Wired for Sound in the 'Near Seas'

By Lyle Goldstein and Shannon Knight

China is deploying an ocean-floor surveillance network to strengthen its antisubmarine-warfare capability.

As China's naval modernization program has shifted into high gear in recent years, numerous defense analysts, both inside and outside China, have rightly pointed to the People's Liberation Army Navy's (PLAN's) quite obvious weaknesses in antisubmarine warfare (ASW) as a persistent Achilles' heel of the evolving force. Although the 2012 introduction of the Type 056 light frigate, which has subsequently been produced at an unusually rapid clip, may represent a significant step toward increasing ASW prowess, there appears to be a long road ahead for Chinese

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The Japan Maritime Self-Defense Force submarine JDS *Unryu* arrives at Pearl Harbor for a routine port visit on 15 October 2013. Until recently, China has neglected antisubmarine warfare against a potential foe such as Japan, but that lack of attention is in the process of being corrected. According to the authors, "China has deployed fixed ocean-floor acoustic arrays off its coast, presumably with the intent to monitor foreign submarine activities in the 'near seas.'"

development in this realm. This is made more likely given the profound paucity of operational experience in the PLAN, as well as the apparently long-time neglect of maritime-patrol aircraft and ship-borne helicopters.

Defense analysts who follow Chinese military literature closely, however, will have noticed over the past several years that the massive Chinese military-industrial complex has now come around to the great importance of ASW, and China's substantial military and science-research energies have shifted accordingly. The fruits of these major research efforts are now gradually coming into view. Most startling is the revelation in numerous Chinese scientific and strategy publications since 2012 that China has deployed fixed ocean-floor acoustic arrays off its coast, presumably with the intent to monitor foreign submarine activities in the "near seas." While it may be nearly impossible to fully assess the effectiveness of these ocean-bottom arrays in enhancing Chinese ASW capabilities, here we endeavor to at least outline in general terms the parameters of these deployed systems that have been revealed in various recent Chinese writings on the subject.

Cold War Echoes

Before exploring in detail the substance of new Chinese revelations, it will be worthwhile to review, albeit briefly, what is known in the open realm regarding the significance of ocean-floor acoustic arrays to the historical development of ASW, and especially its role in the Cold War. According to an authoritative analysis of U.S. Navy ASW development during the Cold War by Owen Coté, ocean-floor arrays commonly known as SOund SUrveillance System (SOSUS) played an immensely important role. First deployed off the Bahamas in 1951, the system was expanded through the 1950s along both coasts of the United States. Coté explains, "SOSUS arrays consisted of hydrophones spaced along undersea cables laid at the axis of the deep sound channel roughly normal to the direction that the array was to listen." The results were stunning, and SOSUS is famously said to have tracked the first *George Washington*–class nuclear-powered ballistic-missile submarine (SSBN) all the way across the Atlantic Ocean in 1961. Suggestive of the system's revolutionary capabilities, it is claimed that a SOSUS array in Barbados accomplished the extraordinary feat of detecting the first Soviet nuclear submarine to enter the Greenland-Iceland-U.K. gap in 1962.

A so-called "happy time" for American ASW followed as SOSUS capabilities were paired with maritime-patrol aircraft squadrons to establish a formidable counter to the growing Soviet submarine fleet. Certain challenges, however, arose surrounding the use of these new systems. First was the imperative, familiar from the use of ULTRA intelligence in World War II, not to reveal the system's locations and capabilities to the adversary. Second, it was clear that Soviet efforts at submarine quieting could eventually undermine the effectiveness of the system. Third, the happy time of the U.S. advantage in passive acoustics afforded partly by the revolutionary SOSUS capabilities partly came to an end when Moscow radically increased the range of its submarine-launched missiles, allowing them to remain in "bastions" near the Soviet coast, and thus avoid NATO ASW barriers.

According to Coté, the U.S. Navy met these challenges by deploying both Fixed Deployable Systems (FDS) wider afield, as well as developing the Surface Towed Array Surveillance System (SURTASS), but he concludes that the end of the Cold War had a "saved-by-the-bell" aspect to it, as submarines were once again gaining the upper hand over ASW forces. Thus, it is clear that SOSUS played a highly critical, but also somewhat contingent role

in the Cold War at sea. Chinese naval analysts have ample awareness regarding the nuances in this important history.[1]

Tantalizing Hints and 'Grey' Research

Signs that Beijing's naval planners had more than a passing interest in ocean-floor surveillance networks go back well over a decade. For example, a researcher at the Chinese navy's Institute 715 published a survey of "ocean surveillance technologies" in 2001 that included a detailed discussion of the American SOSUS program.[2] As revealed here later, it is probably not at all coincidental that the eastern maritime province of Shandong is home to the PLAN's first nuclear submarine base and that one of the most detailed discussions of Chinese undersea sensor networks appeared in the journal *Shandong Science* in 2010. This article was not especially coy regarding its significant military applications and also demonstrated a high level of awareness among Chinese scientists regarding various similar U.S. programs. Moreover, it also observed that, given China's vast coastline, there is enormous potential for the country to develop an ocean-surveillance network.[3]

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The new Type 056 Chinese light frigate *Ji'an* is commissioned and named during a flag-presenting ceremony at a naval port in Shanghai on 8 January. Even though production of such ships has accelerated in part because of their ASW capability, "there appears to be a long road ahead for Chinese development in this realm."

However, Shandong was apparently not the only coastal area pushing forward with ocean-floor sensor research. Farther to the south and located near Shanghai at the mouth of large Hangzhou Bay, a recently established "East Sea Ocean Floor Observation Test Station" was discussed extensively by Chinese researchers in an article appearing in *Science Bulletin* in 2011. Focusing on the collection of a variety of oceanographic information—tidal and current data, for example—experimentation with sonars appears to be ongoing at the station. The wireless data-collection system began its operations in April 2009 at the Xiaoqushan Station.[4]

Although that specific article does not explicitly discuss military applications, another article by several of the same authors appearing in late 2012 discussed the station and military applications for the ocean-floor sensors, alongside civilian uses, including environmental protection, navigation, and disaster prevention. The latter article compares different configurations for ocean-floor sensor networks, including linear, circular, and "tree-type" designs, evaluating both cost and also security and reliability implications. It also mentions the Xiaoqushan Station as the basis for a larger "East Sea Ocean Floor Sensor Network" that will be completed by 2016. It is finally perhaps noteworthy that this discussion also explicitly mentions "undersea mobile sensor stations," as well as fixed sensors.[5]

In the Open

In early 2013, members of the Chinese scientific community opted to go public with the system, and they were not particularly subtle about it. *China Science Daily* ran a reasonably detailed report as the lead article on the front page of the 26 March edition, with the banner headline: "Here They Are Quietly Listening to the Ocean: The Whole Story of the Building of Our Country's First Deep Sea Ocean Floor Sensor Network Base." According to this story, an initial undersea-sensor system was tested back in 2005 in the waters surrounding China's nuclear submarine base at Qingdao in Shandong Province. An additional site was selected for the "Lingshui Base" near Chinese submarine bases on southern Hainan Island, and work formally commenced there in April 2009. Initial setup was completed in 2010, but the site has seen continual upgrades consistent with its dual civilian-military research program. The undersea-sensor system has been integrated into a larger surveillance system that also has air and space components.[6]

Two articles appearing in mid-2013 in the Chinese technical journal *Ship Electronic Engineering*, moreover, seemed to confirm salient details from the earlier article and even to suggest a program that was now at an active-deployment stage. One of these articles, for instance, underlines the inadequacies in China's current system of undersea battle-space awareness and emphasizes

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Chinese naval analysts have studied the Cold War at sea carefully. That is especially true with respect to ASW. The map at right has appeared many times in Chinese naval journals and illustrates close attention to the role of ASW barriers in naval strategy and of ocean-floor sensor arrays within such a barrier strategy. These analysts know that the U.S. Navy was already capable in the early 1960s of using ocean-floor sensors to track its own initial deployment of "boomers," notably including the USS *George Washington* (SSBN-598) pictured here. One quandary for China is how to defeat U.S Navy ASW barriers in the Western Pacific, while at the same time erecting its own such barriers in the same region.

its importance in a holistic "information-based probing and warning system for the near seas" that also includes air and ship-borne assets, among others.[7] A second article in this journal broaches the technical challenge of energy supply by proposing a low-power "sleep wake mode" and mentions the interesting additional problem that a country's undersea sensors are subject to being captured by an adversary.[8] Another Chinese technical paper discusses the importance of advances in "burst communications" for enhancing the military value of the undersea-sensor network.[9] Yet another recent technical article regarding the difficult engineering problems posed by the undersea-surveillance systems strongly hints that Chinese scientists are giving high priority to improving the system's effectiveness.[10]

The Surveillance Network and Naval Strategy

Along with technical treatments regarding the system's many engineering challenges, the Chinese naval press has also carried a couple of articles considering how the new undersea-surveillance network might affect evolving Chinese naval strategy. A mid-2012 analysis in the Chinese naval magazine *Modern Ships* unequivocally confirms the foregoing thesis presented here, stating: "According to newspaper reports, the Chinese Navy is now developing a SOSUS-type system for submarine surveillance."

Interestingly, this analysis—part of a discussion concerning the utility of maritime-patrol aircraft—does not simply applaud this development but rather adopts a somewhat skeptical viewpoint. To be sure, this particular article points out that ASW aircraft have limited sonobuoy payload and range and therefore "require the help of other means in order to make initial contact with the submarine." Citing unspecified sources, the Chinese analyst claims that the "daily discovery . . . rate" of the American SOSUS system was not very high, however, in spite of the Soviets' "noisy" nuclear submarines and the overall ability to make certain contacts at genuinely extraordinary ranges. Notably, this leads to the conclusion drawn by the Chinese author that "SOSUS combined with ASW aircraft . . . would not have high effectiveness in a conflict of short duration, but in a relatively long . . . conflict, [that system] would have a very high value." As a window into current debates among Chinese strategists regarding ASW, this is a significant point. It is also telling that the article dedicates significant analytical attention to the thesis that open-ocean convoy escort-type ASW has historically been very successful, in part dependent on large numbers of escorts. The suggestion here seems to be that the SOSUS-MPA pairing may prove useful to China's ASW effort, but in no way represents a silver bullet for the perennially difficult problem of coping with adversary submarines.

The article goes on to discuss the U.S. Navy's gradual move later in the Cold War from fixed arrays in the open ocean to "sensors . . . deployed in Soviet submarine egress channels," along with the related American planning for assaults on Soviet bastions. Presenting the challenge for Chinese naval strategists, this author concludes, "One can

predict that in a time of war against the Chinese Navy, that the U.S. submarine force would take similar steps to pin down the Chinese Navy."[11]

The cover story of a second quasi-official naval journal, *Naval & Merchant Ships* from mid-2013, similarly shows an acute Chinese sensitivity to their perceived vulnerability to U.S. submarines. Like the *Modern Ships* article, this one provides yet another suggestion regarding China's effort to build ocean-floor sensor networks: "China's fixed-type undersea surveillance system has also been under continuous development since 1996. . . . In 2005 near Qingdao, a comprehensive undersea surveillance system was tested."

Chinese Undersea-Sensor Test Sites

Protecting China's SSBNs

The central concern of this second article is protecting China's SSBNs. The main threat vector is hardly hidden, as the author writes, "In order to cope with U.S. military pressure, China must rapidly strengthen its military capabilities, especially its strategic nuclear capabilities." Moreover, it puts forward a plausible theory of limited war in the nuclear age: "Limited war theory does not permit the enemy country to become a target. . . . But to win the war one must defeat the enemy's military forces [so] the SSBN can become the ideal target." The author asserts that China's surface-launched ballistic-missile range must be extended "so that one-way passage [to the patrol area] is shortened to 5-10 days."

At present, Chinese submarines are evaluated to be highly vulnerable to detection from "U.S. . . . warships employing active sonar . . . [as well as] . . . U.S. nuclear submarines lurking near [Chinese] harbors." To address this dire situation, the ocean-floor surveillance system is deemed critical: "Among the [various ASW] elements, the sonar surveillance [system] is the foundation and heart, offering advanced warning for the sortie of ASW aircraft and light escorts." The author continues, "The hardest part of ASW is early detection. If China can only find the targets, [Chinese] ASW forces can apply pressure against the activities of U.S. submarines, limiting their intelligence and attack capabilities."

While this article discusses other critical ASW elements—even highlighting the role of aircraft carriers, for example—a clear focus and conclusion of this analysis is the priority to build up the ocean-floor surveillance system. It envisions a sequential process: "In order for China to build a relatively tight ASW network, we must first [outside of all major fleet bases] construct fixed seabed sonar arrays for continuous surveillance and control of sea areas close to ports. . . ." In a fascinating passage, the author highlights the crucial role of Taiwan's geography. The author writes, "in order to transform the difficult situation [within the first island chain] . . . China must realize unification [with Taiwan] and drive U.S. military forces from the first island chain. That way, China could dismantle the undersea sensor equipment that the U.S. has deployed . . . and put in place its own undersea surveillance system."

The analysis further advocates that after building a network proximate to Chinese naval bases, the Chinese "Navy should deploy seabed sonar arrays to the west of Okinawa, to the east of Taiwan, and into the Luzon Strait." Nor should China's ambitions for undersea surveillance be restricted to the "near seas," according to this analysis, as the author suggests that more distant areas, such as the Bay of Bengal, may be appropriate sites for future Chinese ocean-floor arrays "in order to support ASW operations in those sea areas."[12]

'Hard at Work'

The sources presented here show beyond any reasonable doubt that China is hard at work deploying ocean-floor surveillance systems in its proximate waters. The program does not, in and of itself, reveal any definitive conclusion regarding Chinese strategic motives and goals. Indeed, it is quite conceivable that Beijing has undertaken the deployment of such sensors as a defensive response to a significant perceived vulnerability. It also remains unclear how much of a boost the generally weak Chinese ASW forces may receive from the new undersea surveillance

system. After all, Western Pacific waters are notoriously complex from an acoustic standpoint, and modern submarines are shockingly quiet.

For U.S. decision makers, the salient point to understand is that China's effort in undersea warfare is both broad and deep. The major undersea warfare gap that now exists between the United States and China may well diminish in coming decades. It is amply clear that China is committing significant research resources to try to detect submarines in nearby waters. In pursuit of the goal of sustaining this core U.S. naval and strategic advantage for the long term, U.S. defense leaders must retain their focus on the Navy's fundamental mission of sea control above all others. To that end, they should continue to prioritize the further development of undersea forces and related systems.

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