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Dual-Use Seabed Mapping: China's Oceanographic Survey Fleet and the U.S. Undersea Advantage in the Western Pacific

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Executive Summary:

Based on AIS data, China's National Oceanographic Survey Fleet conducts extensive seabed mapping within the First Island Chain and within and just beyond the Second Island Chain. Vessel funding, management, and behavior indicate that this mapping supports both undersea military objectives and civilian scientific ones. Regarding undersea military capabilities, this data advances two aims: improving the effectiveness of anti-submarine warfare (ASW) and anti-access/area denial (A2/AD) capabilities against U.S. submarines and enabling the PLAN's future expansion beyond the First Island Chain through enhanced undersea navigation and domain awareness. In a highly contested region with significant potential for crisis and conflict, these developments erode the United States' asymmetric undersea advantage, constrain submarine operations, and diminish the credibility of conventional deterrence.

Problem Statement

The People's Republic of China's National Oceanographic Survey Fleet conducts extensive seabed mapping within the First Island Chain and within and just beyond the Second Island Chain. In addition to supporting civilian scientific objectives, the data from this research also serves dual-use military objectives affecting undersea warfare capabilities for both China and the United States. In a highly contested region with significant potential for crises and conflict, the erosion of the U.S. undersea advantage carries outsized operational and strategic consequences.

Background

The People's Republic of China is working to increase its dominance in the Western Pacific and to strengthen its role in governing the global maritime order. A comprehensive understanding of its near and far seas, both within and beyond the First Island Chain, is critical to this objective. This policy priority is highlighted in the nation's 15th Five-Year Plan, which includes significant investment in ocean sciences, including deep-sea research and deep-sea equipment.¹

The driving force behind Chinese deep-sea research is the National Oceanographic Survey Fleet. Established in 2012, the fleet comprises more than 50 vessels, most of which are deep-sea capable. The survey and research fleet is the largest in the world, outnumbering the combined United States Academic Research Fleet, the National Oceanic and Atmospheric Administration's research fleet, and the U.S. Navy's fleet of oceanographic survey vessels. The Ministry of Natural Resources (MNR) operates most of the fleet and serves as the primary manager, coordinating among ship owners and improving information sharing.² As shown in Figure 1, numerous other organizations and ministries also own ships that operate within the National Fleet. The system closely resembles the University-National Oceanographic Laboratory System (UNOLS), which coordinates U.S. civilian oceanographic research. However, unlike UNOLS, the coordination committee for the National Fleet is overseen by a government official. The People's Liberation Army Navy's (PLAN) distant-ocean research fleet also complements the National Fleet. It is primarily composed of Type 636/636A distant-ocean survey ships, comparable to the U.S. Navy's Pathfinder class.³ Additionally, Chinese state-owned enterprises (SOEs) like COSL and Sinopec Offshore Oilfield Services also have survey vessels and conduct mapping. Because the National Fleet is the main oceanographic research engine and there is a

relative lack of open-source information on other military and commercial research vessels, they are outside the scope of this research.

The National Fleet's Dual-Use Capacity

Given the Chinese Communist Party's broader military objectives and the nature of the National Fleet's operations and composition, there is strong reason to believe that the fleet plays an important role in supporting both civilian scientific objectives and strategic military ones. These concerns fall within the broader context of Chinese Military-Civil Fusion (MCF). This effort, spearheaded and overseen by PRC President Xi Jinping, aims to accelerate the modernization of the PLA, promote military-technological innovation, and close the gap needed to compete with the U.S. military by eliminating barriers between the civilian research and commercial sectors and the defense industrial sector.⁴

The PLA has repeatedly recognized the importance of deep-sea research to gain familiarity with and understanding of the undersea battlespace in the Pacific. Simultaneously, Chinese researchers publicly recognize the military applications of their research. The strongest indications of dual-use research and the most concrete evidence of the MCF lie in the funding structure and mutual agreements between the civilian and military sectors. First, the Chinese Communist Party funds and provides grants to all organizations that own ships in the National Fleet, with most organizations having CCP Party committees that play a managerial role.⁵ Further, the MNR has close ties to the PLAN, with which it has signed two cooperative agreements to promote "civil-military integrated development in the maritime realm."³ The Chinese Academy of Sciences has signed a similar cooperation agreement.¹ Finally, in terms of deep-sea policy, the CCP has repeatedly prioritized national security interests over economic and environmental ones, further increasing the likelihood that ocean survey data collected by the National Fleet is used for military purposes.⁶

Civilian Capacity

The majority of the National Fleet has been built over the past 15 years and consists of comprehensive research vessels. While capabilities vary by vessel, instruments and sensors collect core data on bathymetry, bottom composition, water-column temperature and salinity, the speed and direction of undersea currents, acoustics, and sound propagation. The main research technologies include remotely operated vehicles, underwater gliders, towed arrays, buoys, manned submersibles, unmanned surface vessels, and unmanned underwater vehicles (UUVs).²

Under the UN Convention on the Law of the Sea (UNCLOS), all states have broad freedom to conduct Marine Scientific Research (MSR) in international waters to increase the world's understanding of the marine environment. The data the National Fleet collects supports many of these aims, serving climate research, fisheries management, ecosystem monitoring, conservation, and resource management.⁷ Within a coastal state's exclusive economic zone (EEZ), however, MSR requires that state's consent, typically conditioned on transparency about the research's purpose and findings.⁶ Despite their scientific applications, U.S. allies and partners in the region consistently cite China's research vessels as gray-zone instruments that lack UNCLOS-required transparency, normalize China's presence in contested waters and foreign EEZs, strengthen its maritime claims, and increase its operational awareness.⁷

Military Capacity

The same data, instruments, and sensors collected and used by the National Fleet can help China develop its undersea military capabilities. Understanding the subsea acoustic environment is central to submarine operations and anti-submarine warfare (ASW) in the key strategic areas where the National Fleet conducts surveys. Overall, this data enables submarine and UUV navigation, identifies sonar blind spots where PLAN vessels can operate undetected, supports sonar modeling, and improves China's ability to detect an adversary's undersea operations.⁸ These capabilities are vital as China expands its capabilities and scope as a maritime power.

Tracking the National Fleet

The behavior of the National Fleet's vessels repeatedly signals military cooperation and dual-use research, further blurring the line between scientific, military, and commercial purposes. The mandatory transmission of automatic identification system (AIS) data provides open-source data to track most vessel movements in the National Fleet. Repeatedly, AIS data indicates that National Fleet vessels have stopped at ports with direct affiliations to, or large contingents of the PLAN, including Sanya, Guangzhou, and Qingdao. In addition, National Fleet vessels have ceased transmitting AIS data near PLA installations and other strategic areas of interest.^{1,8}

AIS data from Global Fishing Watch shows that, since 2012, 18 of 54 Chinese civilian research vessels have participated in more than 45 separate bathymetric surveys, collecting data on seabed characteristics and topography. Bathymetric surveys are among the easiest oceanographic research to track because of their distinct, tight-knit back-and-forth, "lawnmower" pattern, shown in Figure 2. AIS tracking shows that mapping activity within the First Island Chain and in waters within and just beyond the Second Island Chain carries the greatest consequence for U.S. national security. Chinese survey activity across these regions appears in Figure 3. Beyond the scope of this research, Chinese vessels also participated in seabed mapping in the Indian and Atlantic Oceans, and the Polar regions.⁹ Overall, the following sections discuss the national security implications of the National Fleet's survey activities for China and the U.S.

The Military Value of Mapping for China

For China, the implications of the National Fleet's mapping are twofold: detection and defense, and force projection. On the detection and defense side, the data contributes to larger ASW projects and systems aimed at anti-access/area denial (A2/AD) in strategic waterways. Broadly, this approach aims to increase subsurface awareness and reduce the operational freedom of U.S. submarines. Because China does not have the capacity to make the entire Western Pacific transparent to U.S. submarines, it can have an outsized return in decreasing the U.S. asymmetric subsurface stealth advantage by strategically improving ASW and A2/AD near chokepoints, bastions, and areas where it intends to operate in the near future.¹⁰

Due to geographic constraints and operational limitations of current Chinese submarine technology, most Chinese submarine activity is presumed to be within the First Island Chain.¹¹ To protect its military, economic, and political interests in its near seas, China has been developing seabed sensing and networked surveillance capabilities within the First Island Chain, often dubbed the "Underwater Great Wall." This is a maturing system that relies on the same types of data the National Fleet collects in its surveys. Additionally, as artificial intelligence

models are trained on the same oceanographic data, they are being incorporated into these models, significantly enhancing their detection capabilities.¹²

The concentration of National Fleet mapping in the Philippine Sea's international waters in Figure 3 is of particular interest to both detection and defense, as well as to force projection. China's air and surface A2/AD capabilities are relatively far more advanced than its subsurface ones. Thus, if the U.S. were to engage in conflict with China, its asymmetric advantage in stealth submarine operations likely means SSNs would play a vital role. On the detection and defense side, mapping in these international waters aims to erode this asymmetric advantage as much as possible.

Chinese International Seabed Authority contracts for deep-sea mining fall just outside Guam and the Mariana Islands, where a cluster of mapping is shown in Figure 3.¹³ However, research vessels spent only 6% of their time in these contracted areas, while also mapping other areas both outside and just inside the Second Island Chain.¹⁴ Given the U.S. military presence in the region, including Naval Base Guam, which hosts forward-deployed SSNs, and the lack of deep-sea deposits within the Second Island Chain, this research is very likely to be dual-use. In the event of conflict, U.S. submarines are likely to transit through the regions within and just outside the Second Island Chain, then head farther west into the Philippine Sea and the South China Sea.¹⁴ Mapping these areas can help detect and track submarines in its far seas, where China aspires to extend its seabed sensing capabilities.¹⁵

On the force projection side, mapping by the Chinese National Fleet in its far seas contributes to its future aims to “break out” of the First Island Chain. In part, this objective stems from the U.S. long-range precision-strike capabilities. In times of conflict, these capabilities make it more survivable to operate in areas where conditions can help avoid detection. In addition, it would allow the PLAN to engage U.S. forces before they enter the South China Sea, thereby placing greater importance on the Philippine Sea.³ Finally, China has very recently demonstrated its JL-2 and JL-3 submarine-launched ballistic missile capabilities. Currently, launching from its defended bastions, China could strike the western seaboard of the U.S.; thus, submarine operations in the far seas would only extend that range.¹⁶ Therefore, China could effectively deter and defend against the U.S. if it extended its submarine capabilities beyond the First Island Chain. While PLAN submarine operations beyond the First Island Chain without U.S. detection are unlikely to pose an imminent threat, National Fleet mapping plays a significant role in helping the PLAN understand the maritime domains in which it aims to operate and rival U.S. primacy.

Takeaways for the United States

The United States maintains maritime superiority in the Western Pacific. Its territory, allies, and defense partners enable it to sustain an enduring and contingency military presence, supported by undersea technologies, including sensors and submarines, which are generally far more advanced than those of China.¹⁷ China's investment in undersea capabilities signals its ambitions to expand its maritime power and influence while eroding that of the U.S. Taken together, these developments have three principal takeaways for the United States.

- **Seabed mapping within and just outside the First and Second Island Chains is dual-use, contributing to PLAN detection and defense and force projection.** The data

likely supports China's maturing ASW and A2/AD systems while enabling the PLAN's ambition to "break out" beyond the First Island Chain.

- **Actions advancing Chinese subsurface capabilities erode the U.S. asymmetric subsurface advantage.** Narrowing the stealth margin of U.S. submarines in key strategic areas makes submarine operations more difficult to conduct and increases operational risk.¹⁰
- **Operational constraints on U.S. submarines harm the credibility of U.S. conventional deterrence in the region.**¹⁰ With increased risks and costs, the credibility of a U.S. intervention in a crisis, such as a Taiwan contingency, is diminished. Subsequent effects include an emboldened China and regional allies and partners who may draw closer to China for their own security.

Given the possibility of new operational conditions within the First and Second Island Chains, the United States needs to consider how to limit the effect of the mapping and data that the National Fleet provides to advance its maritime ambitions. Some key policy areas to review include research and development of counter-sensing and deception technologies, tracking of dual-use research, and the openness of U.S. EEZs to Chinese research vessels, which the U.S. does not condition on reciprocity.

Appendix

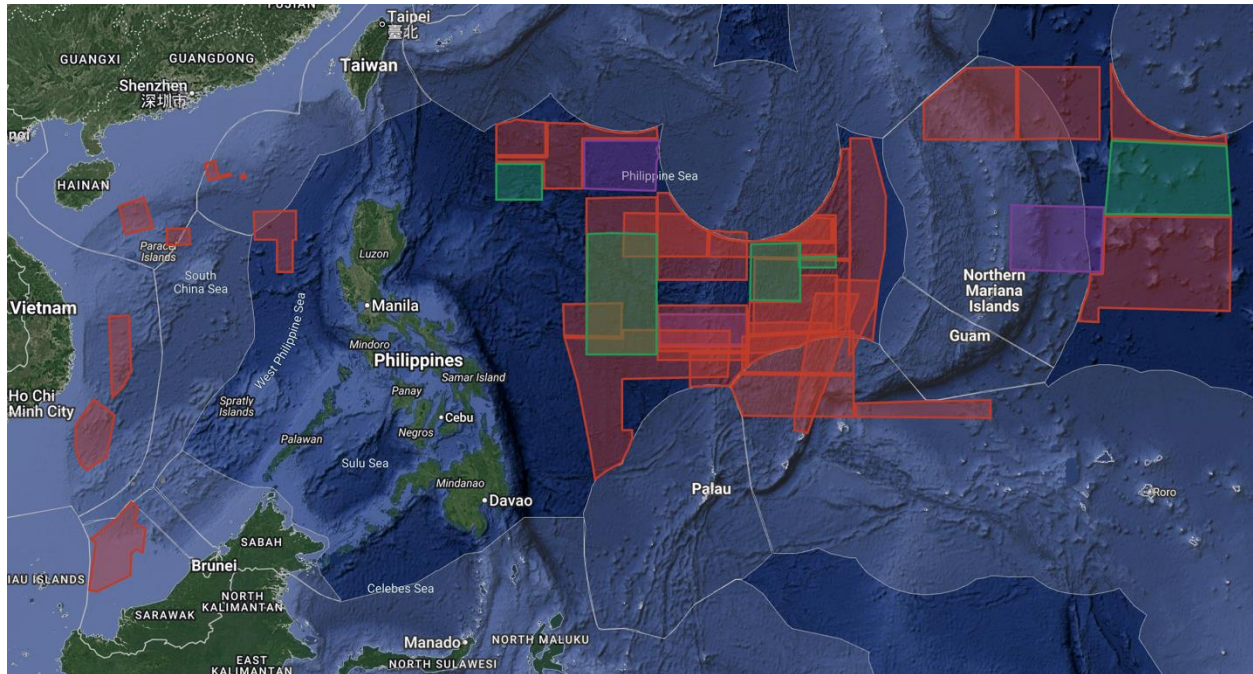
Figure 1: The 18 Chinese research vessels engaged in seabed mapping.

Boat Name	Ministry/Agency	Owner
<i>Xiang Yang Hong 19</i>	Ministry of Natural Resources (MNR)	East Sea Bureau
<i>Xiang Yang Hong 1</i>		First Institute of Oceanography
<i>Xiang Yang Hong 18</i>		
<i>Haiyang Dizhi 4</i>		
<i>Haiyang Dizhi 6</i>		Guangzhou Marine Geological Survey
<i>Haiyang Dizhi 8</i>		
<i>Haiyang Dizhi 10</i>		
<i>Shenhai 1</i>		National Deep-Sea Institute
<i>Xiang Yang Hong 6</i>		North Sea Bureau
<i>Jidi</i>		
<i>Haiyang Dizhi 9</i>		Qingdao Institute of Marine Geology
<i>Xiang Yang Hong 10</i>		Second Institute of Oceanography
<i>Xiang Yang Hong 5</i>		South Sea Bureau
<i>Xiang Yang Hong 14</i>		
<i>Dong Fang Hong 3</i>	Ministry of Education (MoE)	Ocean University of China
<i>Zhang Jian</i>		Shanghai Ocean University
<i>Jia Geng</i>		Xiamen University
<i>Ke Xue</i>	Chinese Academy of Sciences (CAS)	Institute of Oceanology

Figure 2: The lawnmower pattern of Shenhai 1 in the Philippine Sea. Vessels that are mapping typically travel at a speed of 8-10 knots. This AIS data can be retrieved from Global Fishing Watch.



Figure 3: Mapping locations of all Chinese research vessels within the First Island Chain and in waters within and just beyond the Second Island Chain. Red is mapping done by the MNR. Green is mapping done by the Ministry of Education. Purple is mapping done by the Chinese Academy of Sciences.



For the full interactive map with layered EEZs, deep-sea mining contracts, and U.S. installations, allies and partners, click [here](#).

Source: Compilation of CRS, DOD, and open-source AIS data, including information from Fogler (2025).

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