

# If You Can't See 'em, You Can't Shoot 'em: Improving US Intelligence, Surveillance, Reconnaissance, and Targeting

BY SETH CROPSEY AND BRYAN MCGRATH



© 2019 Hudson Institute, Inc. All rights reserved.

For more information about obtaining additional copies of this or other Hudson Institute publications, please visit Hudson's website, **[www.hudson.org](http://www.hudson.org)**

#### **ABOUT HUDSON INSTITUTE**

Hudson Institute is a research organization promoting American leadership and global engagement for a secure, free, and prosperous future.

Founded in 1961 by strategist Herman Kahn, Hudson Institute challenges conventional thinking and helps manage strategic transitions to the future through interdisciplinary studies in defense, international relations, economics, health care, technology, culture, and law.

Hudson seeks to guide public policy makers and global leaders in government and business through a vigorous program of publications, conferences, policy briefings and recommendations.

Visit **[www.hudson.org](http://www.hudson.org)** for more information.

Hudson Institute would like to thank General Atomics for their support of this research and publication, and is grateful for past contributions from Northrop Grumman Corporation and Lockheed Martin Corporation.

#### **Hudson Institute**

1201 Pennsylvania Avenue, N.W.  
Fourth Floor  
Washington, D.C. 20004

+1.202.974.2400  
[info@hudson.org](mailto:info@hudson.org)  
[www.hudson.org](http://www.hudson.org)

Cover: The guided-missile destroyer USS Dewey (DDG 105) transits the Pacific Ocean. Dewey is underway in the U.S. 3rd Fleet area of operations. (U.S. Navy photo by Mass Communication Specialist 2nd Class Devin M. Langer)

# If You Can't See 'em, You Can't Shoot 'em: Improving US Intelligence, Surveillance, Reconnaissance, and Targeting

BY SETH CROPSEY AND BRYAN MCGRATH



# AUTHOR

## **Seth Cropsey**

*Director, Center for American Seapower*

Seth Cropsey began his career in government at the Defense Department as Assistant to the Secretary of Defense Caspar Weinberger and subsequently served as Deputy Undersecretary of the Navy in the Reagan and Bush administrations. In the Bush administration, Cropsey moved to the Office of the Secretary of Defense to become acting assistant secretary, and then principal deputy assistant Secretary of Defense for Special Operations and Low-Intensity Conflict. Cropsey served as a naval officer from 1985-2004.

From 1982 to 1984, Cropsey directed the editorial policy of the Voice of America on the Solidarity movement in Poland, Soviet treatment of dissidents, and other issues. Returning to public diplomacy in 2002 as director of the US government's International Broadcasting Bureau, Cropsey supervised the agency as successful efforts were undertaken to increase radio and television broadcasting to the Muslim world.

Cropsey's work in the private sector includes reporting for Fortune magazine and as a visiting fellow at the American Enterprise Institute, and as director of the Heritage Foundation's Asia Studies Center from 1991 to 1994.

## **Bryan McGrath**

*Bryan McGrath formerly served as deputy director of Hudson Institute's Center for American Seapower.*

McGrath is the founding Managing Director of The FerryBridge Group LLC (FBG), a consultancy specializing in naval and national security issues. Prior to starting FBG, Bryan founded a national security consulting line of business for Delex Systems of Herndon, VA.

A retired Naval Officer, McGrath spent 21 years on active duty including a tour in command of USS BULKELEY (DDG 84), a guided-missile destroyer homeported in Norfolk, Virginia. In command, he received the "Admiral Elmo Zumwalt Award for Inspirational Leadership" from the Surface Navy Association and his ship earned the USS ARIZONA Memorial Trophy signifying its selection as the Fleet's most combat-ready warship. His final duties ashore included serving as Team Lead and Primary Author of the US Navy's 2007 Maritime Strategy A Cooperative Strategy for 21st Century Seapower.

---

*The authors would like to thank Harrison Schramm (US Navy, ret.) for the invaluable assistance he provided in preparing this report.*

# TABLE OF CONTENTS

Introduction	6
Part I: History and Strategy	8
World War II	8
The Cold War	9
Cold War Systems Mature	11
Post–Cold War	12
Renewed Great Power Competition	14
Who is Setting the Pace in Today’s Military Competition?	17
Current State of Maritime ISR/T	17
Part II: Technology	20
National Technical Means	20
Analysis	21
Assumptions	23
Approach	25
Impact of Revisit Rate	25
Analysis and Insights	25
Combined Area / Focused Search	26
Summary	26
Next Steps	26
Recommendations	27
Japan’s Role in Western Pacific Security	29
Current Japanese ISR/T	31
Recommendations for Japanese ISR/T	32
Conclusion	34
Endnotes	35





## INTRODUCTION

The United States today faces the greatest challenge to its international stature since the mid-twentieth century. America's adversaries, despite their differences, threaten to come together in a coalition that can dominate Eurasia and by extension, jeopardize American strategic interests and values globally. Of several potential flashpoints for confrontation, the Western Pacific has the potential to be the most decisive. The most powerful of the three US rivals is Asian, and it is the only adversary with the economic and political power to field a technologically sophisticated, quantitatively superior military force.

Of course, there has been a noticeable, necessary, and welcome increase in discussion of America's operational and theater strategies in the Pacific, alongside a military and civilian focus on responding to renewed great power competition.

---

Photo caption: Chinese guided-missile frigate Yueyang sails in waters during China-Thailand Joint Naval Training 'Blue Commando-2019' at a military port on May 6, 2019 in Shanwei, Guangdong Province of China. (Visual China Group via Getty Images)



*But there is a current lack of appreciation for the critical role of intelligence, surveillance, reconnaissance, and targeting (ISR/T) capabilities in naval combat success.* This operational blind spot has concrete ramifications for the balance of power in the Western Pacific and the ability of the United States to force a political settlement without conflict.

This report tracks the development of naval and maritime ISR/T from the Cold War to the present day. It reveals the fluctuating relationship between ISR/T and weapons ranges that have adversely impacted the US Navy's combat capabilities. While the United States developed longer-range weapons throughout the Cold War and revised tactics and fleet composition to better employ those weapons offensively, the gap that remained between weapons range and targeting information had a negative effect on US Navy combat power. Following the Cold War, ISR/T capacity and capability rose, allowing for precision strikes against ground targets at short and medium range. Finally, the contemporary fleet, facing renewed great power competition, is increasingly receiving long-range strike weapons. However, it lacks the ISR/T complex to identify and hit targets at those ranges in most over-the-horizon combat situations.

Second, this report reviews the current ISR/T capabilities to which the US Navy has access, primarily in the Pacific theater, and performs first-order sufficiency analysis to gain an understanding of the impact the current program of record has on operational requirements.

Finally, the report concludes with several key recommendations to naval policymakers, civilian and military, including the following:

- Congress should direct a Federally Funded Research and Development Corporation to perform a classified evaluation and analysis of Navy ISR/T analytical efforts and report the results.
- The Department of Defense should consider redeploying land-based unmanned aerial vehicles (UAVs), specifically the MQ-9 Reaper remotely piloted vehicle (RPV), from the Middle East to the Pacific, modifying them for maritime ISR.
- The Navy should assess accelerating the current MQ-4C program of record.
- The Navy should consider acquiring a medium-altitude, long-endurance (MALE) UAV that can be launched and recovered onboard surface combatants and deliver targeting data directly, which would efficiently and effectively negate a portion of the ISR/T coverage gaps. The Navy should modify the MQ-25 Stingray UAV to carry its own ISR/T data-gathering suite to provide the carrier air wing (CVW) with organic ISR/T, and rely less on non-traditional ISR, currently being conducted by F/A-18E/Fs and EA-18Gs.
- DoD should work to encourage key allies and partners to increase their own maritime surveillance capabilities, including advocating for foreign military sales of the MQ-4C Triton and the MQ-9B SeaGuardian/Protector.



## PART I: HISTORY AND STRATEGY

### World War II

To understand the gaps and inadequacies in the US Navy's current ISR/T complex, we must review the ISR/T techniques Navy employed in the past and examine their strengths and weaknesses.

A dedicated ISR complex is critical in naval combat. Without eyes, a fleet cannot fight. Athenian statesman and admiral Themistocles used the cover of night to disengage from the numerically superior Persian forces. Lord Nelson used frigates as picket ships at critical points along the European coastline,

keeping his main force out of sight and thereby tempting the French into battle at Trafalgar. During the Great War, the Battle of Jutland was marred by ISR inadequacies on both sides. Neither Britain's Grand Fleet nor Germany's Hochseeflotte knew that it was approaching a fleet action.<sup>1</sup> Only sheer luck encouraged

---

Photo caption: Thick cloud cover around pair of US Navy Douglas SBD Dauntless torpedo dive bombers en route to targets during bombing raid on Japanese-held Wake Island. (Time Life Pictures/US Navy/The LIFE Picture Collection)



Admiral Jellicoe to form his line of ships facing west rather than southeast — in the heat of battle, Admiral Beatty could not communicate heading and course to the Grand Fleet. Similarly, after the primary fleet engagement, the battered German battle line was able to slip away because of the Grand Fleet's poor communication and surveillance techniques.

A fleet cannot fight without eyes, and aviation and radar transformed the meaning of ISR in military conflict. Even traditionalist battleship admirals understood that naval aviation would revolutionize ISR and targeting; aircraft launched from battleships or scouting cruisers could feed superdreadnought gun crews much more accurate targeting information, making even larger and longer-range gun calibers feasible.<sup>2</sup> In reality, of course, the naval aircraft's versatility and range outstripped nearly all expectations, transforming naval aviation into the centerpiece of the modern combat fleet.

The Second World War was the first instance in which national fleets, particularly the US Navy and Britain's Royal Navy, deployed large numbers of radar systems. Pearl Harbor forced the US Navy to embrace the carrier admirals' vision of naval warfare. The Navy's three Pacific carrier groups, unable to form a battleship line, formed the backbone of America's defenses well into 1942. Their success ensured the Navy's transition away from the battleship division and towards the carrier group.

US Navy ISR/T during the Second World War comprised two aspects. First, CVWs included hybrid scout and strike aircraft, known as scout or torpedo bombers, depending upon their payload. The most effective of these, the SBD Dauntless dive bomber, played a critical role in US Navy ISR/T until mid-1944. Dauntless squadrons could operate as either dedicated strike aircraft or scouting hunter-killers, engaging targets of opportunity. Four Dauntless squadrons damaged or sank all four Japanese fleet carriers at Midway, neutralizing three in six minutes. The Navy began phasing out its Dauntless bombers in 1944, replacing them with SB2C Helldivers, though the advent

of rockets made dive bombers less effective by themselves. Nevertheless, the Vought OS2U Kingfisher remained in service throughout the war as a high-endurance observation aircraft, while fighter squadrons supplanted and supplemented dedicated carrier scouts. Moreover, Grumman TBF Avenger torpedo bombers were equipped with airborne early warning radar that could detect enemy aircraft out to 100 miles. This could be called the first dedicated airborne warning and control system (AWACS).

Second, the Fast Carrier Task Force integrated radar picket ships into its force structure. Radar pickets were not, however, offensive platforms, but were deployed defensively to provide early warning against incoming enemy aircraft — particularly inbound Japanese Kamikazes<sup>3</sup> Air Operations Officer James Thatch created a system nicknamed the “Big Blue Blanket,” in which radar picket ships placed fifty miles or more from the Fast Carrier Task Force flat-tops would coordinate with large, persistent fighter sweeps intended to swamp any incoming suicide aircraft. This picket ship system, while decreasing the Navy's operational mobility, was nevertheless effective in context: American fleets were forced to hold position in support of ground troops on Okinawa, making them ripe targets for Japanese harassment. Aside from radar's direct effects on the carrier group, it also enabled US surface combatants to fight at night, offsetting Japan's previous night-fighting advantage.

## The Cold War

The US Navy's early-to-mid Cold War ISR/T complex reflected the needs and structure of the Second World War. Airborne early warning technology was still in its infancy. ISR/T was primarily ship-borne; the CVW would provide the strike element, with the flat-top sailing behind a screen of anti-aircraft-equipped surface combatants.

Changing geopolitical structures modified the role of maritime power, and consequently, the role of the US Navy in American national strategy. The pre-1945 multipolar balance of power

vanished, broken, as the traditional European powers and Japan were, by total war. The new bipolarity modified international political interaction. No longer could shifting alliances release stresses, and no longer could there be multiple political coalitions, notwithstanding the pretensions of the Non-Aligned Movement.

More critically for naval policy, *the Cold War modified the maritime balance*. From the early eighteenth century onwards, European and then global diplomacy had been defined by powers with qualitatively homogenous military capacities. British naval power outstripped Russia's maritime presence, while Russian and German land power were greater than Britain's. Nevertheless, each great power operated strategically meaningful naval and land capabilities. Thus, the sea services of any great power could engage in a fleet action or string of naval engagements with nearly any adversary's battleships — or later, aircraft carriers.

By contrast, the USSR lacked traditional naval forces. Particularly during the early stages of the Cold War, the Soviet Union did not operate large surface combatants in task forces meant to control the seas and take the fight to the enemy, at least not in the traditional sense. Rather, Soviet doctrine was focused upon area denial and harassment using surface combatants, submarines, and maritime strike aircraft. Hence, the US Navy needed to change its conception of its role in national strategy, its "strategic concept," as Samuel Huntington termed it.<sup>4</sup> The Navy could not expect carrier engagements in the central Pacific or North Sea. Rather than establishing sea control with a fleet action, Navy needed to maintain sea control against Soviet pressure while ensuring that amphibious forces could assault hardened land installations with naval support.

Initially, therefore, US planners assumed that they would not face an aggressive Soviet Navy. While Soviet ground forces were a constant threat to Western Europe, the Soviet Navy would not be able to carry out the offensive sea control missions that

the Imperial Japanese or German navies had executed during both world wars. Thus, initial US ISR/T capabilities emphasized early warning rather than targeting. Radar picket ships — and beginning in the early 1950s, submarines — would supplement land-based, long-range arrays to create a multilayered detection network. The focus of US naval strategy was the GIUK gap that runs between Greenland, Iceland, and the United Kingdom. Before the early 1960s, submarines did not pose a nuclear threat, while US diplomacy during the early Cold War blocked Soviet access to the Mediterranean. Hence, during the early years of the Cold War, the Soviet Navy focused primarily on pressuring Western sea lines of communication (SLOCs), a task accomplished only by sortieing through the GIUK gap.<sup>5</sup>

The Second World War structure of radar picket ships and submarines thus matched the US Navy's strategic realities. By maintaining a static defense line in the North Atlantic while coupling radar-ISR/T platforms with anti-submarine-warfare (ASW) surface combatants, the US Navy hoped to detect Soviet submarines and strategic bombers spilling into the Atlantic and over Western Europe. Relatively static ship-based ISR/T also matched US amphibious assault doctrine at the time; techniques akin to those used at Iwo Jima and Okinawa could be applied in the Bosphorus.

The Soviet Navy responded to the new geopolitical situation by developing new technologies and operational techniques that furthered the USSR's strategic interests. The Soviet Union had two maritime imperatives. The first was to defend the Soviet coastline and so-called "naval bastions" from American pressure.<sup>6</sup> This would prevent a land invasion of the USSR, preclude strikes against ground-based nuclear silos and strategic airfields, and provide a safe haven for Soviet nuclear ballistic missile submarines to ensure second-strike capability. The second imperative was to pressure American SLOCs and supply lines. This would disrupt the ability of the United States to reinforce and coordinate with NATO allies and other allies and would jeopardize international trade during great power conflict.

Two technologies changed the naval balance for the Soviet Union. First, the development of nuclear-powered, ballistic missile-carrying submarines (SSBNs) and submarine-launched ballistic missile (SLBM) technology made the Soviet Navy central to the nuclear balance. This was why Navy focused on maintaining naval bastions and creating fleets that could deny the US access to critical areas. Second, the creation of long-range missiles allowed Soviet forces to push the US Navy back outside its strike envelope, decreasing the risks of US pressure against Soviet SSBNs and the Soviet coastline.

It must be noted that the US Navy was not taken aback by these developments. Indeed, the first SSBN and submarine-launched cruise missile (SLCM) were both American. Admiral Hyman Rickover, supported by Chief of Naval Operations Arleigh Burke, spearheaded the development of nuclear-powered submarines in part to give the Navy a clear nuclear deterrence role. However, the Soviet Navy was able to articulate a more coherent long-term strategic vision than its American counterpart, primarily because of its more centralized leadership.<sup>7</sup> Admiral Sergey Gorshkov commanded the Soviet Navy for nearly three decades, ensuring an institutional and strategic continuity that the US Navy could not possess. Gorshkov's talents allowed the Soviets to identify and exploit American vulnerabilities at sea, consistently leaving the US on the back foot despite its superior industrial base and scientific capacity.

Hence, the initial American strategy of ship-based ISR/T proved inadequate to match the Soviet threat. The picket ship and submarine system gained new relevance with Soviet SSBNs and cruiser submarines; critically, it could not provide accurate enough targeting information for US forces to kill Soviet targets.

## Cold War Systems Mature

By the mid-1960s, the US Navy began to identify a growing operational inferiority apropos its Soviet rival. The first move to correct this was establishing carrier-based ISR/T platforms. The E-1 Tracer, the first purpose-built airborne early warning aircraft

operated by the US Navy, entered service in 1958. However, it was never intended to serve as more than a stopgap. The E-2 Hawkeye, which still provides nearly all the CVW's airborne early warning (AEW) capability, entered service in the mid-1960s. Both aircraft served in the Vietnam War, coordinating combat air patrol missions over MiG Alley (in the Korean War), and each platform provided significantly greater ISR range than older radar picket ships and submarines. Critically, each aircraft could also operate with the faster, more-modern carrier groups of the 1960s and 1970s. Radar pickets were last used during the Vietnam War. By 1970, the over-the-horizon HF/DF radars of the E-1 and E-2 had made them obsolete.<sup>8</sup>

These new AEW capabilities renewed the carrier battle group's maneuver potential. However, the potency of missile technology also became apparent in the mid-1960s. Israel's experience in 1967 was illustrative to all parties. Egypt launched long-range missiles from small missile boats, sinking the INS *Elit* and demonstrating the efficacy of ship-to-ship missiles.<sup>9</sup> Israel developed its navy in kind, and with five newly developed *Saar* 3- and *Saar* 4-class missile corvettes, sank five Syrian missile boats without any losses. Both sides deployed electronic warfare techniques and ship-to-ship missiles. This demonstrated that at sea, the carrier need no longer monopolize the strike role.

Beginning in 1981, the United States adopted an increasingly aggressive naval posture. Major exercises like Ocean Venture and Ocean Safari put direct pressure on the Soviet Union at sea.<sup>10</sup> Concurrently, the US began to employ technologies developed throughout the 1970s, beginning with longer-range strike tools, most notably the Tomahawk and Harpoon anti-ship missiles. Countering the Soviet submarine threat also required more robust ASW capabilities on and outside the carrier. The carrier-based S-3 Viking was supplemented by the land-based P-3 Orion, the latter designed exclusively to track Soviet SSBNs and fast-attack submarines. The Light Airborne Multi-Purpose System (LAMPS) program also gave helicopters the ability to extend the fleet's ISR and ASW range while also participating



directly in surface and subsurface combat. Nevertheless, despite technological improvements, it is unclear how accurate American targeting would have been. This led to a disconnect between long-range American strike tools and the US Navy's ability to employ those tools.

## Post-Cold War

The Cold War's conclusion created a new set of strategic imperatives, in turn modifying the Navy's own force structure and capabilities. However, a misreading of the strategic environment resulted in distinct capability gaps, which can still be seen today.

The Second World War transformed the global strategic landscape. However, it fit within a traditional historical pattern. Structural pressures and ideological shifts combined to stress the interwar balance of power. While the specific leaders and critical actions may have been unique, the same general trend occurred numerous times throughout European history and in other countries as well. The conflicts between Athens and Sparta, Venice and the Ottomans, England and France, and finally, the Entente and Central Powers, were all variations upon a similar theme.

By contrast, the Cold War ended without actual confrontation. There was no struggle between Soviet armor and NATO anti-tank units in central Europe, nor was there an amphibious landing in Turkey or a major offensive in the North Sea. American strike aircraft did not press Warsaw Pact air defenses. Most critically, the often-predicted apocalyptic nuclear exchange between West and East never occurred. Rather, the Soviet Union simply disintegrated. The USSR's command economy could not keep pace with the West's dynamic capitalist system. The aggressive military posture that NATO and other US allies adopted in the 1980s crystallized the situation for the Soviets: all their nuclear and conventional investments, bought at the price of internal economic destitution, could not compete with a focused, strategically minded West.

Nevertheless, the Soviet collapse was largely unanticipated. Indeed, in retrospect, it was a series of random factors that led to the USSR's disintegration, rather than the sum of American strategy's individual elements. The Berlin Wall fell only because of a public gaffe by an East German party spokesman. One wonders if the targeted application of force between 1989 and 1991 would have broken up Eastern Europe's liberalization movements, as it did in China at Tiananmen. Soviet collapse, therefore, was likely accidental, not inevitable.

Hence, two distinctions between the Cold War and other cycles of systemic change come to the fore. First, before the Cold War, no contest for global leadership had ever ended with the challenger simply collapsing without an armed confrontation. Second, the challenger's collapse stemmed less from external systemic pressures than from random internal events, combined with the stifling bureaucracy of the Soviet system.

One can draw a critical conclusion from these distinctions: while the Soviet Union collapsed and the balance of forces changed momentarily, the end of the Cold War did not necessarily signal a legitimate diplomatic or political transformation. American interests in Europe had not changed. The United States still needed to prevent any power or coalition from gaining hegemony on the Eurasian landmass, which in turn required denying any single political unit dominance over the Eurasian heartland. The heartland, what Mackinder termed Eurasia's "pivot point," intersects with Russian territory.<sup>11</sup> Thus, absent a complete redefinition of the Russian regime, a united Russian polity would inevitably jeopardize American interests.

Nevertheless, American statesmen thought that the Soviet Union's collapse ushered in a new age of unprecedented international stability, and hoped that no other great adversary would arise. The US, acting as the sole global superpower, would be able to police an international order resting upon seemingly universal liberal norms. Great power conflict was no longer a strategic imperative. Russia, it seemed, was politically

crippled, while China lacked power-projection capabilities and disproportionately benefited from the international economic system.

The military therefore refocused on small, localized wars against sub-peer adversaries, eschewing concerns of great power conflict. The Navy was no exception. Once again, the Cold War Navy's strategic concept involved preserving SLOCs, maintaining the US second-strike capability, and supporting amphibious assaults against Russian and other targets. The threat against American SLOCs seemed to have disappeared. Second-strike capability remained important, but all legs of the nuclear triad were cut in the post-Cold War environment. Hence, amphibious support was the only mission with which the Navy could justify its capabilities and role.<sup>12</sup>

Amphibious support — through air interdiction, counterair missions, or close air support — requires precise ISR/T. The Navy did expand its *ground-focused* ISR/T capabilities. This, however, degraded its naval ISR/T capabilities while also narrowing its strike range. Two factors explain these changes. First, the ground targets the Navy would be tasked with striking lacked robust anti-air defenses. The experience of the Gulf War demonstrated, it appeared, that niche stealth capabilities, alongside precision-guided munitions and electronic jamming, could disrupt or destroy any anti-air network that US armed forces would encounter. Moreover, as the Navy and the US military overall emphasized counterinsurgency and irregular warfare in the early 2000s, suppressing and destroying enemy air defense missions became less important. Both counterinsurgency and irregular warfare required variegated ISR/T capabilities and the ability to strike at range. While munitions ranges did not decrease, strike aircraft range did.

Second, the Navy shifted its combat power globally. This change is reflected in the change from “carrier battle groups” to “carrier and expeditionary strike groups” to provide greater global coverage.<sup>13</sup> Rather than amassing multiple carrier groups

in the Eastern Mediterranean and Pacific to control geostrategic chokepoints, the Navy distributed its combat power throughout different combatant commands, supporting land campaigns in a piecemeal fashion.

This strategic shift catalyzed several changes in the Navy's operational structure with clear implications for ISR/T. The Cold War Tomahawk anti-ship missile had a range of 700 nautical miles. The Navy retains the standard missile-2 (SM-2), the standoff land attack missile-expanded response (SLAM-ER), and the Harpoon, all of which have anti-ship capability within 100 nautical miles. However, the loss of the Tomahawk cut surface combatant strike range to one-seventh of its previous reach. Surface combatants were re-tasked with ground support and precision-strike missions, akin to the Tomahawk land attack missile salvos that inaugurated Desert Storm. At sea, the surface combatant's primary missions became fleet air and anti-submarine defense, along with maritime security missions involving ship-based boarding teams.

As surface combatants de-emphasized the surface strike role, Navy planners naturally turned to the CVW to fill the resulting gap in anti-ship capabilities. Once again, naval air power demonstrated its near-universal flexibility: the same set of platforms can perform nearly every mission imaginable, with requisite technological modification. ISR/T capacity and capability also increased. The advances in satellite imagery developed for the Cold War's nuclear arms treaties became an increasingly effective imagery intelligence source for combat fleets. Beginning with the RQ-2 Pioneer's deployment on *Iowa*-class battleships, the Navy progressively integrated UAVs into its surveillance structure.<sup>14</sup>

While US Navy ISR/T did improve throughout the 1990s and early 2000s, strike range remained relatively static or even decreased. The budgetary and strategic pressures of the 1990s prompted the Navy to shrink the CVW both in variety and in number of platforms. Comparison is illustrative. During the late

Cold War, the CVW included eight different aircraft using six different airframes: a dedicated interceptor and air superiority fighter (F-14), a medium-range fighter-bomber (F/A-18), a long-range attack aircraft (A-6E), a dedicated electronic warfare platform (EA-6B), a maritime patrol platform (S-3), a subsonic attack aircraft (A-7), a modified CVW organic range extender (KA-6D), and an AEW platform (E-2C). This air wing could handle every conceivable combat mission, from interdiction and offensive counter-air (OCA) to surface strike and ASW. Its strength, once again, stemmed from its diversity of capabilities. The dependable long-range A-6 airframe served well as a platform for strikes, suppression of enemy air defenses (SEAD), and range-extension. The F-14's strike range gave it the ability to double as an interdictor, and the F/A-18's aerodynamics allowed it to conduct OCA missions while still maintaining payload capacity for strike missions.

In contrast, by the early 2000s, the CVW had shrunk to only three airframes, excluding the C-2A Greyhound carrier onboard delivery aircraft. F/A-18 variants have taken over every mission, apart from AEW and anti-submarine warfare. The standard F/A-18C Hornet and F/A-18E Super Hornet replaced the F-14 and A-6E, while the EA-18G Growler replaced the EA-6B. UH-60 Black Hawk variants have monopolized the anti-submarine-warfare role and performed general utility missions and combat search and rescue. The CVW lost its organic tanking capacity, first re-tasking the S-3 and then F/A-18s to "buddy tanking" missions. Hence, while ISR/T did improve in the 1990s and early 2000s, strike range shrank, since the F/A-18 airframes that took over nearly every mission in the CVW lacked the endurance of their predecessors. ISR/T therefore outstripped weapons capability.

This disparity between ISR/T and strike range, however, did not limit the Navy's effectiveness in the late 1990s and early 2000s. Navy's three major missions — in Yugoslavia, Afghanistan, and Iraq — were all conducted against relatively unsophisticated adversaries. In Iraq, effective operational planning and

coordination masked deficiencies that might have become apparent in a longer campaign. After 2003 the US Navy, and by extension the Air Force and Marine Corps Aviation, did not need to conduct the same high-threat-environment missions that would require long-range standoff munitions. Precision strikes increased in importance with the US ground commitment in Iraq and Afghanistan, but there were no questions about access to the strike envelope.

## Renewed Great Power Competition

By the end of the George W. Bush administration, geopolitical trends were once again shifting. Although Western governments did not recognize the renewal of great power competition until Russia's 2015 intervention in Syria and China's increased aggression in the Western Pacific, signs of geopolitical stress had been apparent for at least a decade. Even before US involvement in Iraq and Afghanistan there were red flags. For example, in April 2001, a Chinese J-8 interceptor shadowed and collided with a US Navy EP-3E Aries II SIGINT aircraft on a routine patrol.<sup>15</sup> The Chinese pilot was killed, while the EP-3E was forced to land at China's Hainan Island military base. China demanded a formal apology and one million dollars in compensation, and it refused to allow American mechanics to repair the damaged aircraft and fly it off Hainan.

Despite the hopes of US foreign and national security planners as the Cold War ended, the United States again faces the prospect of peer and near-peer competitors, and dangerous sub-peer competitors like North Korea.

China and Russia have distinct interests and objectives, even though they are united by a general distaste for a US-led liberal international order and by hostility to it. This is a principle point of differentiation from the great power competition of the latter half of the twentieth century. Although the communist bloc ultimately split in two, there was still an overarching ideology that linked Moscow and Beijing not only with proxy states, but also with guerrilla groups and insurgents in Africa and Latin America.



By contrast, there is no ideological congruity between Russian kleptocracy and Chinese Mandarin authoritarian capitalism, apart from general illiberalism.

The similarity of the strategic and operational approaches of each adversary is worrying. China, Russia, and others, such as Iran, all learned the clearest lesson from the Gulf War: Do not allow the United States easy access to nearby territory. The Iraq War modified this lesson, as the US-led coalition achieved a similarly spectacular conventional victory with one-third of the forces and used airborne infantry, local partners, and precision-guided munitions in a decisive role. This taught US adversaries that they must not only deny the United States access to nearby territory for *staging* purposes, but also for *strike* missions.

Each adversary has used a unique mix of political and military tools to force US assets out of strike range. Notably, China, Russia, and Iran all executed the initial phases of their grand strategies within six years of each other, and without formal international coordination. Russia invaded northern Georgia in 2008, conquering the country's Black Sea coastline. In 2010 in Iraq, the US allowed Nouri al-Maliki's State of Law Coalition to disrupt the democratic process, and Iran exploited the ultimate public dissatisfaction with the elections to solidify its contacts with Iraqi Shia groups. In late 2013, China began constructing its artificial islands in the South China Sea. Russia's 2014 annexation of Crimea increased its control over the Black Sea coastline, leaving Turkey the only other Black Sea naval power. Several months later during the first major ISIS offensive, Shia paramilitaries — manned by former insurgents trained and supported by Iran — filled the void left by the collapse of conventional Iraqi security forces.

While Russia and Iran pose unique threats, China is the most robust US adversary. Its economic power allows it to field larger forces than the United States that in many instances approach the sophistication of front-line Western combat aircraft, ships, and submarines. By examining China's current mix of

capabilities and US responses to them in the past decade, we can identify the gap in ISR/T that is so potentially damaging to US combat power, and by extension, diplomatic and strategic credibility in the Asia-Pacific.

China hopes to monopolize the Asia-Pacific. The causes are manifold: its will to power, its desire to reclaim its traditional role as the world's great political-economic unit, its desire to assert cultural supremacy. Alternatively, it may be China's pervasive fear of the West and paranoia about legitimacy. However, the precise combination of reasons is irrelevant. China's actions indicate that it hopes to dominate the first island chain and then use it as a springboard to humble Japan and project power into the Western and Eastern Pacific. To accomplish this goal, Beijing must have two subsidiary theater strategic objectives that entail specific geographical target sets and explain its mix of capabilities. First, China must neutralize US and allied forces in the region. Second, it must prevent the United States from reinforcing its allies and forward-deployed assets in a longer conflict, thereby isolating the first island chain from the rest of the Asia-Pacific.

Taiwan, the Philippines, and Vietnam are China's most likely initial targets. The Vietnamese ports of Da Nang and Hai Phong lie parallel to China's lines of communication in the South China Sea. Submarines, ships, strike aircraft, or land-based anti-ship missiles launched from Vietnam would prevent a Chinese offensive towards the Straits of Malacca or Lombok. Philippine resistance would disrupt any movement between the South and East China Seas, making it more difficult for China to concentrate forces between theaters. Hence, Beijing's immediate operational objective must be to neutralize the Philippines and Vietnam.

However, Taiwan is of even greater importance. The People's Liberation Army (PLA) outclasses its Philippine and Vietnamese counterparts at every level of escalation — a fact that has allowed Chinese warships, behemoth coast-guard cutters,

fishing fleets, and oil rigs to violate Vietnamese and Philippine territorial waters with impunity.<sup>16</sup> But the Taiwanese, despite being outnumbered, field a sophisticated Western-style military and are geographically positioned to threaten mainland China's population and economic centers with long-range missiles during a protracted conflict.

The United States has formal military obligations towards the Philippines, while the relationship between Hanoi and Washington has improved over the past half-decade, substantially owing to Chinese aggression. The Taiwan Relations Act does not commit the US to support the Republic of China against the mainland; it instead restrains unilateral US executive branch policy change toward Taiwan.<sup>17</sup> Nevertheless, it is difficult to imagine a US president who would be unwilling to support Taiwan in defending its sovereignty, or a Congress that would permit American indifference to Taiwan's fate. The US regional base network, most significantly in Japan, compels Chinese planners to assume that forward-deployed US forces, including a carrier strike group (CSG) and increasingly strategically minded Japan Self-Defense Forces, will become involved in a Sino-Taiwanese engagement and will likely support the Philippines and Vietnam during a similar fight in the South China Sea. Moreover, the geographic nature of the first island chain makes general war — that is, concurrent Chinese offensive operations against Taiwan, Vietnam, and the Philippines — more likely than a local scenario. A larger engagement, in turn, raises the likelihood of a longer one, as US follow-on forces rush to support regional partners and local assets.

Thus, in the initial phases of a conflict, the PLA will be planning to:

- eliminate Vietnamese and Philippine aviation and naval capabilities;
- encircle and bombard Taiwan in preparation for invasion absent political capitulation;
- destroy or otherwise neutralize forward-deployed US forces in Japan and elsewhere in the Western Pacific, potentially

destroying the necessary infrastructure for US follow-on forces;

- do the same to the Japan Maritime Self-Defense Forces and Japan Air Self-Defense Forces attempting to intervene;
- threaten, and if necessary, disrupt and destroy incoming US reinforcements from the Western and Eastern Pacific.

Medium- and long-range missiles are the most effective means to accomplish these goals. Hypersonic glide vehicles like the DF-ZF, launched from at least one thousand miles away and fitted onto ballistic missiles, would threaten US CSGs and surface action groups approaching Taiwan or the Philippines from bases in Japan or Guam.<sup>18</sup> China is developing air-launched anti-ship ballistic missiles for use on its H-6K strategic bombers, and the CH-AS-X-13 will allegedly have a range of nearly two thousand miles. By combining these with an assortment of shorter-range cruise and ballistic missiles — ship, shore, air, and submarine-launched — Beijing hopes to construct a layered network that can saturate targeted locations and threaten reinforcing US ships and aircraft. Not only has China invested in longer-range weapons and delivery systems; it has also emphasized development of a robust ISR/T complex alongside its weapons to ensure effective implementation, including seabed sensors<sup>19</sup> and over-the-horizon targeting mechanisms.<sup>20</sup>

The United States has responded with technological advances of its own. The SM-6 missile functions as both an anti-air tool capable of countering cruise and ballistic missiles launched at American CSGs and a high-speed anti-ship missile. The most advanced Tomahawk variants collate targeting data from the entire available sensor network of the joint force and can be redirected mid-flight towards alternative targets. Moreover, the long-range anti-ship missile (LRASM) and joint air-to-surface standoff missile-extended range (JASSM-ER) give the US Navy capabilities that allow it to engage in the long-range missile duels China seems to envision.

## Who is Setting the Pace in Today's Military Competition?

The US will also soon field hypersonic weapons of its own. The hypersonic technology vehicle 2 (HVT-2) project — itself an outgrowth of the Falcon project of the Defense Advanced Research Projects Agency (DARPA) — has morphed into DARPA's Tactical Boost Glide program.<sup>21</sup> The advanced hypersonic weapon, a part of the Conventional Prompt Global Strike program, is another major US effort.<sup>22</sup> But most important, America has made strides in hypersonic gun munitions that Russia and China have yet to match. While Sino-Russian efforts have emphasized transformative technologies, the US may soon be able to deploy Mach 3 conventional munitions fired from standard naval guns.<sup>23</sup> During RIMPAC 2018, the destroyer USS Dewey fired twenty hyper-velocity projectiles through its five-inch deck gun.<sup>24</sup> There are clearly questions surrounding doctrine and acceptable levels of risk to the US carrier group. However, with proper funding, the US Navy can avoid being outranged during pre-conflict maneuvering or armed confrontation.

Nevertheless, without an actual ISR/T complex to identify targets and feed precise data back to the fleet, American long-range missiles will not improve the strategic balance in the Western Pacific. *The US currently lacks ISR platforms, manned or unmanned, that can remain on station for long enough, cover enough ground, and feedback enough information to an American fleet to allow US commanders to shape the combat environment.* In the worst case, America's adversaries may outpace the US in a conflict's opening phases, forcing Washington to decide between accepting high casualties or ceding an operational region. Less catastrophically, if the US lacks information on China's movements in the Pacific, this can allow Beijing to manipulate the time and place of potential confrontations, forcing US commanders to choose between unsavory escalation scenarios.

Notably, China has not neglected the most robust aspect of US ISR/T, American satellite capabilities, and has been rehearsing knocking out satellites since the mid-2000s.<sup>25</sup>

## Current State of Maritime ISR/T

The central point here is that there is a mismatch between the increased range of US Navy anti-ship weapons and the ISR/T architecture that supports their employment. This monograph, an unclassified document relying on publicly available information about US weapons and the sensors and networks that support them, aims to raise questions for deeper analysis in classified forums and possible oversight questions for Congress. The analysis is first order, and simple but revealing.

The Navy, or more correctly, the fleet, fights as a system made up of ships, submarines, aircraft, networks, weapons, sensors, and the computing power to tie them all together. This maritime system fits broadly within the joint warfighting architecture; it is a consumer of information derived elsewhere and a supplier of information to the other domains (land, air, space, cyber, etc.). The focus in this monograph lies mainly within the maritime domain and its ability to generate situational awareness and targeting accuracy on adversary surface combatants in the Western Pacific. We chose the Western Pacific because the People's Liberation Army Navy (PLAN) is the prominent naval threat for the US Navy and because a conflict between the US and China would take place at or very close to the sea. In addition, to the extent that the Russian Navy poses challenges in this area, they are related to the challenges posed by the PLAN.

Several factors indicate that fleet anti-surface warfare (ASUW) weapons are not adequately supported by the targeting environment. The first is the complexity of that environment. For a missile to impact an adversary surface ship, several things must happen: the ship must be located, it must be identified, it must be discerned against the background of other ships in the area and false targets, it must be designated for engagement, and it must be tracked to a degree of precision that is within the capability of the missile employed. All things being equal, the more capable the missile, the less the need for the architecture to provide it with accurate targeting. Finally, the targeting data supplied to the missile must be accurate.



The information to meet these requirements comes from many sources and uses a variety of techniques. Among the sources are satellites, UAVs, manned aircraft, surface- and subsurface-based sensors, and land-based sensors. The techniques these sensors employ are either active or passive. Active techniques require the emission of electromagnetic (EM) radiation. Passive techniques exploit the emissions of adversary sensors, specifically electro-optical (EO), infrared (IR), radio frequency (RF), synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), light detection and ranging (LIDAR), and sound navigation ranging (SONAR) transmission paths, to name a few.

The missiles employed contain nearly as much complexity as the targeting architecture. They feature a variety of delivery platforms, ranges, flight paths, speeds, countermeasures, stealth, and seeker technology (using some of the same EM paths as the targeting architecture). All these elements must exist within a coherent information exchange environment that provides the shooter with enough confidence that the weapon being fired will have its desired effect within the given rules of engagement at an acceptable level of risk. This information exchange environment must derive from a systems architecture that relates the weapons, platforms, networks, and sensors effectively. This architecture defines such requirements as how fast information must be transmitted (latency), how subject to loss the information is in transmission (quality of service), what the transmission path is, what information is transmitted, and what platforms (or nodes) are involved in the exchange.

In late 2016, the US Navy's Directorate for Warfare Systems (N9) set up the Digital Warfare Office (N9I) to help coordinate and integrate multiple nodes and to streamline requirements. However, there remains a bureaucratic kluge of platform-based resource sponsors (most within N9); a separate resource sponsor for networks and some sensors and unmanned platforms, the Directorate for Information Warfare (OPNAV N2N6); and a variety of acquisition organizations that

report to several different program executive officers. There is no fleet systems architect, and hence, no fleet systems architecture.

There is evidence that this situation has not escaped congressional attention. The 2018 National Defense Authorization Act (NDAA), section 1066, directed the secretary of the Navy to provide a report to Congress on a series of elements that could only be adequately addressed by a coherent "maritime intelligence, surveillance, reconnaissance, and targeting" architecture.<sup>26</sup> Such a report would have been classified, perhaps highly. However, there have not yet been any major organizational changes indicating that congressional interest has spurred the Navy to action.

The bureaucratic kluge referred to previously creates interesting dynamics. Three separate US Navy platform sponsors, N96 (Surface), N97 (Submarines), and N98 (Air) have an abiding interest in neutralizing enemy surface ships. All three manage investment portfolios that have pieces of the information kill chain required to do so. For example, N96 allocates resources to surface ship radar programs, N97 to submarine sonar systems, and N98 to the aircraft that employ air-based radar systems. Irrespective of the firing platform (air, sub, or ship), N98 allocates resources for the missiles, and so must balance the requirements of the other platform sponsors within its own portfolio. Additionally, the networks and data links that provide and share information among the platforms have an entirely separate resource sponsor, at N2N6, which must also balance the demands of the other platform sponsors within its portfolio. Finally, any aircraft involved in the ISR/T architecture is resourced from N98's portfolio, which competes with numerous other aircraft programs.

Before moving on to examine ISR/T architecture in the Western Pacific, a discussion of the relevant major unmanned ISR/T systems is required. The focus here is the MQ-4C Triton, the Navy's major unmanned system, as manned aircraft with ISR/T

capability are either less capable (like the Navy's MH/SH-60R helicopters) or likely to be time-shared with more manpower-intensive missions such as anti-submarine warfare (like the P-8A Poseidon<sup>27</sup>). While both aircraft can contribute to the

surface ISR/T picture, the discussion here is about systems tasked primarily or exclusively to this mission. Additionally, smaller, range-limited unmanned systems such as the MQ-8C Fire Scout are not discussed in detail.



## PART II: TECHNOLOGY

### National Technical Means

For the purposes of this report, national technical means (NTM) refers to satellite-based sensors that locate, track, and identify adversary surface ships.<sup>28</sup> Using active and passive sensors, these satellites provide imagery intelligence (IMINT), signals intelligence (SIGINT), and measurement and signatures intelligence (MASINT). These capabilities are so highly classified that there is no point in speculating about them here. There is little to inform an unclassified discussion in open source, and command and control of these assets will likely not reside where fleet users have consistent access such as they enjoy with other means of generating targeting information. Additionally, since the language of the 2018 NDAA directed the Navy to report on operational concepts, “including consideration of distributed combat operations in a satellite denied environment,” this report focuses on provision of ISR/T data to fleet users from sources and sensors over

which the fleet exercises primary or exclusive control.<sup>29</sup> Even in the absence of this congressional language, it is difficult to imagine NTM assets tasked primarily or exclusively to support Navy tactical engagements.

The MQ-4C Triton is a marinized variant of Northrop Grumman’s Global Hawk unmanned aircraft system (UAS). When this land-based, unmanned aircraft joins the fleet it will be the Navy’s workhorse high-altitude long-endurance (HALE) platform. The Navy intends to buy sixty-eight such aircraft (plus two test aircraft) to maintain twenty operational/deployed

---

Photo caption: The MQ-4C Triton unmanned aircraft system completes its inaugural cross-country ferry flight at Naval Air Station Patuxent River, Md. Triton took off from the Northrop Grumman Palmdale, Calif., facility Sept. 17. (U.S. Navy photo by Erik Hildebrandt/Released)



aircraft filling five ISR orbits worldwide over the course of twenty years.

With endurance of over twenty-four hours, maximum altitude in excess of 55,000 feet, and a mission radius of 2,000 miles, Triton will reach initial operational capability in 2021. It will have a multi-intelligence (multi-INT) electronic warfare package (upgraded over the test aircraft) in addition to its already considerable sensor suite. Triton will perform its maritime surveillance mission with an advanced maritime radar, an automatic identification system receiver, an electro-optical/infrared (EO/IR) camera, and low- and high-band multi-INT signals receivers.<sup>30</sup>

Although operations concepts for this capability are not publicly available, the fact that the Navy will purchase only five operational orbits when they are fully developed suggests that the Triton is likely to become a high-demand, low-density asset, even when all five are operationally available.

Additionally, it is unclear where the tasking and command/control of this asset will reside. Ultimately, to contribute to the ASUW architecture, fire-control quality information derived from this platform's sensors must make its way from onboard processors through suitable data links and eventually to a combat platform. The most effective mechanism for doing this would be direct communication between the Triton and the firing platform, for which Triton would provide either a fully attributed track to the host combat system, or appropriate sensor data for fusion with other sources. Given the current approach, in which Triton is controlled from a geographically remote ground station and track data is then forwarded through other data paths to shooters, it is unclear how tactically responsive Triton would be to the real-time targeting needs of individual platforms. The Triton's endurance and sensor diversity make it an open question whether a direct downlink would even be worthwhile, given the platform's capacity to focus on the operational level of war while providing a wide-area surveillance picture.

For the purposes of this discussion, Triton will be considered a theater asset, with tasking controlled at the numbered fleet level or above. Tracks generated by Triton would be downlinked to a ground station in a maritime operations center, then forwarded to fleet users over various information paths. Individual shooters, task group commanders, and even strike group commanders would have to compete among themselves and with other national tasking — especially relevant given the multi-INT upgrades Triton has fielded — to reposition Triton's orbits or re-orient its sensor focus.<sup>31</sup>

## Analysis

China's threat to the US Navy's sea control abilities within the first island chain is increasing. Reasonable operational goals for the Navy's response should include maintaining fire-control quality tracking on all PLAN combatants out of their home ports within the first island chain, and suitable weapons pairings capable of acting upon the tracks maintained.<sup>32</sup>

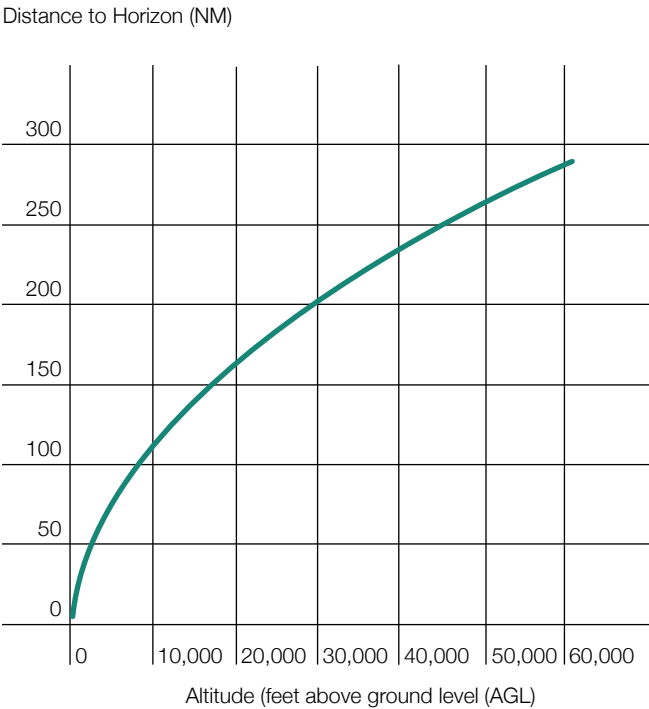
First, in some circles there is a sense of metaphysical certainty that the Chinese ISR/T complex already enjoys this level of targeting mastery over US naval surface forces within the first island chain. As a result, there have been calls to eliminate the US carrier force and to shift striking power from surface ships to submarines and develop longer-range missiles that can be fired from relative sanctuary. If one believes that Chinese ISR/T is ubiquitous in the first island chain, then is it not logical to impose the same ubiquity upon China's ships?

Second, the National Security Strategy directs shifting from conventional deterrence by punishment to conventional deterrence by denial. For this approach to succeed, forward-deployed forces must not only be armed with more missiles and longer-range missiles, but must also be supplied with targeting precision. Put another way, without sufficient ISR/T in the everyday peacetime environment, the deterrent fielded will not be able to provide a sufficient disincentive to PLAN forces seeking to disrupt the security environment. Many

analysts tend to focus on the capability and capacity of naval forces to fight and win, but only after the shooting has started. A powerful conventional deterrent underpinned by an effective ISR/T architecture offers the prospect of preventing the shooting in the first place, certainly more so than ceding

Figure 1. Range to Horizon (NM) as a Function of Height of Eye (Flight Altitude)

Maximum range to horizon



This chart represents the maximum range to the horizon and does not factor for natural or other obscurants, particularly weather. In our analysis, we consider two cases: an optimistic case where the aircraft operates at 50,000 feet and can see 90% of the distance to the horizon, and a less optimistic case where the aircraft operates at 18,000 feet and can see 60% of the distance to the horizon. In actual operations in the South China Sea, it is not uncommon for visibility to be less than 10 NM and for the ceiling (bottom of cloud bank) to be lower than 10,000 feet.

the battlespace, which is itself antithetical to deterrence by denial.

A forward-deployed naval posture in which the fleet is capable of tracking all PLAN combatants within the first island chain and also maintains weapons assignments paired to PLAN combatants is a more credible conventional deterrent than the current posture. This monograph does not address questions of missile assignments, capabilities, and capacities, except to acknowledge the Navy’s program of extending the range of these interceptors. This places a greater demand on constructing targeting architecture, and the Navy is responding, but only slowly and inefficiently.

Below is a standalone exposition of such an architecture exploring the number of airborne searchers required to cover a given area of interest. The area of interest is not strictly tied to any particular geography, although our assumptions are consistent with searching for deployed surface naval vessels inside the first island chain in the Pacific Ocean near China.<sup>33</sup>

Figure 2. Impact of Distance and Transit on Search Time spent performing mission as a fraction of time airborne

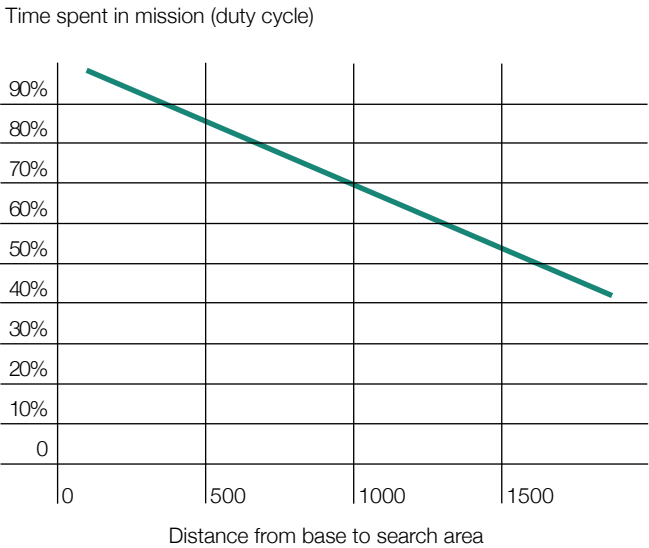
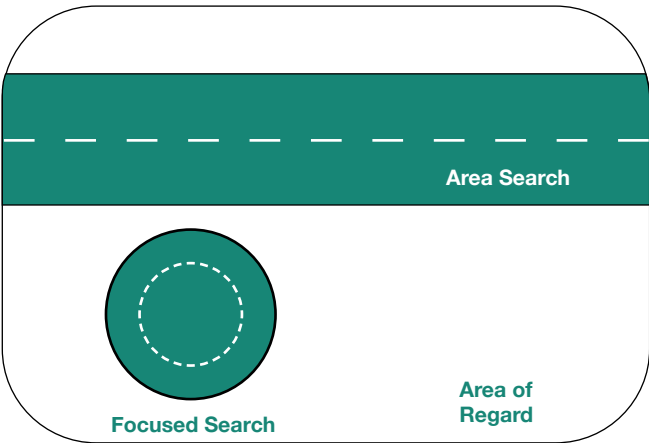


Figure 3. Depiction of Area and Focused Search



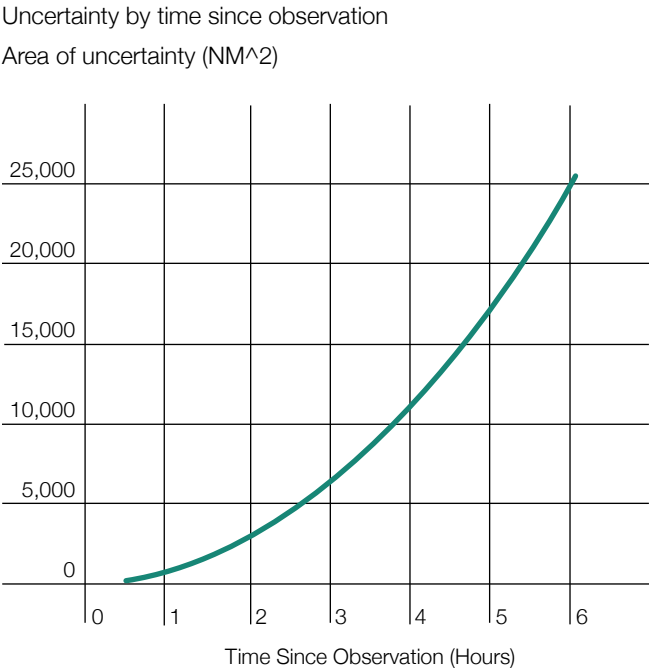
Area search (top) “mows the grass” in strips, while focused search (bottom left) “cuts a donut” around a specified point. In both cases, the fundamental tensions are between the sensor range (determining the width of the search path) and revisit rate.

Similarly, while the analysis applies to airborne search problems generally, the system considered is the MQ-4C, the Navy’s primary, unmanned, land-based ISR/T platform.<sup>34</sup> This effort is limited by both classification and sophistication. Specifically, we do not have any detailed information about the detectors to be employed and make several simplifying assumptions about the characteristics and scheduling of search assets. We have been consistent with our assumptions in that they tend to *overestimate* the effectiveness of search, and thus, the results should be considered a *lower bound* on the actual number of searchers required.

Assumptions

Our analysis makes several key assumptions, which for the sake of transparency and comprehensibility are made explicit. The purpose of these assumptions is to help make the overall scenario realistic while working within the information to which we have access.

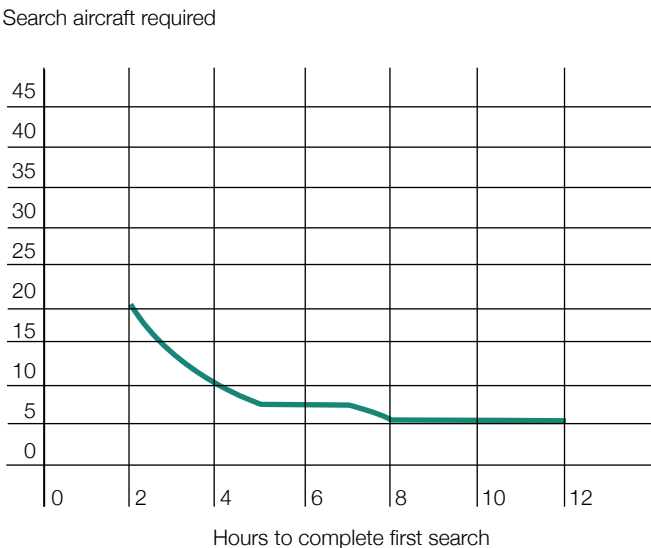
Figure 4. Growth in Area of Uncertainty as a Function of Time since Last Observation



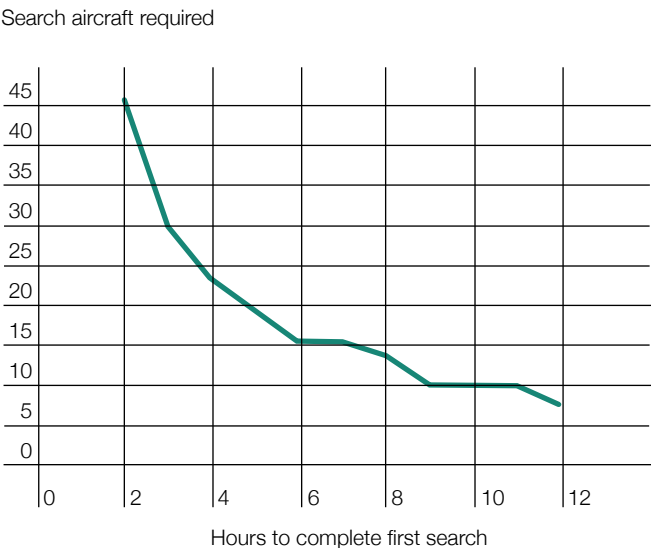
We assume no contribution from any other assets in this scenario. We believe that this is warranted because we are concerned that various stakeholders believe that so-called “national” assets—including, but not limited to, satellites and cyber--will be available when called on, without knowing who all of the requesters might be. We are implicitly admitting that airborne visual searches for surface ships are unlikely to compete favorably for limited assets. We also do not include contributions from allies or “incidental” search contributions from other US Navy or Air Force assets transiting the area. As we are not exploring specifics, we use an adjusted “distance to the horizon” as a proxy, with the assumption that if a vessel can be seen, it will be detected. This is a tremendous simplification of the search problem (see Figure 1). For an accessible description of some of the more complex nuances of search at sea, we recommend *Naval Operations Analysis* published by the Naval Institute Press.<sup>35</sup>

Figure 5a and 5b. Aircraft Needed to Conduct Search of 1.66 Million NM in the Time Required

Aircraft required to complete “first-pass” search of Area: 50,000 feet, 90% visibility



Aircraft required to complete ‘first-pass’ search of area: 18,000 feet, 60% visibility



Additionally, we assume that the search is a “survey” in the sense that the searchers do not change their behavior when they find a (possible) target. Our assessment would change dramatically if the searchers were re-tasked to loiter over observations of interest. We expect this is likely to happen in a real scenario.

Additionally, searchers suffer no attrition; they are never shot down and have a mishap rate of zero.

We assume a fixed maintenance availability of 80 percent, which accounts for both scheduled (routine) and unscheduled (failure) maintenance. We assume that an aircraft will spend as much time on the ground for maintenance, servicing, and mission debriefing and planning as it spends on mission time (see Figure 2).

This chart shows the duty cycle, defined as the amount of time spent searching divided by the total time airborne, as a

function of distance from the search area. At approximately 1,300 NM, a searcher will spend 50% of its time in transit; beyond this breakpoint, searchers spend more time getting to and from the at-sea operating area than they do performing their primary mission.

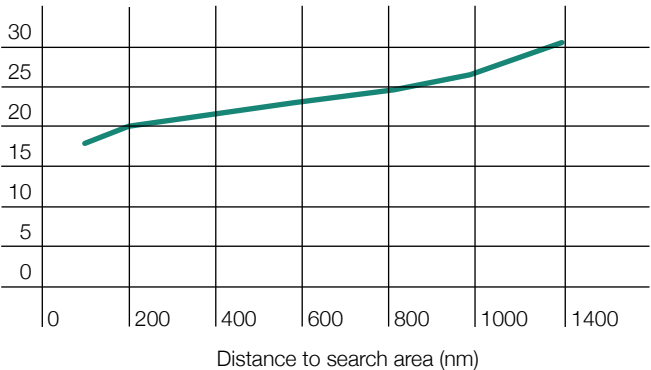
Of these assumptions, the most critical — and the one that merits the greatest exploration using more sophisticated methods — is the zero false positive rate. A false positive occurs when the sensor registers an object — in this case a ship — when there is, in fact, no ship present. The issue of a false positive is critical in both military applications (such as visual detection of improvised explosive devices) and non-military applications (such as drug testing).<sup>36</sup> In search applications, false positives redirect assets and have the overall effect of slowing the progress of the search and requiring more searchers.



Figure 6. Impact of Distance from Base on Aircraft Required to Search in a Specified Time

Searchers required as a function of distance to search area

Searchers required at 18,000 feet, 60% visibility



This plot combines the time requirements for area search with the duty cycle assumptions laid out in the preceding section.

### Approach

Using these assumptions, we focus on two search disciplines. First is area search, which is sometimes referred to as “mowing the grass.” This type of search is most appropriate for a survey-type search where there is no a priori knowledge of where the targets are likely to be, and the overall objective is to conduct rapid and orderly coverage of the area.

In other circumstances it is necessary to focus the search over a particular target. This can be done either offensively, to keep a watch on an adversary’s asset, or defensively, to create a “barrier” against an adversary’s approach. In our analysis we call this “focused search,” in which the focus point is maintained at the limit of the range of detection, while flying a “donut” around it (see Figure 3).

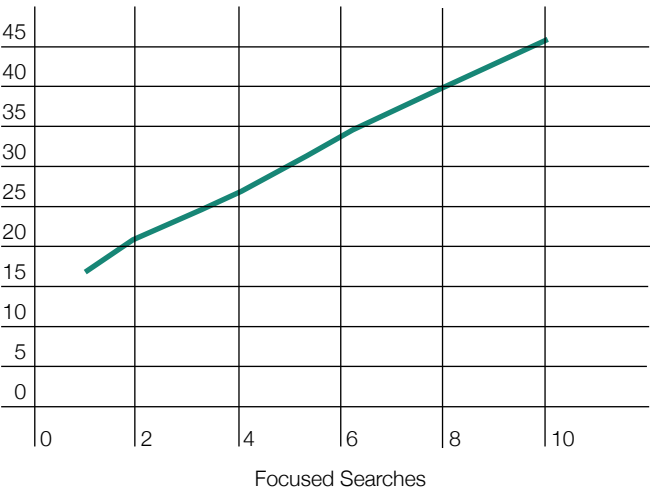
### Impact of Revisit Rate

With unlimited time and adequate bases, one searcher is sufficient. However, in a real scenario, targets need to be

Figure 7. Impact of Focused Search on Overall Required Aircraft

Aircraft for combined search

Aircraft required



In this example, the focused search assets have a one-hour revisit rate, while the area search has a six-hour revisit rate. The focused searchers stay within 100 NM of their target, and the area searchers are at 18,000 feet and 90% visibility.

revisited. The “drift” of a ship at sea grows as the square of the time since the last observation. Even at modest speeds, these can grow very quickly, as shown in Figure 4.

A fundamental tension is the frequency of revisit (requiring more searchers) vs. the difficulty of reacquiring a “lost” target.

### Analysis and Insights

In this section, we synthesize our framework and consider how many searchers it will take to look at a swath of ocean representative of the first island chain. First, we consider the number of searchers on station needed to conduct an area search, as determined by the time necessary to conduct the search (see Figure 5).

Aircraft needed to conduct search of 1.66 million NM in the time required (horizontal axis). The number of aircraft required to conduct this search grows dramatically as the time to search (revisit time) decreases.

The plot above considers a single search. If this is to be done persistently, we must consider the impact of transit distance from the base to start point. We choose a single point in the plots above — six hours at 18,000 feet and 60 percent visibility — and account for both transit time and “turnaround” time. The stark impact of transit and turnaround is shown in Figure 6.

## Combined Area / Focused Search

To conclude this analysis, we briefly consider the impact of combined search, with a focused search on fixed points as well as an area search. A commander would not likely choose to rely wholly on focused search; in general, using circles to fill a plane is not efficient.<sup>37</sup> We assume that the focused search area reduces the overall search burden. As an example, consider the total number of searchers required if a total of six areas must be searched; these may be divided in any manner between offensive and defensive targets. Additionally, because these are “tight” searches, we assume that the revisit time is one hour for the focused searches (see Figure 7).

## Summary

We are not privy to the full scenarios used to plan the Navy’s requirement for MQ-4C aircraft, and this report focused on only one geographic location rather than on a global distribution. Nevertheless, our analysis suggests that the planned buy of five orbits is dramatically smaller than would be needed in the forgiving assumptions of the sketches presented here.<sup>38</sup> The computations here are straightforward, and we chose the cases for their illustrative value, regardless of any particular operation or concept.

This analysis is devoted to determining the degree to which a representative level of ISR/T assets can cover a large, maritime

battlespace with the aim of maintaining fire-control quality tracks on a representative number of PLAN surface ships at sea. A thorough analysis, including cost, would, in our opinion, be done at the appropriate classification level, and most likely in an air-centric campaign analysis setting. Because of the unclassified nature of this work and limited scope, our analysis here is mostly focused on time, schedule and distance. A fuller approach — including specific sensor phenomenologies — will be required to put more exact bounds on the problem.

## Next Steps

Because it is the services that make the final decision on how many aircraft to buy, we explore what they should be considering when conducting classified, follow-on analysis. None of these cases was analyzed here, and they are presented in order, from greatest to least impact.

- *Effect of false positives and loitering over unknown datum.* A follow-on analysis is needed that uses either applied probability or simulation models; the latter are more easily extended and more readily accepted by the stakeholders.<sup>39</sup> In this scenario, aircraft conducting searches encounter true or false positives, and then invest time to determine if the target is real or false. The net effect will be to dramatically reduce the effective rate of search. More important, it will place the search effort commanders on the horns of a dilemma: When is it better to break from an ongoing search to investigate a contact, and when it is better to continue on and revisit the datum later? (But remember the rate of drift!)
- *Manpower, maintenance, and supply over a prolonged operation.* Many scenarios begin either at or slightly before hostilities. While these are the most stressing cases for the warfighting units, such as fighter aircraft and surface ships, they are not necessarily the most stressing for support functions such as ISR. It is possible, likely even, that China will seek an extended period of tension before hostilities erupt. To maintain prolonged ISR over a large swath of ocean

for an extended period requires thinking about how these aircraft are maintained and how they would be operated in a threat scenario, with a particular eye towards the size and location of spare parts depots. A robust ISR capability that expires due to lack of maintainability is of limited utility.

- *Division of roles in an integrated ISR picture.* Critics will surely challenge our assumption that the only contribution to wide-area oceanic ISR is the MQ-4C. It is important to create a fully inclusive picture of ISR assets and to understand how each contributes to the overall enterprise, if only to create a better understanding of gaps in coverage. With unmanned aircraft, there is a strategic factor that we would be remiss if we failed to address: Because they are unmanned, they can accept greater risk of attrition than a manned aircraft with a similar mission (and therefore operate closer to the “edge”). Additionally, they provide policymakers greater flexibility if they are lost due to accident or presumed enemy action, since the US retains response options at the low end of the spectrum of conflict, which include doing nothing.

## Recommendations

In order to provide a credible conventional deterrent (by denial) in the maritime domain, the Navy must become more lethal. It is attempting to do so by investing in longer-range and more energetic missiles that can be used against land targets and moving maritime targets. These efforts are to be encouraged, but the increased range and energy purchased by these investments will be sub-optimal if the Navy does not create an ISR/T architecture that takes advantage of these enhancements.

The United States should work closely with its allies and like-minded friends in the Western Pacific to create a network that provides targeting data of the required precision to those who can make use of it. Such a network will necessarily comprise space-based, land-based, and sea-based platforms and sensors, some manned, some unmanned. We have

chosen to concentrate here on the MQ-4C UAS, a major investment that the Navy is making, while recognizing that additional assets can be integrated into the picture. The choice of focus was meant to demonstrate the extent of the challenge.

This report raises questions about the sufficiency of unmanned maritime ISR/T, given renewed great power competition, the US Navy's continuing global responsibilities, and its Navy's deployment of longer-range anti-ship missiles. The Navy should give greater attention to this subject, and to that end, the following recommendations are offered.

### Recommendation 1: Bound the problem.

Congress should direct the Navy to contract with a suitable Federally Funded Research and Development Center or other agency capable of classified operational analysis to 1) review the Navy's response to the 2018 NDAA tasking, and 2) perform its own theater-by-theater analysis of the Navy's ISR/T requirement that accounts for requirements in both peace and war, using a threat-based modeling system. The report should include recommended platform and sensor combinations (including new ones) and rough order magnitude (ROM) costing. The analysis should consider the efficacy of the Navy's operational goal of tracking all PLAN combatants in the first island chain and maintaining weapons assignments for each. Is this a realistic goal? If so, what combinations of assets would be required and at what ROM cost?

### Recommendation 2: To supplement the Navy's MQ-4C fleet, DoD should transfer or redeploy USAF MQ-9 Reaper aircraft modified for a maritime, multi-INT configuration Navy.

The US Air Force possesses more than 200 MQ-9 Reapers, with many primarily allocated to operations in the Central Command AOR.<sup>40</sup> As Washington winds down land operations in Afghanistan, Iraq, and Syria, DoD should consider re-

missioning some portion of the air force Reaper fleet to maritime patrol ISR/T missions. Reaper manufacturer General Atomics has designed a variant, the MQ-9B SeaGuardian, which incorporates a high-definition EO/IR sensor, a multimode 360° maritime surface search radar, enhanced weatherization, and an automatic identification system (AIS).<sup>41</sup> Presumably, existing Reapers with a similar sensor package could fill a near-term need, and if the Navy's global ISR/T requirement exceeds the sixty-eight operational MQ-4Cs for which it plans, acquiring SeaGuardian RPVs would be a cost-effective alternative to more Tritons.

This option has drawbacks. First, the air force does not have deep experience in maritime surveillance, nor does the Navy have experience with the Reaper system. Neither of these issues is insurmountable, but what may be more important is establishing a coherent kill chain from Reaper to a Navy shooter. The issues of target-forwarding from Triton to the shooter, described earlier, would also exist in a marinized Reaper. DoD should report to Congress as soon as possible on the feasibility of such a re-allocation of aircraft and the risks associated with it.

### Recommendation 3: The Navy should consider accelerating and increasing the current MQ-4C program of record.

This program is just getting to initial operational capability, so the possibility of increasing production remains viable.

### Recommendation 4: The Navy should consider acquiring a medium altitude/long endurance (MALE) UAV that can be launched and recovered onboard surface combatants and deliver targeting data directly.

Dispersed surface combatants armed with long-range anti-ship missiles require organic targeting, especially in comms/satellite denied or degraded environments. Continuing to rely on inorganic targeting (NTM, land-based UAVs) presents

significant operational risk to the surface force, risk that could be mitigated by a UAV capable of sustained operations at range with reconfigurable sensor packages.

This idea began several years ago with the DARPA/Northrop Grumman program called TERN (tactically exploited reconnaissance node), but little progress has been made.<sup>42</sup> TERN would have provided surface ships with a UAV, which, when operated in pairs, could have maintained continuous ISR coverage out to 600 miles with a minimum sensor payload of 500 pounds.

Bell Aviation also has a medium altitude long endurance (MALE) UAV concept, known as the V-247 Vigilant and based on the company's V-280 Valor, which is competing for the army's future vertical lift program. The V-247 advertises performance specifications that exceed DARPA TERN's requirements, in an airframe that can carry 600 pounds of payload for eight hours at a 450-mile mission radius at a maximum altitude of 25,000 feet, which is a horizon distance of over 190 miles.

An important opportunity exists for the Navy to work with the Marine Corps, since the Marines are considering a MALE UAV through their Marine Air-Ground Task Force Unmanned Aircraft System Expeditionary (MUX) project.<sup>43</sup> An analysis of Marine Corps requirements for MUX (expeditionary strike group ISR/T, early warning, weapons control) shows considerable overlap with the needs of dispersed surface combatants, and the confluence of need should be more closely examined within the Navy.

### Recommendation 5: The Boeing MQ-25 Stingray airframe should be modified to add aircraft carrier-based ISR, which currently does not exist.

In the summer of 2018, the Navy announced that the platform for its carrier-based aerial refueling system (CBARS) UAV would be Boeing's MQ-25 Stingray.<sup>44</sup> The CBARS program was a revision to an earlier carrier-launched UAV initiative known as the Unmanned Carrier-Launched Airborne Surveillance



and Strike (UCLASS) program, which as the name indicates, was dedicated to producing an aircraft optimized for ISR and weapons delivery, as opposed to fuel delivery. The evolution of the Navy's concept of the carrier-launched UAV — from a vehicle providing long-range, semi-stealthy strike and surveillance to a vehicle that would serve primarily as a tanker — had many critics, but the Navy persisted in its more limited requirement.<sup>45</sup> Congress should direct the Navy to report on options to add ISR/T capability to the MQ-25 Stingray, either as a modification to the current requirement or a variant to be acquired separately.

**Recommendation 6: DoD should work to encourage key allies and partners to increase their own maritime surveillance capabilities, including by advocating for foreign military sales of the MQ-4C Triton and the MQ-9B SeaGuardian.**

The analysis performed in this study focuses on US maritime ISR in one theater, without regard for the contributions of other nations, a prudent starting point for any analysis of this kind. However, friends and allies have maritime ISR/T responsibilities of their own, and encouraging them to acquire US-built systems offers a path to greater interoperability and data-sharing, even as it lowers unit costs for all participants. Additionally, the US has global maritime ISR/T responsibilities to support its globally dispersed Navy. DoD should leverage the contributions of others as much as possible.

One Pacific ally in particular, Japan, bears closer examination.

## **Japan's Role in Western Pacific Security**

To understand Japan's current role in Western Pacific security, and by extension, analyze its current ISR/T capabilities as they relate to its defense responsibilities and strategic interests, requires a brief overview of Japan's postwar military organization and Cold War strategic role.

Imperial Japan unconditionally surrendered to the United States, the United Kingdom, and China on 2 September 1945. It was

immediately clear how the US-Soviet postwar rivalry would influence Japanese defense policy in the next forty years: Japan did not formally end its state of war with the USSR until 1956, four years after the Treaty of San Francisco entered into force.<sup>46</sup> Japanese planners certainly understood the threat the USSR posed in Asia. In August 1945, four years after the Soviets had signed a neutrality pact with Japan, they pounced, destroying a weakened Japan's forces in Manchuria during a three-week campaign. The use of atomic weapons against Hiroshima and Nagasaki certainly influenced Imperial Japan's strategic calculus.

The role of the Soviet offensive in Manchuria in sharpening Japan's sense of crisis should not be underestimated.<sup>47</sup> Japanese home island defensive planning committed all resources to defending against an amphibious assault against Kyushu, Japan's southernmost island. Particularly after the USSR occupied the northern half of the Korean Peninsula, Japan became aware of an equally substantial threat from the north, which it lacked the military forces to combat. Not only would surrender to the Allies spare Japan atomic devastation; it would also prevent a US-Soviet postwar partition akin to that of Germany and Korea.

The American postwar occupation of Japan, much like that of Germany, emphasized purging the former imperial power of its militaristic spirit. Article 9 of postwar Japan's American-drafted constitution — which regulates the nation's affairs to this day — explicitly bans the use of military force to settle Japan's international disputes.<sup>48</sup> Japan was wholly dependent upon the United States for territorial defense and until 1950 had only a small police force.

Japan was an invaluable staging platform for US forces during the Korean War. Indeed, without ready access to stockpiled American weapons and equipment in occupation military bases, alongside air and ground forces, it is unclear if the US would have been able to fight in Korea at all. As containment cohered into a formal strategy, Japan became one of the keystones

of the US Pacific security architecture, along with Taiwan and South Korea.

Japan, however, unlike the other two partners, did not contribute major military capabilities. It did establish a National Police Reserve, which in 1952 it converted into the 110,000-strong National Security Force.<sup>49</sup> In 1954, Japan officially established the Japan Self-Defense Forces (JSDF), with ground (JGSDF), air (JASDF), and maritime (JMSDF) components.<sup>50</sup> Nevertheless, persistent pacifist sentiment and the Japanese economic miracle sapped public and political support for robust military capabilities.<sup>51</sup>

Moreover, the restrictive interpretation of Article 9 prevented overseas deployments, making Japanese units useless in a Korean or Taiwanese contingency.<sup>52</sup> Thus, JSDF units were tasked with defending Japanese territory against Soviet invasion. The US maintained and developed its post-occupation base architecture, most importantly at Yokosuka naval base, one of Imperial Japan's largest naval arsenals, and on Okinawa. During the Vietnam War, Okinawa served as a major American logistical hub. Moreover, there are unconfirmed reports that the US stockpiled nuclear weapons in Japan throughout the Cold War in preparation for a Far Eastern conflagration.<sup>53</sup>

This role began to evolve during the 1980s. The Reagan-era maritime strategy in Europe and Asia emphasized aggressive forward defense, rather than the more passive approach that dominated US strategic planning throughout the 1970s. The JMSDF was tasked with defending the Pacific "out to a thousand nautical miles from Yokosuka," as the threat from China subsided following the diplomatic thaw between China and the US of the 1960s and 1970s.<sup>54</sup>

US forces were re-tasked with pressuring the Soviets in the Far East. Starting with the 1982 NORPAC exercises, the US Navy, alongside its South Korean and Japanese counterparts,

demonstrated its ability to pressure the Soviet nuclear submarine bastion in the Sea of Okhotsk.<sup>55</sup> The effect this had on Soviet strategy should not be underestimated. NATO and affiliated forces demonstrated their ability to jeopardize Soviet second-strike capability in the east and west, thereby convincing the Soviets that the West had militarily outpaced them. The Soviets collapsed after a decade of offensively minded Western military maneuvers.

The collapse of the Japanese asset price bubble in 1991, along with declining security pressures following the Cold War, sapped public support for a more robust defense posture. In the 1990s, the Japanese population saw the JSDF as a political liability, even more than during the 1970s. Despite its low funding, legislators viewed it as poaching resources from more critical social and economic programs. Nevertheless, in 1999, Japan passed the Regional Affairs Law, allowing the JSDF to provide "rear support" for American forces during a Pacific contingency.<sup>56</sup>

The threat from North Korea began Japan's two-decade rearmament process. Pyongyang's 1998 test of the Taepodong-1 intermediate-range ballistic missile made the Japanese anxious. Although North Korea would not test a nuclear device until 2006, the threat to Japan was apparent. Tokyo began developing space-based ISR capabilities, while the JSDF began to orient itself towards missile defense.<sup>57</sup>

The year 2005 marks another inflection point. From 2001 to 2004, the JASDF scrambled fighters over one hundred times in response to Russian airspace incursions. However, in 2005 it had to scramble over two hundred times to intercept Russian and Chinese aircraft violating Japanese airspace.<sup>58</sup> On 9 October 2006, North Korea conducted its first nuclear test, while almost exactly three months later, on 11 January 2007, China conducted an anti-satellite missile test. Japanese planners realized they faced an increasingly hostile security environment.

Japan concurrently expanded its military capabilities. Today's JSDF fields fourth- and fifth-generation combat aircraft: F-35A/Bs, F-15s, EF-4Js, and F-2s, the latter an F-16 variant. It also has Aegis-equipped surface combatants, attack submarines, and two de-facto aircraft carriers, and operates an amphibious assault brigade. Japan plays the same critical role for US basing and logistics as it did during the Cold War. It is the only country to permanently host a US aircraft carrier, currently the USS Ronald Reagan, and its accompanying strike group.

However, Japan can now serve as a full-fledged military ally. Not only have the JSDF's capabilities increased, but the current prime minister, Shinzo Abe, has persistently pushed the Diet to expand Japan's legal military reach. The contemporary JSDF can intervene in support of allied nations under attack, making Japanese involvement in a Korean or Taiwanese contingency a legitimate possibility.

Abe has forced a constitutional review of Article 9, to take place by 2020, which could potentially alter restrictions on Japanese military deployments. Japanese forces, particularly at sea and in the air, are under direct Chinese pressure, and indeed, Japan created its Amphibious Rapid Deployment Brigade (ARDB) in 2018 specifically to counter Chinese encroachment on the Japanese-controlled Ryukyu Islands. Finally, in a Taiwanese contingency, Japan's territory in the Ryukyus must be a Chinese target: the islands serve as a chain from Japan to Taiwan that China must sever if it hopes to subjugate its democratic neighbor.

Thus, Japan's contemporary ISR/T capabilities, and overall force structure, are of critical importance to US planning and regional security.

## Current Japanese ISR/T

Japan's current ISR/T capabilities can be divided by JSDF branch. These capabilities have specific gaps that can be remedied in the short and long term.

The JGSDF's most significant land-based ISR/T capability in the string of Japanese islands that lie to the southwest is a radar post on Yonaguni Island, 110 kilometers from Taiwan.<sup>59</sup> The post, which became active in 2016, provides valuable coverage of the Taiwan Strait and East China Sea. The JSDF has announced plans to expand the post into a full-fledged military base housing a joint JGSDF-JASDF airborne early warning squadron. Nevertheless, it is worrying that the Japanese defense force branch receiving the most funding has the thinnest ISR/T capabilities. Japan will deploy two Aegis Ashore platforms to Akita JGSDF base in northwest Honshu, primarily to intercept North Korean missiles.<sup>60</sup>

Nevertheless, the JGSDF lacks robust ISR/T capabilities, or for that matter a major focus on amphibious operations. The JSDF did convert the amphibious-capable Western Army Infantry Regiment into the ARDB in April 2018. When fully developed, the brigade will include three infantry regiments, several support battalions, and a signal company. The ARDB is designed to give Japan a "gray zone" buffer capability; it can be deployed to retake islands in the Ryukyus occupied by Chinese amphibious forces during a pre-Taiwan fait accompli.<sup>61</sup> However, the rest of the JGSDF is focused on territorial defense, and indeed, the public views the army's primary role as disaster relief, not combat operations.

The JMSDF naturally fields the greatest variety of maritime ISR/T capabilities, and Japan has some of the most robust maritime capabilities of any American ally. It fields twenty attack submarines, two anti-submarine-warfare helicopter destroyers, three Landing Ship Tanks, eight Aegis-equipped guided-missile destroyers, thirty other medium and small surface combatants, and two de facto aircraft carriers. Japan's eight Aegis-equipped ships — two *Maya* class, two *Agato* class, and four *Kongo* class — serve as the backbone of its ballistic missile-defense capabilities. Of course, the Aegis combat system doubles as a powerful fleet-based ISR/T platform.

As indicated above, Japan has converted its two Izumo-class helicopter destroyers into de facto aircraft carriers able to field

ten to twelve F-35Bs, flown by JASDF pilots.<sup>62</sup> In the abstract, the *Izumo*-class conversions are similar to the specialized anti-air-warfare Landing Helicopter Assault ships USS *America* and *Tripoli*, or the Cold War-era sea control ship concept, although the US Navy's *America* class outweighs the *Izumo* class by nearly 20,000 tons. This choice in favor of conversion has expanded the degree to which Japan can use its F-35Bs as ISR/T platforms.

The JASDF lacks organic tanking capability. Deploying vertical takeoff and landing F-35Bs onto the *Izumo* class allows Japan to ferry its Lightning IIs between small airfields in the Ryukyus. Not only does this boost Tokyo's ISR/T reach; it also creates strategic uncertainty about the location of Japan's deadliest air assets. The JMSDF also operates two dedicated maritime patrol aircraft: the US-built P-3C Orion and the indigenously developed Kawasaki P-1, along with ship- and land-based SH-60s.<sup>63</sup> The P-1 is comparable to the American P-8 Poseidon in role and capability.

The JASDF, along with its impressive fighter fleet, fields several dedicated ISR/T platforms. On the ground, the JASDF operates a network of radars and anti-air missile platforms collectively known as the Japan Aerospace Defense Ground Environment (JADGE),<sup>64</sup> which includes Patriot PAC-2 and PAC-3 missiles and will include Aegis Ashore batteries.<sup>65</sup> The JASDF operates two airborne early warning platforms: thirteen E-2C/D Hawkeyes and four Boeing E-767s, the latter comparable to the American E-3 Sentry. In addition, Tokyo plans to purchase three RQ-4 Global Hawk HALE reconnaissance drones.<sup>66</sup>

Japan also maintains a fleet of reconnaissance satellites under its Information Gathering Satellite program. The oldest part of modern Japanese ISR/T, the program was created in 1998 in response to North Korea's ballistic missile testing and still focuses on monitoring Pyongyang's nuclear capabilities. In June 2018, Japan placed its eighth operational satellite in orbit.<sup>67</sup>

## Recommendations for Japanese ISR/T

A review of the current state of Japanese ISR/T reveals several capability and force disposition gaps that it would benefit Japan (and the US) to correct, along with several capabilities on which the JSDF can capitalize as it modernizes its forces.

First, Japan would benefit by investing in greater ground-based ISR/T in the Ryukyu Island chain. The only major Japanese radar installation in the Ryukyus is at Yonaguni Island, as discussed above. While this provides coverage of Taiwan and the southern part of the East China Sea, China may pressure the entire island chain in the event of conflict or during pre-conflict stages. Japan needs better early warning of Chinese aircraft and ships, civilian and military, that would probe disputed islands in the Ryukyus. Constructing facilities like the one at Yonaguni would greatly improve Japan's air and surface ISR/T picture. This could also help redirect JGSDF funds towards relevant maritime and aerial forward defense operations, rather than allowing territorial defense to remain the priority.

07Third, Japan should explore using MALE UAVs to extend its current maritime ISR/T capabilities. It can fulfill this requirement in three mutually reinforcing ways:

1. Procure Reaper MALE UAVs (MQ-9B SeaGuardian) and base them on airfields in the Ryukyus, covering movements through the straits within the island chain.
2. Explore ship-based UAVs for deployment on its front-line surface combatants.
3. Explore a flat-deck-launched UAV that can be deployed from the *Izumo* class.

The third option deserves more attention. The JSDF did gain deterrence capabilities by converting its *Izumo*-class destroyers into de facto aircraft carriers. However, before their conversion, they provided valuable anti-submarine-warfare capabilities to



the JMSDF. It is unclear how much combat power will be gained by the *Izumo* conversions.

While the operationally ambiguous placement of Japanese F-35Bs will frustrate Chinese planning, in the event of full Chinese commitment to a high-end conflict, Japan's naval F-35Bs will be overwhelmed. Thus, it would be prudent for Tokyo to explore other uses for its new small carriers. A UAV patterned on the OV-10 Bronco, for instance, that can land without an arresting hook and increase Japanese situational awareness, would be a worthwhile investment. Once again, however, Japan would benefit from an increased focus on UAV development and deployment.

Fourth, Japan should investigate using UAVs to boost its intercept capabilities. The JASDF has intercepted around one thousand aircraft per year since 2016,<sup>68</sup> primarily Chinese and Russian.<sup>69</sup> Using MALE or HALE UAVs to identify incoming

Chinese and Russian aircraft could allow the JASDF to scramble interceptors earlier and more efficiently.

Fifth, the upcoming replacement of Japan's aging F-2 air superiority fighter is an opportunity to mesh different platforms. Even a fourth-generation-plus replacement for the F-2 should have greatly increased ISR/T capabilities.

Sixth, Japan should explore the possibility of pairing its submarines with unmanned undersea vehicles (UUVs) and, in concert with the United States, developing a doctrine for deploying them. Swarming UUVs, equipped with sensors and torpedoes, can extend the range and domain awareness of Japanese submarines, allowing them to better police and respond to Chinese incursions into Japanese waters.

Seventh, an underwater acoustic network to detect enemy submarines would be valuable for American and Japanese ISR/T.

# CONCLUSION

China's increasingly modernized armed forces, their continued expansion, new technology such as hypersonic missiles, the growing range of China's anti-ship missiles, and Beijing's increasingly robust anti-access/area denial network are just some of the challenges the US faces in deterring conflict in the South China Sea, the East China Sea, and the Yellow Sea.

Power is shifting in the waters proximate to the Asian mainland, and the consequences threaten the ability of the United States to communicate with regional allies, enforce its centuries-old

policy of free navigation in international waters, and — ultimately — remain the Pacific's dominant sea power.

Maritime power, like a complex machine, is composed of many parts. Among the most important is the ability to outrange an adversary, for which the range of weapons is as critical as the ability to target the adversary effectively. The ability to target a potential adversary's naval power deserves far more attention than it has received. This report has offered recommendations to invigorate and restore American sea power's regional and global sinews.

# ENDNOTES

- 1 Robert Massie, *Castles of Steel: Britain, Germany, and the Winning of the Great War at Sea* (New York: Random House, 2003), 605-08.
- 2 Sidney Ballou, "Seagoing Aircraft," *Proceedings Magazine* 50, no. 261 (November 1924).
- 3 Walter R. Borneman, *The Admirals: Nimitz, Halsey, Leahy, and King — The Five-Star Admirals Who Won the War at Sea* (New York: Back Bay Books, 2012), 405-08.
- 4 Samuel Huntington, "National Policy and the Transoceanic Navy," *Proceedings Magazine* 80, no. 5 (May 1954), <https://blog.usni.org/posts/2009/03/09/from-our-archive-national-policy-and-the-transoceanic-navy-by-samuel-p-huntington>.
- 5 John F. Lehman, *Oceans Ventured: Winning the Cold War at Sea* (New York: W. W. Norton, 2018), 39-41.
- 6 Jan S. Breemer, "The Soviet Navy's SSBN Bastions: Why Explanations Matter," *RUSI Journal* 134, no. 4 (1989), 33-35.
- 7 Seth Cropsey, *Seablindness: How Political Neglect Is Choking American Seapower and What to Do About It* (New York: Encounter Books, 2017) 34-36.
- 8 Norman Friedman, *US Destroyers: An Illustrated Design History* (Annapolis: Naval Institute Press, 2004), 230-33.
- 9 Abraham Rabinovich, *The Boats of Cherbourg: The Navy That Stole Its Own Boats and Revolutionized Naval Warfare* (New York: Henry Holt, 1988), 5.
- 10 Lehman, *Oceans Ventured*, 85-101, 201-06.
- 11 H. J. Mackinder, "The Geographical Pivot of History," *Geographical Journal* 23, no. 4 (1912), 435.
- 12 See the navy's two strategic concept publications in the immediate post-Cold War period: ...*From the Sea: Preparing the Naval Service for the 21st Century*, September 1992, <https://www.navy.mil/navydata/policy/fromsea/fromsea.txt> and *Forward...From the Sea: The Navy Operational Concept*, March 1997, <https://www.navy.mil/navydata/policy/fromsea/ffseanoc.html>.
- 13 Peter D. Haynes, *Towards a New Maritime Strategy: American Naval Thinking in the Post-Cold War Era*, (Annapolis: Naval Institute Press, 2015), 122-30.
- 14 "RQ-2A Pioneer Unmanned Aerial Vehicle (UAV)," United States Navy Fact File, last updated 9 September 2013, [https://www.navy.mil/navydata/fact\\_display.asp?cid=1100&tid=2100&ct=1](https://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=2100&ct=1).
- 15 "China-U.S. Aircraft Collision Incident of April 2001: Assessments and Policy Implications," Congressional Research Service, last updated October 10, 2001, <https://fas.org/sgp/crs/row/RL30946.pdf>.
- 16 Michael Green et. al., *Countering Coercion in Maritime Asia* (Washington, DC: Center for Strategic and International Studies, 2017), 202-23, [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/170505\\_GreenM\\_CounteringCoercionAsia\\_Web.pdf?OnoJXfWb4A5gw\\_n6G.8azgEd8zRIM4wq](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/170505_GreenM_CounteringCoercionAsia_Web.pdf?OnoJXfWb4A5gw_n6G.8azgEd8zRIM4wq).
- 17 See Taiwan Relations Act of 1979, Pub. L. 96-8, 93 Stat. 14 (1979), section 2, subsection b and section 3, subsection c.
- 18 Joseph Trevithick, "China Shows Off Hypersonic Vehicle Test Model After US Navy Weapon Test," *War Zone*, 7 November 2017, <https://www.thedrive.com/the-war-zone/15828/china-shows-off-hypersonic-vehicle-test-model-after-us-navy-weapon-test>.
- 19 Ewen Levick, "China's 'Underwater Great Wall,'" *Maritime Executive*, 18 June 2018, <https://www.maritime-executive.com/editorials/china-s-underwater-great-wall>.
- 20 "China Integrates Long-Range Surveillance Capabilities," *Jane's IHS Markit*, 2017, [https://www.janes.com/images/assetsets/477/75477/China\\_integrates\\_long-range\\_surveillance\\_capabilities.pdf](https://www.janes.com/images/assetsets/477/75477/China_integrates_long-range_surveillance_capabilities.pdf).
- 21 Peter Erbland, "Tactical Boost Glide Project Information," DARPA, <https://www.darpa.mil/program/tactical-boost-glide>.
- 22 "Advanced Hypersonic Weapon," *Army Technology*, <https://www.army-technology.com/projects/advanced-hypersonic-weapon-ahw/>.
- 23 Sam LaGrone, "Pentagon: New Rounds for Old Guns Could Change Missile Defense for Navy, Army," *USNI News*, 18 July 2016, <https://news.usni.org/2016/07/18/pentagon-new-rounds-old-guns-change-paradigm-missile-defense-navy-army>.
- 24 Sam LaGrone, "Navy Quietly Fires 20 Hyper Velocity Projectiles through Destroyer's Deckgun," *USNI News*, 8 January 2019, <https://news.usni.org/2019/01/08/navy-quietly-fires-20-hyper-velocity-projectiles-destroyers-deckgun>.
- 25 *China Military Power: Modernizing a Force to Fight and Win*, Defense Intelligence Agency, 2019, 40-45, [https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China\\_Military\\_Power\\_FINAL\\_5MB\\_20190103.pdf](https://www.dia.mil/Portals/27/Documents/News/Military%20Power%20Publications/China_Military_Power_FINAL_5MB_20190103.pdf).
- 26 National Defense Authorization Act for Fiscal Year 2018, Pub. L. No. 115-91, 131 Stat. 1283 (2018), section 1066.
- 27 One retired Navy flag officer put it this way in an off-the-record discussion: "Given the size of the problem, we can't afford to use killing machines [P-8As] as searching machines."
- 28 ISR/Tan excellent, if somewhat dated discussion of how the fleet would use satellite-based sensing to aid in ISR/T can be found in National Research Council of the National Academies, *C4ISR for Future Naval Strike Groups* (Washington, DC: National Academies Press, 2006), <https://doi.org/10.17226/11605>, especially chapter 7.
- 29 National Defense Authorization Act for Fiscal Year 2018, Pub. L. No. 115-91, 131 Stat. 1283 (2018), section 1066(b)(4).

- 30 Jeff Newman, "Unmanned Triton Gets Signals Intelligence Upgrade," *Naval Aviation News*, 17 March 2017, <https://navalaviationnews.navylive.dodlive.mil/2017/03/14/triton-upgraded-with-signals-intelligence-sensor/>.
- 31 The authors of this report agree that the MQ-4C Surveillance System is a wise investment of Navy dollars, that the system is exceptionally capable, and that its acquisition and fielding should be accelerated. However, and as will become clear, we believe that the size of the area intended for surveillance is too large to be meaningfully understood by the current MQ-4C program of record.
- 32 This is an admittedly imprecise term. "Fire-control quality" tracks are those tracks whose location is sufficiently fixed that the assigned weapon is able to acquire the track given its own capabilities. The more capable the missile, the less precise the target must be, all other things being equal.
- 33 Specifically, its size, which we estimate at 1.66 million square NM.
- 34 To that end, we have shaped our assumptions accordingly: 270 knots speed, 24 hour endurance, 10 percent reserve fuel.
- 35 Daniel H. Wagner, W. Charles Mylander, and Thomas J. Sanders, eds., *Naval Operations Analysis* (Annapolis, MD: Naval Institute Press, 1990).
- 36 Aviators (and others) who have had to take the booth audiogram will know well the sensation of not being certain if an event (in this case, a beep tone) took place or not.
- 37 Think, for example, of an egg carton.
- 38 Attentive readers will notice that the analysis here is based on airframes, while the navy's program of record is based on orbits. Note that orbits are a function of a number of factors, including maintenance, distance to station, and turnaround time. The navy assumes four aircraft per orbit.
- 39 The search problem in this case forms a continuous time Markov chain (CTMC) where the transition events are between search, detection, and prosecution. Analysis would involve finding the limiting behavior of the process to determine the impact of sensor specificity on the first passage time of (true) detection.
- 40 "MQ-9 Reaper," US Air Force, 23 September 2015, <https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104470/mq-9-reaper/>.
- 41 "SeaGuardian: Persistent Maritime Domain Awareness," General Atomics Aeronautical, [http://www.ga-asi.com/Websites/gaasi/images/products/aircraft\\_systems/pdf/SeaGuardian\\_Data-Sheet\\_111418.pdf](http://www.ga-asi.com/Websites/gaasi/images/products/aircraft_systems/pdf/SeaGuardian_Data-Sheet_111418.pdf).
- 42 Henry S. Kenyon, "Navy Turns to Tern to Make Every Ship an Aircraft Carrier," *Signal*, 1 November 2017, <https://www.afcea.org/content/navy-turns-tern-make-every-ship-aircraft-carrier>.
- 43 Joseph Trevithick, "Marines Want Their Multi-Role Vertical Takeoff Combat Drone to Be a Flying Radar First," *War Zone*, <https://www.thedrive.com/the-war-zone/21376/everything-you-need-to-know-about-the-usmcs-ambitious-vertical-takeoff-combat-drone>.
- 44 Valeri Insinna and David Larter, "US Navy Selects Builder for New MQ-25 Stingray Aerial Refueling Drone," *Defense News*, <https://www.defensenews.com/naval/2018/08/30/us-navy-selects-builder-for-new-mq-25-stingray-aerial-refueling-drone/>.
- 45 Joseph Trevithick, "The US Navy May Have Watered Down Its MQ-25 Drone Even More," *Warzone*, <https://www.thedrive.com/the-war-zone/12753/the-us-navy-may-have-watered-down-its-mq-25-drone-even-more>.
- 46 *United Nations Treaty Series*, Union of Soviet Socialist Republics and Japan, Joint Declaration, 19 October 1956, vol. 263, 99-118, <https://treaties.un.org/doc/Publication/UNTS/Volume%20263/v263.pdf#99>.
- 47 Tsuyoshi Hasegawa, "The Atomic Bombs and the Soviet Invasion: What Drove Japan's Decision to Surrender?," *Asia-Pacific Journal* 5, no. 8, 1 August 2007, <https://apjif.org/-Tsuyoshi-Hasegawa/2501/article.html>.
- 48 Constitution of Japan, Article 9, [https://japan.kantei.go.jp/constitution\\_and\\_government\\_of\\_japan/constitution\\_e.html](https://japan.kantei.go.jp/constitution_and_government_of_japan/constitution_e.html).
- 49 Frank Kowalski, *An Inoffensive Rearmament: The Making of the Postwar Japanese Army* (Annapolis, MD: US Naval Institute Press, 2014), 72.
- 50 Kanako Takahara, "SDF emerging as the military it truly is," *Japan Times*, 17 April 2007, [japantimes.co.jp/news/2007/04/17/reference/sdf-emerging-as-the-military-it-truly-is/#.XbCvaZnKi1s](http://japantimes.co.jp/news/2007/04/17/reference/sdf-emerging-as-the-military-it-truly-is/#.XbCvaZnKi1s).
- 51 Michael MacArthur Bosack, "New Era, New Self-Defense Forces," *Japan Times*, 27 June 2019, <https://www.japantimes.co.jp/opinion/2019/06/27/commentary/japan-commentary/new-era-new-self-defense-forces/>.
- 52 Karl Gustafsson, Linus Hagström, and Ulv Hanssen, "Japan's Pacifism is Dead," *Survival* 60, no. 6 (2018), 138.
- 53 Robert S. Norris, William M. Arkin, and William Barr, "How Much Did Japan Know?," *Bulletin of the Atomic Scientists* 56, no. 1 (January/February 2000), 12.
- 54 John Lehman, *Oceans Ventured: Winning the Cold War at Sea* (W. W. Norton, New York: 2018), 99-103.
- 55 Ibid., 107-18.
- 56 Narusawa Muneo, "The Overseas Dispatch of Japan's Self-Defense Forces and U.S. War Preparations," *Asia-Pacific Journal* 12, no. 31, 28 July 2014, 1, <https://apjif.org/-Narusawa-Muneo/4158/article.pdf>.
- 57 Sarah Buckley, "Analysis: Japan's Spy Satellites," *BBC News*, 28 March 2003, <http://news.bbc.co.uk/2/hi/asia-pacific/2892641.stm>.



- 58 Masataka Oguro, *Ensuring Japan's Future Air Security: Recommendations for Enhancing the JASDF's Readiness to Confront Emerging Threats*, Brookings Institution, September 2018, 7, [https://www.brookings.edu/wp-content/uploads/2018/09/FP\\_20180925\\_JASDF\\_readiness.pdf](https://www.brookings.edu/wp-content/uploads/2018/09/FP_20180925_JASDF_readiness.pdf).
- 59 Shannon Tiezzi, "Japan to Station Troops on Yonaguni, Near Disputed Islands," *Diplomat*, 19 April 2014, <https://thediplomat.com/2014/04/japan-to-station-troops-on-yonaguni-near-disputed-islands/>.
- 60 Mike Yeo, "Japan's Election Result Unlikely to Stop Aegis Ashore Deployment despite Controversy," *Defense News*, July 29, 2019, <https://www.defensenews.com/digital-show-dailies/smd/2019/07/29/japans-election-result-unlikely-to-stop-aegis-ashore-deployment-despite-controversy/>.
- 61 Lt. Gen. Koichiro Bansho (JGSDF Ret.), "Japan's New Defense Strategy in the Southwest Islands and Development of Amphibious Operations Capabilities," in *U.S.-Japan Alliance Conference: Meeting the Challenge of Amphibious Operations* (Santa Monica, CA: RAND Corporation, 2018), 9-14.
- 62 Michael Peck, "Japan Doesn't Know What to Do with Its New F-35 Armed Aircraft Carriers," *National Interest*, 24 May 2019, <https://www.defensenews.com/digital-show-dailies/smd/2019/07/29/japans-election-result-unlikely-to-stop-aegis-ashore-deployment-despite-controversy/>.
- 63 "KHI Gives MSDF First P-1 Anti-Sub Patrol Aircraft," *Japan Times*, 27 March 2013, <https://www.japantimes.co.jp/news/2013/03/27/business/khi-gives-msdf-first-p-1-antisub-patrol-aircraft/#.XVGWqpNK1t>.
- 64 "Japan Boosting Missile Defense to Face North Korean Threat: Intercept Systems Getting Upgraded to Handle High-Flying Missiles," *Nikkei Asian Review*, 5 December 2017, <https://asia.nikkei.com/Politics/Japan-boosting-missile-defense-to-face-North-Korean-threat2>.
- 65 Thomas Karako, *Shield of the Pacific: Japan as a Giant Aegis Destroyer*, Center for Strategic and International Studies, May 2018, 1-3, [https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180523\\_Karako\\_ShieldofthePacific.pdf?](https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180523_Karako_ShieldofthePacific.pdf?).
- 66 Stephen Carlson, "Japan Issues Contract to Purchaser RQ-4 Global Hawk Surveillance Drones," UPI, 20 November 2018, <https://www.upi.com/Defense-News/2018/11/20/Japan-issues-contract-to-purchaser-RQ-4-Global-Hawk-surveillance-drones/3111542721963/>.
- 67 Adrienne Harebottle, "Japan Places Eighth Reconnaissance Satellite in Orbit," *ViaSatellite*, 13 June 2018, <https://www.satellitetoday.com/government-military/2018/06/13/japan-places-eighth-reconnaissance-satellite-in-orbit/>.
- 68 Peter Layton, "Japan's Air Force Steps Up Its Scrambles. What are the Risks?" *War on the Rocks*, 4 April 2019, <https://warontherocks.com/2019/04/japans-air-force-steps-up-its-scrambles-what-are-the-risks/>.
- 69 Franz-Stefan Gady, "Japan Scrambles Fighter Jets 999 Times in 2018 in Response to Foreign Aircraft," *Diplomat*, 2 May 2019, <https://thediplomat.com/2019/05/japan-scrambles-fighter-jets-999-times-in-2018-in-response-to-foreign-aircraft/>.

## Notes

[illegible]

## Notes

[illegible]

Hudson Institute  
1201 Pennsylvania Avenue, Fourth Floor, Washington, D.C. 20004  
+1.202.974.2400 [www.hudson.org](http://www.hudson.org)