own characteristics and difficulties. Unfortunately, all three rivals have the technology to challenge the U.S. access to its territory, preventing a first Gulf War-style massed invasion.

Since the early 2000s, China has embarked on a major military modernization program. From beginning its first strategic submarine patrols to experimenting with carrier aviation, to recently announcing the construction of its first domestically built aircraft carrier, the Chinese military has become a modern instrument that can conceivably challenge American power. It has numerous effective air-to-air platforms, a large submarine fleet, and an effective air defense system. U.S. bases are increasingly vulnerable to Chinese attack. More important, China's DF-21 hypersonic missile threatens to cripple the carrier by speeding through its defensive escort screen and destroying or disabling the platform itself. Both the carrier and its air wing are vulnerable, in addition to the land bases that would typically house Air Force refueling platforms. China has harassed American naval forces in contested areas, such as the South and

East China Seas, and has shown a willingness to confront American allies, namely Japan, in various conflict points.

Russia's resurgent military has focused mainly on improving its ground and air capabilities. On the specific topic of access denial, the highly potent Russian S-300 and S-400 air defense systems increase the ability of the Russian military to prevent American aircraft from striking ground targets. The resurgent Russian surface and submarine fleet push the U.S. Navy even further away from shore, complicating any sort of effective power projection. Russia has demonstrated its desire to shackle the U.S. in certain critical regions through its actions in Eastern Europe and the Middle East. Russian-backed separatists have destabilized Ukraine, and thrown the EU and NATO into disarray. Meanwhile, the Russian military props up the Assad regime and destroys the Syrian opposition, while claiming the moral high ground by fabricating strikes against ISIS. The S-300 missile system now deployed in Syria has forced the U.S. to enter into deconfliction procedures with the Russians on the ground, demonstrating the degree to which small actions can create larger diplomatic and military effects in critical areas.

Iran's burgeoning anti-access network has expanded since the nuclear deal this past July. The Islamic Republic has already taken advantage of the new trade deals it has cultivated to purchase aircraft technology. Iran is receiving the S-300 missile system from Russia, and has developed close ties with the Chinese. Its strategic position along the Strait of Hormuz increases its ability to manipulate the world's energy supply, making the country an even greater threat. The Islamic Republic aims to deny the U.S. access by both destabilizing the countries around it, like Syria and Iraq, and simultaneously increasing its own armed forces to defend its southern coast. This layered anti-access network will be difficult for the U.S. to break through, if the need arises. An Iranian naval presence in the Red Sea, purchased with recently unfrozen funds or future oil revenues, would add to Iran's regional weight giving it influence in the approaches to the Suez.

These three threats intermingle with various non-state and proxy groups in the Middle East and Europe. Russia directly controls separatist rebels in Eastern Ukraine, and has propped up the so-called Donetsk People's Republic for nearly two years. Hezbollah (Iran's proxy in Lebanon) gives the Islamic Republic a foothold on the Mediterranean coastline. Unaffiliated groups like ISIS, Jabhat al-Nusra, and al-Qaeda pose a threat to the United States and its allies. They undermine regional stability, and have the potential to strike the American homeland.

All of these threats exist in overlapping regions. ISIS, al-Qaeda, Jabhat al-Nusra, and Iran all compete for power in the Middle East. Russian intervention in Syria has added another ingredient to this bubbling cauldron. China and Iran both have interests in the Indian Ocean and Pacific, and have a close relationship on energy issues. Finally, Russia's intervention in Syria, its Eastern European mischief, and its presence in the Northern Pacific ensure that its military force spans multiple regions. The U.S. must confront multiple high and low intensity threats in the same region. The current carrier air wing is not designed to confront these challenges. Its short strike range and loiter time, small size, and inefficient cost put American commanders at a disadvantage in any encounter with their Russian, Chinese, and Iranian adversaries.

Role of Unmanned Systems:

Unmanned systems can play a critical role in remedying the difficulties previously identified. The benefits of unmanned aircraft can be restricted to ISR, strike, and refueling.

Using an unmanned platform for ISR missions could allow new, more advanced sensors to be integrated into the fleet. Additionally, without the physical pilot in the aircraft, the airframe could be made more compact, stealthier, or more spacious for fuel or sensors. A proper unmanned ISR system would integrate the most modern sensor technology into a high-endurance platform that could remain on station for a day or more. The Predator and Reaper drones embody this concept on a smaller scale, with the Reaper's 1,000 nautical mile range, 14-hour endurance time, and several thousand pounds of potential ordinance proving invaluable to American forces throughout the Middle East. A more sophisticated ISR platform could fulfill the reconnaissance role of the E-2.

Unmanned platforms are also suited to strike missions. First, the platform can be constructed with more inherent stealth characteristics – namely a lower radar profile and internal weapons bays. Without a pilot, the structure of the airframe can be modified as needed. Second, deep strike missions into contested territory are risky. Placing an unmanned system in harm's way instead of a manned aircraft could make higher risk missions viable. If the UAV is destroyed, the mission can be moved to another manned or unmanned aircraft. Third, the increased loiter time that UAV's offer allows for improved sea control operations. The ability to remain on-station for over 12 hours would allow the carrier to control a larger amount of airspace with fewer sorties, instead relying on long-term presence flights from unmanned sea control surface warfare aircraft.

Finally, refueling is a natural fit for unmanned platforms. The design benefits inherent in a UAV allow for grater fuel storage. Once again, removing the pilot greatly increases the storage space of the airframe. Thus, a UAV designed for air-to-air refueling could both remain in flight for several hours, and service multiple aircraft. This would eliminate the need for buddy or Air Force tanking by once again providing the carrier air wing with an organic tanking capability.

The current unmanned system for the Navy, the UCLASS vehicle, the X-47B, is likely to play an increasing role in naval aviation. Similar in shape to the USAF B-2 Spirit bomber, the UCLASS is designed to have a low radar profile. The platform could be used for strike, ISR, refueling, or some combination of the three.

Recommendations – Unmanned Systems:

In the near future, unmanned systems should initially be used as tanking and range extending aircraft. At its current developmental stage, the UAV naturally fits as a tanking platform. Added tanking ability is the most direct path to extending the air wing's range. The extra space in the UCLASS platform could be taken up by more fuel. Refraining from using UCLASS variants as strike platforms in the near future ensures that Navy is not putting unproven technology into a contested combat environment. Instead, it would be maximizing the tools currently at its disposal, giving the service breathing room to continue experimenting with the development of different types of unmanned systems.

Although tanking should be a priority for the first widely-deployed unmanned system, strike/sea control and ISR should be considered as the technology matures. The Sea Avenger UCAV is a candidate for an extended loiter time strike aircraft. A different approach might consider placing smaller UAV platforms on destroyers and cruisers, to give them a greater degree of organic ISR capability. A Reaper-style drone—or even a smaller one—launched from an *Arleigh-Burke* would significantly increase the ISR coverage of the carrier group, and take some of the strain off the already hard-pressed carrier air wing.

Further into the future, I hope that Navy will consider creating a full-fledged ISR and strike unmanned platform. The advantages of using an unmanned system in a contested environment cannot be overstated. The potential decrease in human cost is coupled with the ability of an unmanned system to perform maneuvers that a human pilot cannot, such as tight turns and high-speed vertical strikes.

Recommendations and Issues – The Carrier Air Wing:

This testimony has argued that the current carrier air wing is challenged to perform all its necessary missions. Integrating unmanned systems into the air wing, particularly as tankers and ISR platforms, would begin to address these challenges. Other issues remain.

First, there is the question of the diversity of platforms in the air wing. Using the F/A-18 platform for a strike fighter, interceptor, air superiority fighter, and electronic warfare platform may save costs. Nevertheless, the F/A-18 platform cannot perform all the missions it is assigned with equal efficacy. Developing dedicated airframes for different roles within the air wing would ensure the more effective allocation of aircraft, and improve each aircraft's performance in its specific mission set. Greater certainty about the nation's strategic objectives and the role of seapower in achieving them ought to precede any decision about which combat roles require a dedicated aircraft.

Second, and again according to a clear strategic rationale Navy would benefit from considering the development of a manned air superiority fighter to replace the F/A-18 in its fleet air defense and air superiority role. The supermaneuverable Su-35 and its variants can outfly every aircraft in the American military apart from the F-22 Raptor. In addition, the F-18 cannot intercept incoming enemy aircraft at range, making the carrier less effective, and more vulnerable. A dedicated air superiority platform that can double as a long-range interceptor would fill this critical gap in the carrier air wing.

Third, these strategic questions should include revisiting the concept of a dedicated ASW aircraft. The S-3 did not lose its role as an ASW platform because of its inefficacy – rather, the Soviet submarine threat declined, allowing the aircraft to be transitioned to other duties. The resurgent Russian and Chinese navies both field advanced and numerous submarine fleets. Their numbers will grow. Russian and Chinese submarines have tailed American carrier groups in the Asia-Pacific. The US' allies have renewed their focus on ASW aircraft. Japan has purchased a number of P-8A Poseidon aircraft to patrol the disputed East China Sea, and South Korea recently received several S-3's to increase its ASW capabilities. Should we not be considering the same improvements? Increasing the number of P-8A's throughout the Navy's land-based air stations will help remedy this undersea vulnerability. But if land-based ASW was insufficient

during the Cold War, what makes it sufficient today? The USSR was an economic nonentity compared to China.

Fourth, what exactly is the role of the F-35C in the air wing? Despite its various vulnerabilities and costs, the F-35 does provides important strike and stealth capabilities to the carrier air wing. However, the platform is not designed to conduct air-to-air missions. Although long-range missiles could remedy some of this aerial vulnerability, is the F-35C reliable in a real dogfight? Historical experience has shown that assumptions of purely beyond-visual-range combat conducted by missiles are unwarranted. This raises important questions about the F-35C's potential role in the air wing, as well as whether some of its role could be taken up by either the F/A-18 or a newly developed air superiority fighter.

Fifth, do we need a low-end, low-cost platform for air support and strike missions against targets like ISIS? Using high-end platforms like the F/A-18 and the future F-35B and C to attack insurgency groups is very expensive. Each F/A-18 sortie can cost several million dollars, after accounting for flight costs, the price of munitions, and air force tankers. This cost dwarfs ISIS' expenditures on each convoy and group of fighters. During the Vietnam War, the Navy used the A-1 Skyraider propeller-driven aircraft to attack North Vietnamese ground targets. The aircraft's long loiter time and low cost made it a highly effective tool to attack lightly armored, low-cost guerillas in Indochina. The A-1's other contemporary counterinsurgency aircraft, the OV-10 Bronco, could launch from a carrier without a catapult. The A-7 served a similar role in the later stages of the war. Both platforms were survivable, and relatively cheap compared to the higher end A-6 and F-4. There is value in versatility, making the F/A-18 an important aircraft for the air wing. Nevertheless, when high and low-end threats persist in the same region, it is necessary for the carrier air wing to have a tool for persistent strikes against insurgent targets, along with high-end platforms that can confront greater threats.

Sixth, the Navy should increase the size of the carrier air wing to full strength. Budget restrictions have forced the Navy to downsize the carrier air wing, decreasing its efficacy. ISR capabilities have suffered, due to the smaller number of E-2C's present on the flattop. Strike and air-to-air missions have also been affected, as a lower number of aircraft increases airframe fatigue. Regardless of other developments, the carrier air wing ought to be increased to its full strength.

Seventh, the Navy would benefit from reconsidering how it uses stealth aircraft. As previously stated, the carrier is a poor environment for inherently stealthy platforms. Nevertheless, the carrier could need stealth platforms for strikes against entrenched enemy targets. If these platforms are needed, the Navy could transport them onto the carrier, and use them for one or two sorties to maximize their stealth capabilities. After striking the identified targets, these assets should be returned to a shore base for cleaning and refit. Better to rent a car when you travel than buy one.

Recommendations – The Carrier Platform:

The carrier's survivability in contested environments has been questioned for many decades. Historical experience has proven that the carrier is a defensible platform when operating within its system – the carrier strike group. The supercarrier is the most effective platform for

achieving localized air superiority and sea control, and then projecting power against enemy targets. A carrier under 60,000 tons will not have a large enough air wing to be a viable fleet capital ship, and will lack the hull area needed for three armored decks. Nothing can match the ability of the carrier to provide on-target force in a wide array of situations. Building smaller carriers for high end engagements is impractical.

If the Navy is to explore the small carrier option, it can take one of two routes. First, it could use these platforms to strike against low-end targets, for example in the Middle East and North Africa. Such a model is similar to the approach of employing low-cost platforms on the supercarrier to free up more expensive airframes for operations against high value targets. As threats like ISIS proliferate across the Greater Middle East, in tandem with rising high-end adversaries in the region like Iran and Russia, the U.S. may have to choose to place one or two available carriers in the Persian Gulf/Arabian Sea, or along the North African coastline. Small carriers could allow the Navy to maximize its assets, by freeing up supercarriers for patrols in more critical areas, while smaller platforms conduct strikes against insurgency groups.

Three methods exist for the low-intensity carrier idea. First, the Navy could build a smaller platform from the keel up. This affords it the greatest degree of design flexibility, since a 20,000-40,000 ton carrier can be built with a full catapult and trap launching and landing system, diversifying the potential air wing, and increasing the strike range of aircraft on board. Second, the Navy could convert older LHD/LHA's into smaller carrier platforms. The three remaining *Tarawa*-class LHD's and the *Wasp*-class are all candidates for conversion. Such a conversion would mirror the SCB-27 and SCB-125 rebuilds on the *Essex*-class aircraft carriers after World War II, and would include the installation of an angled deck, catapult, and trap, along with the strengthening of the flight deck to withstand CATOBAR operations. Third, the Navy could repurpose its existing *Wasp* and *America*-class LHD's/LHA's for strikes against lower priority targets. It could field an aircraft like the OV-10, which had the capability to take off without a catapult from an LHD.

Second, the Navy could build 60,000 ton conventionally powered carriers to supplement the supercarrier fleet. These ships could be contracted to multiple shipyards, decreasing the cost of construction. The 60-strong air wing of these mid-sized carriers would make them capable against high and low-end targets. Four to six of these ships, much like the aforementioned low-intensity attack carriers, would free up American supercarriers, and ensure the efficient allocation of assets. They should in no way be understood as substitutions for the congressionally-mandated requirement for 11 large-deck carriers.

Recommendations – Miscellaneous:

There are several other smaller issues with the carrier air wing whose solution would help ensure its short and long term efficacy. First, the Navy, and U.S. military as a whole, would benefit by developing cheaper munitions for use against lower-priority and lower-tech targets. Sustained campaigns against insurgent groups like ISIS are likely in the foreseeable future. Operation Inherent Resolve has demonstrated the strain that long-term bombing campaigns can put on the American supply chain. The U.S. is currently running low on guided munitions, the critical tool for American airpower when it attacks ground targets. Developing lower-cost munitions for use against groups like ISIS is therefore critical, considering the long-term nature of insurgency

challenges. These cheaper munitions could be paired with the low-cost ground attack aircraft previously suggested, to create a specific tool for fighting insurgent groups in the Middle East and Africa.

Conclusion:

The carrier air wing is the U.S. Navy's most critical tool for achieving its objectives. From ISR and Strike to Sea Control and Air Superiority, there is no replacement for the efficacy of the carrier air wing carried onboard a large-deck flattop. Unmanned systems will be a part of the future of naval aviation, with a more limited tanking role in the immediate future that expands to ISR and Strike as technology develops. Aside from unmanned platforms, Navy would benefit from reevaluating the full composition of the air wing, and reemphasizing diversity and mission specificity, to ensure the greatest possible level of combat ability.

Despite the importance of these recommendations, I cannot stress the importance of strategy. If we do not understand our adversaries and our goals, what we build and buy is irrelevant. A proper strategy is more critical than any specific procurement or development can ever be.