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Ryan D. Martinson

Peter A. Dutton

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中国海事研究所
China Maritime Studies Institute



U.S. NAVAL WAR COLLEGE
Est. 1884
NEWPORT, RHODE ISLAND



CHINA MARITIME STUDIES INSTITUTE
CENTER FOR NAVAL WARFARE STUDIES
U.S. NAVAL WAR COLLEGE
686 CUSHING ROAD (3C)
NEWPORT, RHODE ISLAND 02841



China's Distant-Ocean Survey Activities: Implications for U.S. National Security

Ryan D. Martinson and Peter A. Dutton¹

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China Maritime Studies Institute
U.S. Naval War College
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Today, the People's Republic of China (PRC) is investing in marine scientific research on a massive scale. This investment supports an oceanographic research agenda that is increasingly global in scope. One key indicator of this trend is the expanding operations of China's oceanographic research fleet. On any given day, 5-10 Chinese "scientific research vessels" (科学考查船) may be found operating beyond Chinese jurisdictional waters, in strategically-important areas of the Indo-Pacific. Overshadowed by the dramatic growth in China's naval footprint, their presence largely goes unnoticed. Yet the activities of these ships and the scientists and engineers they embark have major implications for U.S. national security.

This report explores some of these implications. It seeks to answer basic questions about the out-of-area—or "distant-ocean" (远洋)—operations of China's oceanographic research fleet. Who is organizing and conducting these operations? Where are they taking place? What do they entail? What are the national drivers animating investment in these activities?

It comprises five parts. Part one defines the fleet, and the organizations that own and operate it. Part two examines primary operating areas. Part three describes the range of activities conducted by Chinese research vessels while operating in distant-ocean areas. Part four sketches the key strategic

purposes driving state investment in out-of-area oceanography. Part five discusses the implications of Chinese oceanographic research for U.S. national security.

Fleet Composition

Several different Chinese agencies, research institutes, and universities own and operate oceanographic research vessels. Until 2018, the State Oceanic Administration owned by far the most ships, including the large *Xiang Yang Hong* series of vessels. In March 2018, China's National People's Congress passed legislation to dissolve the State Oceanic Administration, placing its functions under the new Ministry of Natural Resources (MNR).² Within the MNR, several institutes conduct out-of-area research. Chief among them are the First, Second, and Third Institutes of Oceanography. They own their own vessels and often embark their scientists aboard ships operated by other groups. MNR oversees the Polar Institute of China, owner of the 20,000-ton *Snow Dragon* polar research vessel. Each of the MNR's regional bureaus—North, East, and South—also own and operate ships capable of out-of-area research operations.

MNR vessels constitute the bulk of China's National Marine Research Fleet. The National Fleet was set up in 2012 in order to improve coordination between ship owners and foster information sharing. This was an apparent attempt to emulate the University-National Oceanographic Laboratory System (UNOLS), which coordinates civilian use of oceanographic research vessels in the United States.³ A Coordination Commission formulates policy guiding use of the National Fleet.⁴ A government official heads the Commission. Decisions made by the Commission are implemented by its office, located within the MNR's Department of Science and Technology.⁵

Several other organizations own ships that belong to the National Fleet. Two are major players in distant-ocean operations: the Chinese Academy of Sciences (CAS) and China Ocean Mineral Resources R & D Association (COMRA). CAS owns a handful of research vessels, including the *Shiyan 3*, which in early 2018 surveyed Pakistan's exclusive economic zone (EEZ), and the *Kexue*, a frequent visitor to the Philippine Sea.⁶ CAS oversees several important oceanographic research institutes: the Institute of Oceanology, the South China Sea Institute of Oceanology, and the Institute of Acoustics, all of which own their own vessels and/or embark scientists aboard vessels owned by other groups. COMRA is a quasi-governmental entity set up in the 1990s to promote China's exploration of sea bed resources in high seas areas.⁷ It owns one major distant-ocean research vessel: the 5,600-ton, Soviet-built *Dayang 1*. Several Chinese universities also own ships belonging to the

National Fleet. **Table 1** list major units of the National Fleet that conduct distant-ocean cruises.

Figure 1 in the Appendix shows three key members of the National Fleet.

Table 1. China's National Marine Research Fleet (Distant-Ocean Vessels)⁸

Owner	Ship Name	Built	Home Port	Tons	Notes
Ministry of Natural Resources (Former State Oceanic Administration)	<i>Snow Dragon</i>	1993	Shanghai	21,000t	Owned by the Polar Research Institute.
	<i>Xiang Yang Hong 01</i>	2016	Qingdao	5,000t	Owned by the First Institute of Oceanography.
	<i>Xiang Yang Hong 03</i>	2016	Xiamen	5,200t	Owned by the Third Institute of Oceanography.
	<i>Xiang Yang Hong 06</i>	1995	Qingdao	4,900t	Owned by the MNR North Sea Branch
	<i>Xiang Yang Hong 09</i>	1978	Qingdao	4,400t	Owned by the MNR North Sea Branch. Mother ship of the <i>Jiaolong</i> deep-sea submersible.
	<i>Xiang Yang Hong 10</i>	2014	Wenzhou	4,600t	Owned by the Second Institute of Oceanography.
	<i>Xiang Yang Hong 14</i>	1981	Guangzhou	4,400t	Owned by the MNR South Sea Branch.
	<i>Xiang Yang Hong 18</i>	2015	Qingdao	2,400t	Owned by the First Institute of Oceanography.
	<i>Xiang Yang Hong 19</i>	2011	Shanghai	4,000t	Owned by the MNR East Sea Branch. Former China Marine Surveillance 50.
	<i>Xiang Yang Hong 20</i>	1969	Shanghai	3,090t	Owned by the MNR East Sea Branch.
	<i>Haice 3301</i>	2005	Guangzhou	4,000t	Owned by the MNR South Sea Branch. Former China Marine Surveillance 83.
Chinese Academy of Science (CAS)	<i>Kexue</i>	2012	Qingdao	5,000t	Owned by the CAS Ocean Research Institute.
	<i>Shiyan 01</i>	2009	Guangzhou	2,500t	SWATH hull design. Owned by the South China Sea Institute of Oceanology.
	<i>Shiyan 03</i>	1981	Guangzhou	3,300t	Owned by the South China Sea Institute of Oceanology
China Ocean Minerals R & D Association (COMRA)	<i>Dayang 1</i>	1984	Qingdao	5,600t	Former Soviet survey ship. Purchased from Russia in 1994.
Dalian Maritime University	<i>Yukun</i>	2008	Dalian	5,900t	N/A
Ocean University of China	<i>Dong Fang Hong 2</i>	1995	Qingdao	3,500t	N/A
Xiamen University	<i>Jiageng</i>	2017	Xiamen	3,700t	N/A

The MNR also oversees the China Geological Survey. Its vessels are active in distant-ocean areas, though they do not belong to the National Fleet. The China Geological Survey administers the Guangzhou Marine Geological Survey, owner of several research vessels. Its activities primarily focus on exploration of seabed resources in Chinese-claimed areas, especially the South China Sea. However, several of its ships—including the *Haiyang 4* and *Haiyang 6*—routinely operate beyond the First Island Chain.⁹ Another China Geological Survey affiliate, the Qingdao Institute of Marine Geology, owns the 4,350-ton *Haiyang Dizhi 9*, which was commissioned in late 2017.

Table 2. The China Geological Survey Fleet (Distant-Ocean Vessels)

Owner	Ship Name	Built	Home Port	Tons
Guangzhou Marine Geological Survey	<i>Haiyang 4</i>	1980	Guangzhou	3,300t
	<i>Haiyang 6</i>	2009	Guangzhou	4,600t
	<i>Haiyang Dizhi 8</i>	2017	Guangzhou	6,900t
	<i>Haiyang Dizhi 10</i>	2017	Guangzhou	3,400t
Qingdao Institute of Marine Geology	<i>Haiyang Dizhi 9</i>	2017	Qingdao	4,350t

Primary Operating Areas

For decades, China’s oceanographic research activities were almost entirely concentrated within the First Island Chain, in waters often referred to as the “near seas” (近海). These activities were largely driven by military and sovereignty objectives.¹⁰ In the 1980s, China’s civilian research fleet surveyed remote sections of the South China Sea, laying the foundation for China’s ultimate occupation of seven land features in the Spratly Islands.¹¹ Beginning in 2002, civilian experts led by the Second Institute of Oceanography conducted surveys of the East China Sea, collecting data needed to buttress China’s claim to seabed resources out to the Okinawa Trough—a claim that Japan rejects.¹² In September 2003, the State Council approved Project 908, a comprehensive survey and assessment of all Chinese-claimed maritime space in the near seas. It took over 30,000 scientists and technicians more than eight years to complete.¹³

Chinese research vessels have operated beyond the First Island Chain since the 1970s. However, the current scale of activities is without precedent in Chinese history. A review of China’s oceanographic research activities in October 2017 illustrates the scale and geography of Beijing’s ambitions. According to publicly available data, eleven research vessels operated out-of-area in that month:¹⁴

- In early October, *Xiang Yang Hong* 18 conducted survey operations just north of Okinotorishima, a Japanese coral feature in the Philippine Sea.
- In early October, polar research ship *Snow Dragon* completed an 83-day Arctic cruise. It transited Japan's Tsugaru Strait on October 4th, arriving in Shanghai four days later.¹⁵
- The first day of October saw the *Dong Fang Hong* 2 steaming south of Japan's Kyushu Island, part of a lengthy cruise that would take it from the high seas of the North Pacific to Micronesia's EEZ.
- In first half of October, *Xiang Yang Hong* 10 operated in Micronesia's EEZ and the U.S. EEZ southwest of Guam.
- In mid-October, COMRA's *Dayang* 1 appeared west of Guam, remaining in the Philippine Sea for two weeks, arriving at its home port of Qingdao on November 1st.
- The Guangzhou Marine Geological Survey ship *Haiyang* 6 spent the first half of October operating in the high seas north of Micronesia, in waters where China maintains contract rights with the International Seabed Authority to explore for cobalt rich ferromanganese crusts.
- In the first half of October, and perhaps without precedent, a China Coast Guard cutter (1307) escorted *Xiang Yang Hong* 09—the mother ship of the deep-sea submersible *Jiaolong*—as it operated in an area west of the Marianas Islands. From October 14-16, the pair sailed to a position southwest of Guam, within the U.S. EEZ, presumably for diving operations in the Mariana Trench.
- In October, *Xiang Yang Hong* 03 and *Xiang Yang Hong* 06 conducted separate surveys of the Clarion-Clipperton Fracture Zone, an area southeast of Hawaii where China and several other states possess mineral contract rights under the auspices of the International Seabed Authority.
- In the second half of October, CAS research vessel *Kexue* operated in the Philippine Sea, including within the EEZs of Palau and Indonesia.
- *Xiang Yang Hong* 01 spent October operating in the South Atlantic, the third leg of its circumnavigation of the globe.¹⁶

Figure 2 shows a map of Chinese operations in the Western Pacific in October 2017.

The bulk of China's out-of-area research activities occur in the strategically important waters between the First and Second Island Chains of the Western Pacific (See **Figure 3**).¹⁷ Some take place in the large section of high seas in the Philippine Sea, where Chinese vessels can conduct marine scientific research without permission from any coastal state. Chinese ships also commonly operate in the huge EEZ of the Federated States of Micronesia and in the EEZ of the U.S. territory of Guam. The International Seabed Authority has granted China rights to explore for seabed minerals in four contract zones: two southeast of Hawaii, one east of Guam, and one southeast of Madagascar (see **Figure 4**). Much activity observed in distant-ocean areas involves journeys to, from, and within these contract zones. The *Snow Dragon* also regularly operates in the polar regions.¹⁸

Types of Research Activities

What do China's oceanographic research vessels do at sea? Many of these ships, especially those commissioned since 2012, are "comprehensive research vessels," meaning they can perform a wide range of research activities, and often do on any given cruise. They principally serve as platforms for instruments, sensors and other equipment used to collect oceanic and atmospheric data.

Some sensors are attached to the ship. Many vessels, for instance, have "science masts" in the bow for collecting meteorological data. All have acoustic and other sensors affixed to the hull; the newest ships, like the *Kexue*, are fitted with "gondolas"—retractable structures on the bottom of the ship that prevent bubbles from skewing measurements.¹⁹ Acoustic Doppler Current Profilers (ADCPs) direct sound waves into the water column; returning echoes provide information on the direction and speed of undersea currents. Multi-beam echo sounders use pulses of sound to obtain precise measurements of ocean depth. This data can then be used to determine the contours, or bathymetry, of the seabed. Ships engaged in bathymetric surveys operate in a characteristic "lawn-mower" pattern.

Some sensor are towed behind the ship. The CAS research vessel *Shiyan 1*, for instance, has a twin-hull (SWATH) design, ensuring better stability while towing its acoustic array. Several of these vessels can tow streamers used for seismic surveys. They direct sound waves into the seabed, with the strength and pattern of returning echoes used to determine the geologic composition of the subsoil, including potential oil and gas deposits.

Other equipment is lowered into the sea from stationary ships. The CTD rosette, for example, collects information on the temperature and salinity of the water column at various depths. Since these factors are associated with many undersea processes, they are key variables in much oceanographic research.

Chinese research vessels deploy surface and subsurface buoys, which are equipped with instruments that record environmental data, transmitting it back to China via satellite communications, or storing it for later recovery and analysis.²⁰ Chinese scientists have deployed indigenously-designed “White Dragon” surface buoys in the Philippine Sea and Indian Ocean. These units are capable of collecting and transmitting meteorological and oceanographic information in real-time.²¹ In 2017, Chinese researchers moored a subsurface buoy in the northwest section of Micronesia’s EEZ (in the Challenger Deep trough). This buoy—developed by a team of scientists from Northwest Polytechnic University, China Ocean University, the CAS Institute of Acoustics, and the First Institute of Oceanography—is equipped with hydrophones used to study deep-sea sound propagation.²²

China’s oceanographic research vessels also host various types of underwater vehicles. The *Xiang Yang Hong* 09, for example, deploys the *Jiaolong* deep-sea submersible, capable of taking Chinese scientists to some of the deepest locations in the ocean. Other vehicles are unmanned. These include remotely-operated vehicles (ROVs) such as the *Sea Horse* and autonomous underwater vehicles (AUVs) such as the *Qianlong* 1, 2, and 3, which are equipped with sensors and cameras to explore for seabed resources. China’s research vessels also now deploy underwater gliders such as the *Sea Wing*. Because of their endurance and economy, gliders make excellent platforms for measuring basic characteristics of the undersea environment, such as temperature and salinity. In August-September 2017, *Xiang Yang Hong* 03 launched two *Sea Wing* gliders in high seas areas southeast of Hawaii.²³ Chinese scientists have also deployed the *Sea Wing* in the Philippines EEZ, off the country’s east coast (see **Figure 5**).

China’s out-of-area research vessels serve as platforms for the research and development of new marine equipment and instruments. For example, engineers from a laboratory jointly founded by the Xi’an Institute of Optics and Precision Mechanics and the Qingdao National Laboratory for Marine Science and Technology conducted extensive testing of underwater optics technologies during a 2017 cruise to the Mariana Trench.²⁴ The CAS Shenyang Institute of Automation routinely sends engineers and scientists aboard research vessels heading to distant-ocean areas to test underwater vehicles. For example, the Institute embarked several personnel aboard the *Dayang* 1, which left

Qingdao on March 20, 2018, to test the Institute's new *Qianlong* 3 AUV in the South China Sea and Western Pacific.²⁵

Figure 6 shows the range of research activities conducted by China's distant-ocean research fleet.

Strategic Purposes

China's deployment of oceanographic research ships and related platforms in distant-ocean areas is part of a massive program to collect oceanic data. What is the ultimate purpose of this collection effort? Several interests drive the Chinese government's investment in out-of-area oceanographic research.²⁶ Two of the main drivers have the greatest significance for U.S. national security. These include a desire to 1) explore, and ultimately exploit, seabed resources in high seas areas and 2) support the development of China's blue-water naval capabilities. While not a major driver, Chinese oceanographers also serve political functions for the Chinese party-state: as ambassadors of good will, and tools with which to assert China's maritime rights and interests.

Seabed Resources

Interest in seabed resources is a big—perhaps the biggest—driver behind China's distant-ocean survey operations.²⁷ PRC leaders regard international seabed areas as a potential source of minerals to support China's future economic development. This logic was summarized by State Oceanic Administration Director Liu Cigui in remarks to China's representative to the International Seabed Authority in late 2013. Liu told Ambassador Dong Xiaojun, "China possesses a long coastline, vast maritime space, and rich marine resources. But per capita endowments are low. To ensure the sustainable development of our economy, we must continue to expand our maritime development space. We must focus on the 250 million km² of high seas. For the sake of future generations, we must vie for more marine resources and maritime rights."²⁸ As this passage suggests, Chinese discourse often regards seabed resource exploration and exploitation as a competition between states. Much of China's activities are driven by a desire to be the first country to commercially exploit international seabed resources, and lead the industry.²⁹

Marine science is closely entwined with the PRC's strategic objective of transforming China into a "maritime power" (海洋强国), which is largely an economic concept. This aim, first articulated in a 2003 planning document, was famously emphasized in Hu Jintao's 18th Party Congress Work Report (November 2012).³⁰ Hu outlined the four key components of China's maritime power strategy:

marine resources, the ocean economy, marine environmental protection, and maritime rights and interests.³¹

Chinese leader Xi Jinping has personally expressed his commitment to explore and exploit seabed resources in high seas areas. At a July 2013 Politburo meeting about China’s maritime power strategy, Xi declared that China must “thoroughly perform ocean and polar scientific survey work, perform deep-sea and distant-ocean survey research, expand international cooperation in marine science and technology, and make preliminary preparations for exploiting ocean and polar resources.”³² In a May 2016 speech at a national convention on scientific and technological innovation, Xi again singled out the importance of deep-sea resources: “The deep sea contains earthly treasures that aren’t remotely understood or developed. But if we want to obtain these treasures, then we must master key technologies for entering the deep sea, surveying the deep sea, and developing the deep sea.”³³

The PRC is engaged in a whole-of-government effort to pursue commercial exploitation of seabed resources in high seas areas.³⁴ China currently possesses contract rights under the auspices of the International Seabed Authority to explore for seabed resources in four separate zones.³⁵ Quasi-governmental agency COMRA represented China in the first three contracts. The most recent contract, signed in May 2017, was concluded by China Minmetals Corporation, a mining company.³⁶ In February 2016, China passed the PRC Law on Exploration and Development of Resources in Deep Sea Seabed Areas, aimed at laying the institutional foundation for the country’s move from seabed resource exploration to resource exploitation.³⁷

Table 3. Chinese Contracts to Explore for Seabed Resources in High Seas Areas

#	Contract Period	PRC Contract Party	Location of Contract Zone	Resource Type
1	2001-2016, 2016-2021 (renewed)	COMRA	Clarion Clipperton Fracture Zone	Polymetallic nodules
2	2011-2026	COMRA	Southwest Indian Ridge	Polymetallic sulphides
3	2014-2029	COMRA	Western Pacific Ocean	Cobalt-rich ferromanganese crusts
4	2017-2032	China Minmetals	Clarion Clipperton Fracture Zone	Polymetallic nodules

China's oceanographic research fleet serves on the front lines in this effort. Vessels conduct high-resolution bathymetric surveys of high seas areas with potential deposits of seabed minerals, using shipboard multi-beam echo sounders and new-generation UUVs for this purpose. In July 2018, for instance, *Xiang Yang Hong* 10 completed a 250-day cruise to the Indian Ocean, during which it surveyed part of COMRA's 10,000 km² contract zone in the Southwest Indian Ocean. The crew deployed the UAV *Qianlong* 2, which conducted nine dives for a total of 257 hours.³⁸ Data collected during these types of surveys inform Chinese decisions about where to apply for future contract rights, and which sections of existing contract zones merit additional focus. Aside from exploring for seabed resources, Chinese research vessels also perform biologic surveys of areas contract zones, as required under International Seabed Authority rules.

*Naval Strategy*³⁹

During the command of Admiral Wu Shengli (2006-2017), the People's Liberation Army Navy (PLAN) dramatically expanded the content and geographic scope of its operations. No longer fixated on preparing for and deterring war, the service came to embrace the diverse set of non-combat missions for which navies are uniquely suited.⁴⁰ Many of these operations took place in waters beyond the First Island Chain, in what Chinese strategists call the "far seas" (远海).⁴¹ In 2008, the PLAN sent its first task force to the Indian Ocean for anti-piracy operations off the Horn of Africa, a watershed moment which, less than ten years later, resulted in the opening of China's first overseas base (in Djibouti).⁴² Beijing has used the PLAN in other non-combat roles, such as assisting international efforts to dispose of Syria's chemical weapons (2014), searching for missing Malaysian airlines flight 370 in the Indian Ocean (2014), evacuating Chinese citizens from Yemen (2015), holding joint exercises with Russia and other countries, and making countless port visits throughout the Indo-Pacific.

The PLAN's interest in the far seas is not confined to non-combat operations. During Admiral Wu's tenure, it also started conducting deployments and training to prepare the service to fight in the far seas.⁴³ Many conflict scenarios in East Asia could lead to hostilities between China the United States. The U.S. Navy's long-range precision strike capabilities, amply demonstrated during the conflicts of the 1990s, have created a strong impetus for the PLAN to develop the ability to engage U.S. forces beyond the First Island Chain—well before they arrive in theater.⁴⁴ As a result, the ocean space between the First and Second Island Chains has assumed great importance for Chinese naval strategy.

The geographic expansion of Chinese naval operations has created intense demands to speed mastery of the “ocean battlespace environment” (海战场环境) in new ocean areas. Some of these demands are met by the PLAN itself. The Chinese Navy, like the U.S. Navy, possesses a corps of meteorologists and oceanographers that support the fleet. The PLAN operates a number of Type 636/636A distant-ocean survey ships, analogues of the U.S. Navy’s *Pathfinder* class hydrographic survey ships. These ships perform bathymetric surveys and collect oceanographic and meteorological data, which serve as inputs for the production of charts and the development and improvement of forecasting systems. Indeed, the PLAN’s distant-ocean survey fleet has more than tripled since 2015. **Table 4** lists key elements of this fleet. **Figure 7** shows PLAN distant-ocean survey ship *Haiyang 25*.

Table 4. The PLAN’s Distant-Ocean Survey Fleet⁴⁵

Hull Number	Name	Built
Haiyang 20.	<i>Zhu Kezhen</i>	2003
Haiyang 22	<i>Qian Sanqiang</i>	2008
Haiyang 23.	<i>Qian Xuesen</i>	2015
Haiyang 24.	<i>Deng Jiaxian</i>	2016
Haiyang 25.	<i>Qian Weizhang</i>	2016
Haiyang 26	<i>Chen Jingrun</i>	2016
Haiyang 27	<i>Wang Ganchang</i>	2017
Haiyang 28	<i>Zhu Guangya</i>	2017
Haiyang 29.	<i>Mao Yisheng</i>	2018

Oceanographers at civilian agencies and research institutes support the PLAN in a number of ways. They share information, such as bathymetric data needed in the creation of charts. When the PLAN began to routinize far seas operations, its knowledge of ocean areas beyond the First Island China was extremely limited.⁴⁶ To remedy this problem, the PLAN sought to leverage the data and expertise resident in the Ministry of Land and Resources (predecessor of the current MNR). In January 2009, the two signed the Agreement between the Ministry of Land and Resources and the People’s Liberation Army Navy on Strengthening Geologic Surveying and Marine Mapping.⁴⁷

Civilian oceanographers also support the PLAN through their efforts to model oceanic processes. Especially important are the dynamic elements of the ocean battlespace environment, such as surface and subsurface currents, tides, and surface and subsurface waves. These and related factors—such as ocean temperature, density, and salinity—directly affect all manner of naval operations, from basic

navigation to amphibious landings. Militaries that are more aware of current conditions and better able to predict future conditions have an advantage over their adversaries. In the words of one PLAN analyst, “the side with fuller, more accurate, and timelier mastery of the ocean battlespace environment will have the initiative on the battlefield.”⁴⁸ Civilian oceanographers develop models for understanding oceanic phenomena. These models can then be applied to the development of combat systems and tactics needed by the fleet.

The study of the dynamic ocean is especially important for undersea warfare. Temperature is a key factor affecting underwater sound propagation. The ability to know and predict the location of currents, eddies, and other oceanic phenomena confers an advantage to submarine commanders seeking to elude detection.⁴⁹ To maximize the performance of sonar and other systems used to detect foreign submarines, navies must develop accurate oceanographic models for all of the ocean areas where they intend to operate.

Chinese oceanographers are heavily funded to conduct research on the physical oceanography of the Philippine Sea. Their work helps the PLAN master the ocean battlespace environment in this strategically-vital ocean space. The Qingdao National Lab—in conjunction with the MNR and CAS—is leading an enormous project to build an integrated network of fixed and mobile sensors to monitor the undersea conditions in the Western Pacific, South China Sea, and the Indian Ocean. The evocatively-named “Transparent Ocean Project” is intended to achieve the ability to conduct large-scale, real-time ocean observation. Project scientists are developing models for understanding—and ultimately predicting—the dynamic undersea environment. Project funders and participants openly acknowledge the security objectives driving their scientific work.⁵⁰ Though the network is still being developed, existing infrastructure is already serving the oceanographic needs of the PLAN. Data collected from sea-based sensors is shared with the MNR’s National Marine Environment Forecasting Center, which in turn supplies oceanographic and meteorological products to the PLAN.⁵¹

Like the Qingdao National Lab, the MNR conducts research to support China’s naval development. The First Institute of Oceanography describes its mission as “promoting progress in marine science and technology to serve management of the marine environment and marine resources, *maritime national security*, and marine economic development” (emphasis added).⁵² When *Xiang Yang Hong* 01 was commissioned in 2016, authoritative sources stated that its various tasks would include “comprehensive observation in the field of military oceanography.”⁵³ The Third Institute of

Oceanography likewise performs “military oceanography” and “projects for national defense construction.”⁵⁴ Research conducted by MNR entities is likely coordinated and shared with the PLAN by means of mechanisms set up in 2009. In January of that year, the State Oceanic Administration signed a major cooperative agreement with the PLAN, including provisions for cooperation in marine science.⁵⁵ The relationship between the two deepened as a result of a second cooperative agreement signed in April 2017, intended to “further promote civil-military integrated development in the maritime realm, and support the construction of a world-class navy.”⁵⁶

Given the significant degree of civil-military integration in marine science, at least some Chinese distant-ocean cruises involve activities more akin to “military surveys.”⁵⁷ That is, embarked scientists are collecting data primarily intended to serve military aims, not “in order to increase scientific knowledge of the marine environment for the benefit of all mankind,” as marine scientific research is defined in the United Nations Convention on the Law of the Sea.⁵⁸ China’s close civil-military integration differs markedly from the U.S. approach of clearly distinguishing between military surveys—which are only conducted by U.S. Navy special mission ships—and marine scientific research, done by civilian academics aboard civilian-operated vessels.

Despite these known ties between the PLAN and civilian research institutes, civil-military integration in marine science is far from perfect. Synergy is the ideal, not necessarily the reality. Chinese experts in positions of authority candidly acknowledge shortcomings. For example, at the March 2018 legislative sessions in Beijing, State Oceanic Administration official Zhang Haiwen suggested a degree of disappointment with achievements to date: “In recent years, there has been lots of cooperation between the military and civilians, but in the marine field there are many more aspects of civil-military integration that can be further developed, such as information sharing and ocean monitoring, among others.”⁵⁹ Still, Chinese leaders recognize the problems and are taking steps to remedy them. The April 2017 cooperative agreement (discussed above) was a step in that direction.⁶⁰

Maritime Diplomacy

China’s distant-ocean survey activities serve political functions. Chinese leaders employ research platforms as tools of maritime diplomacy, both cooperative and competitive. Out-of-area marine scientific research helps protect the PRC’s maritime rights and interests. According to a 2017 article published under the byline of the State Oceanic Administration Party Committee, “China not only possesses sovereignty, sovereign rights, and jurisdiction over three million square kilometers of

claimed jurisdictional maritime space. It also has extensive and broad maritime rights and interests in the polar regions, deep-sea areas, and other ocean areas.”⁶¹ Chinese policymakers believe that maintaining a claim to these rights requires research activities to assert them. In March 2013, *Haiyang 6* departed Guangzhou for a cruise to the eastern Pacific, presumably the Clarion-Clipperton Fracture Zone, to conduct resource, environmental, and biological surveys. An article published in a State Oceanic Administration periodical declared that the overarching purpose of the mission was to “safeguard China’s mineral resource rights and interests in international seabed areas.”⁶² Guided by this mode of thinking, Chinese leaders could sanction, or perhaps even direct, the operations of oceanographic research vessels to challenge the excessive claims of other coastal states. The October 2017 operations of the *Xiang Yang Hong 18* near Japan’s Okinotorishima (cited above) may have in part been motivated by such political considerations.

China’s research fleet is also used as a tool of cooperative diplomacy. This function likely gained new impetus from the 21st Century Maritime Silk Road, Beijing’s ambitious initiative to bolster political and economic ties between China and countries rimming the Indian Ocean. In June 2017, China issued the Vision for Maritime Cooperation under the Belt and Road Initiative, which highlights cooperation in marine scientific research between China and countries along the 21st Century Maritime Silk Road.⁶³

When abroad, vessels must periodically stop in foreign ports to take on fuel and provisions, make repairs, and swap out crew members. At these times, the vessels often host foreigner visitors, especially foreign scientists and civilian administrators. For example, from 18-22 April 2016 the CAS South China Sea Institute of Oceanology vessel *Shiyan 1* docked in Colombo, Sri Lanka for replenishment after completing the first half of a cruise in the eastern part of the Indian Ocean. While in Colombo, faculty, students, and administrators from the University of Ruhuna were invited to tour the ship.⁶⁴

Sometimes Chinese research vessels are tasked to help other countries survey their own jurisdictional waters. For example, the Second Institute of Oceanography has signed a number of agreements with Indian Ocean countries to help them survey their continental shelves. In June 2016, scientists aboard *Xiang Yang Hong 10* conducted seismic and bathymetric surveys of the continental shelves of Mozambique and Seychelles. Lead scientist, Tang Yong, said that this cruise would enable China to “accumulate precious experience for engaging in international cooperation in the field of marine

surveys and lay a foundation for deepening China-Africa cooperation in the field of marine science and technology.”⁶⁵

Aside from providing intangible political benefits, cooperation in marine science ensures Chinese access to strategically-important ocean areas within other states’ EEZs.⁶⁶ The Qingdao National Lab, for instance, has conducted joint research with the Maldives Bureau of Meteorology on the physical oceanography of waters adjacent to the Maldives. They performed two cruises, one from October-November 2015 and the second in September 2017, during which they observed ocean temperature, salinity, and currents using shipboard instruments. They also jointly deployed at least one subsurface mooring.⁶⁷

Implications

China’s out-of-area oceanographic research activities raise a number of concerns for U.S. policymakers. The scale of Beijing’s investment in these operations now dwarfs that of any other country, including the United States. When it was set up in 2012, the National Fleet comprised just 19 vessels.⁶⁸ By the end of 2017, it had expanded to 50 ships, half classed as distant-ocean capable.⁶⁹ This number does not include the five large hulls owned by the China Geologic Survey. The fleet continues to expand. As of September 2017, ten other oceanographic research vessels were in various stages of design and construction.⁷⁰ The Chinese government is also funding development of a catalog of other research platforms, including manned submersibles, AUVs, and surface and subsurface moorings. China’s expanding investment contrasts markedly with declining government support for marine science in the U.S.⁷¹ America’s UNOLS fleet possesses only nine large ships, over half of which were commissioned more than twenty years ago.⁷²

Marine science is a key pillar of U.S. naval power. In their quest for truth, civilian oceanographers create knowledge that can be translated into new systems, platforms, and tactics used by the fleet. They are a source of ideas and insights that can help solve problems facing the military, both in wartime and peacetime.⁷³ They also educate the men and women who serve the military, as active duty meteorologists and oceanographers, U.S. Navy scientists, and researchers in private industry. America’s comparative neglect of marine science risks ceding the great discoveries of the future to a strategic competitor, and weakening the U.S. oceanographic community just when it is most needed.

China is also pursuing a far more robust degree of civil-military integration than currently exists in the U.S. Beijing has mobilized civilian scientists to directly serve military aims. The State Oceanic

Administration—now the Ministry of Natural Resources—is the biggest player in Chinese distant-ocean research. Since 2009, it has worked closely with the PLAN to help lay the foundation for the PLAN’s transformation into an oceanic navy. The Chinese Academy of Science and the Qingdao National Lab also conduct research on behalf of the PLAN. Beijing’s approach to civil-military integration in marine science makes it difficult for the U.S. to fully appreciate the naval significance of Chinese collection operations.⁷⁴

While the quantity of China’s distant-ocean research is unsurpassed, the quality of marine science in the PRC still trails that of the U.S. In a February 2018 interview, renowned acoustician Yang Desen from the Harbin Engineering University lamented China’s comparative lack of basic research, paucity of basic data, and shortfall of well-trained scientists.⁷⁵ PLAN scientist Da Lianglong expressed similar views in March 2018. China’s basic marine research remains derivative: Chinese scientists still tend to “follow and imitate others.” Truly innovative research is rare, and a gap remains between China and the world’s maritime powers.⁷⁶ However, given all that China has achieved in the last fifteen years, U.S. policymakers would be foolish to assume Beijing cannot overcome these challenges.

China’s distant-ocean survey activities may be a leading indicator of China’s evolving naval strategy. They portend a future in which PLAN warships and submarines routinely operate on all the world’s great oceans. This is true not just because Chinese research ships are laying the scientific foundation for naval operations in new areas. They are also preparing for future activities to exploit seabed resources, which the Chinese Navy will be asked to protect. Indeed, international maritime space constitutes one of the new frontiers in Chinese national security thinking. The 2015 *Science of Military Strategy*—an authoritative volume published by China’s National Defense University—highlights “military struggle in the deep sea.” The authors identify China’s “international sea bed resource extraction interests” as a key source of future insecurity.⁷⁷ The July 2015 revision to China’s National Security Law added new text about the need to “safeguard the security of our nation’s activities, assets, and other interests in...international seabed areas.”⁷⁸ China possesses seabed contract rights in strategically important locations: east of Guam and southeast of the Hawaiian Islands. If China moves to exploit resources in these areas, it could justify decisions to bolster Chinese naval presence.⁷⁹

China’s distant-ocean survey activities also serve political purposes. These functions are subsidiary to the economic and military drivers discussed above. Still, their efforts to forge closer ties with other

coastal states in the Indo-Pacific could create good will that Beijing can leverage in times and circumstances where U.S. and Chinese interests collide. These interactions also allow China to promote its views on the international maritime order, which differ markedly from those held in the U.S.

This report addresses basic questions about China's distant-ocean marine science. In doing so, it has raised many new ones. Future work should closely examine specific civilian research projects. What questions are Chinese scientists seeking to answer? Which oceanic phenomena are of greatest interest? What instrument and techniques are they using to answer these questions? Follow-on research should seek a far more detailed understanding of relationships between civilian research institutes and the PLAN. What funding arrangements exist between the Chinese military and the MNR, CAS, and the Qingdao National Lab? How are data and findings shared? How does the work of civilian scientists and engineers get translated to the production of hardware, systems, and tactics used by the PLAN? These questions, and many others, must be satisfactorily answered before we can fully grasp the risks and challenges presented by Beijing's growing interest in distant-ocean marine science.

APPENDIX

Figure 1. Key Members of China's Distant-Ocean Research Fleet



Kexue



Xiang Yang Hong 01



Dayang 1

Figure 2. Chinese Survey Operations in the Western Pacific (October 2017)⁸⁰

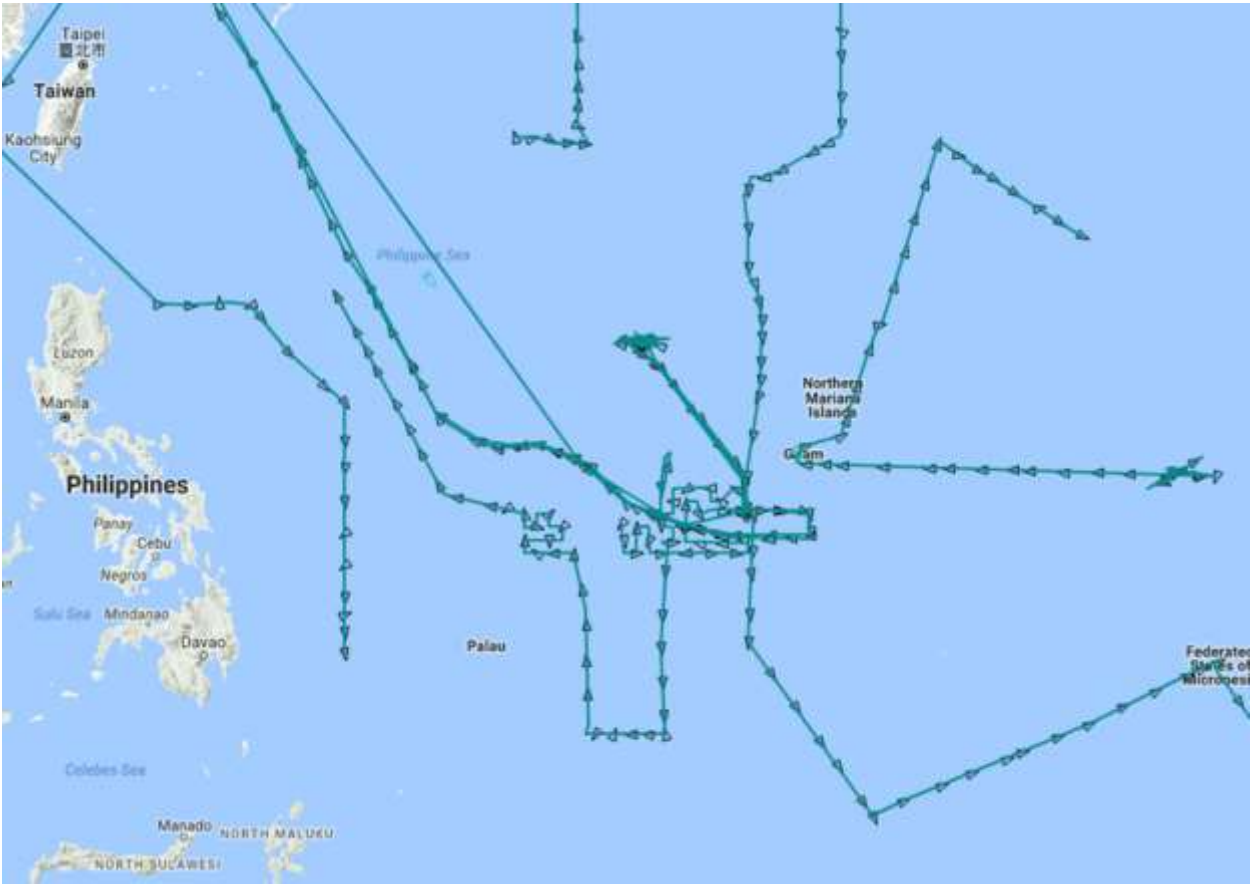


Figure 3. The “Island Chains”



Figure 4. The Location of China's Contract Zones with the International Seabed Authority

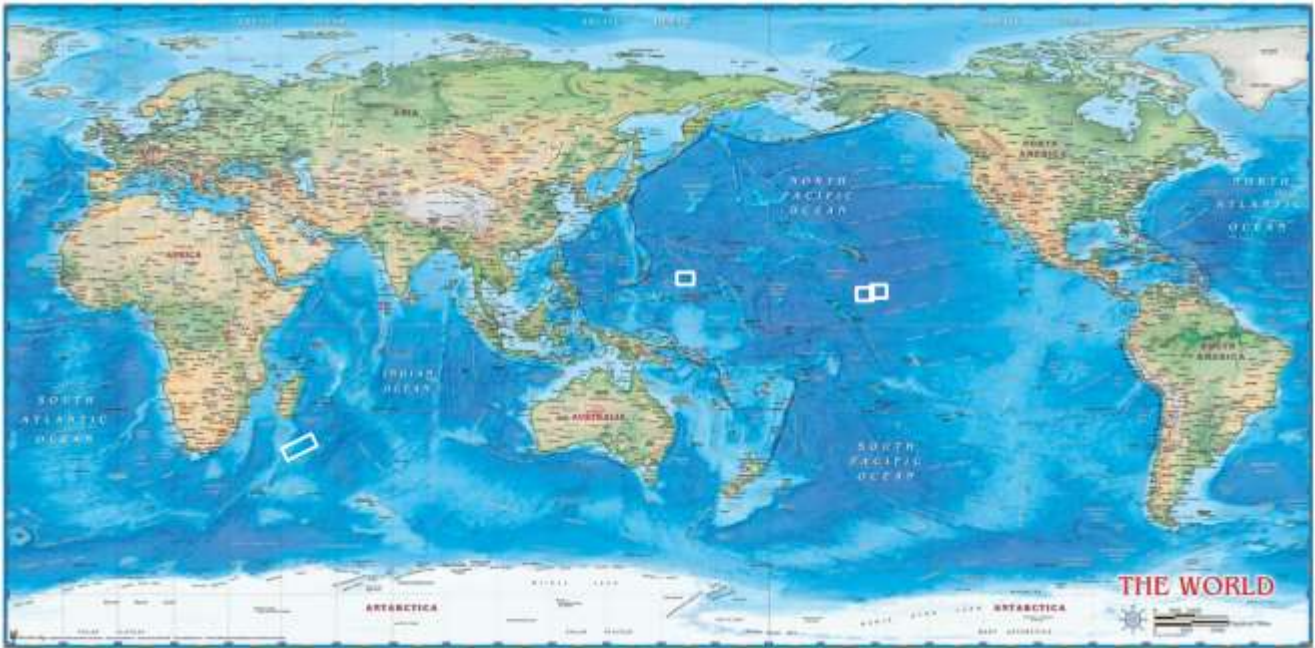


Figure 5. Company Brochure for the *Sea Wing* (showing operations in the Philippines EEZ)⁸¹

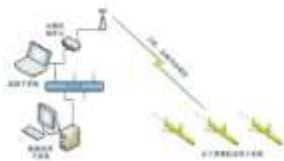
“海翼” 水下滑翔机



系统组成

水下滑翔机系统包括水下滑翔机本体和水面监控系统。水下滑翔机本体搭载各种测量传感器，执行海洋环境参数观测作业任务。水面监控系统由高性能便携式控制系统和水面控制单元组成，通过卫星和无线通信链路与水下滑翔机本体进行通信，实现对一台或多台水下潜航器的远程监控，具有信息显示、任务规划、编辑与下载等功能。

水下滑翔机本体采用模块化设计，分为首部模块、姿态调节模块、科学测量模块和尾部模块等。首部模块安装测深声纳和深度计；科学测量模块主要安装 CTD，可根据需求定制扩展其他测量传感器；姿态调节模块安装有俯仰调节装置、滚体控制单元等；尾部模块安装浮力调节装置、航向控制装置、应急处理单元、卫星通信定位模块、无线电通信模块，以及通信定位天线等。



产品介绍

水下滑翔机是一种将浮标、潜标技术与水下机器人技术相结合而研制出的一种无外挂推进装置，依靠自身浮力驱动的新型水下移动观测平台，其具有低噪声、低能耗、投放回收方便、制造成本和作业费用低、作业周期长、作业范围广等特点，已逐渐成为一种通用的水下观测手段。水下滑翔机主要功能包括海洋环境参数测量、自主滑翔运动控制、自主测量路径跟踪、测量数据存储、远距离信息传输与控制等。

中国科学院沈阳自动化研究所自 2003 年起开展水下滑翔机相关研究工作，从“十一五”到“十三五”连续三次获得科技部项目支持，先后研制出“海翼”水下滑翔机原理样机、“海翼”水下滑翔机海试样机、“海翼”水下滑翔机工程样机。

海上试验与应用情况

2014 年 10 月，“海翼”水下滑翔机首次在高海完成连续工作超过一个月，累计航程超过 1000 公里，共获得了 220 多个观测数据，创造了我国水下滑翔机海上工作时间最长和航程最远的纪录。从 2014 年至今，“海翼”水下滑翔机累计海上工作天数 436 天，累计航程 9100 多公里，海上观测路径遍布东海、南海和西北太平洋。

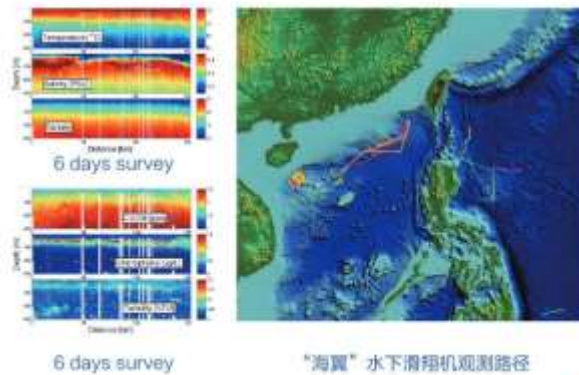


Figure 6. Activities of China's Distant-Ocean Research Fleet



Figure 7. PLAN Distant-Ocean Survey Ship *Haiyang 25*



NOTES

¹ The views expressed here are the authors' alone. They do not represent the estimates or policies of the U.S. Navy or any other organization of the U.S. government. The authors thank Jay Batongbacal, Bill Murray, Paul Schmitt, and Kathleen Walsh for their suggestions and insights. The authors accept sole responsibility for any errors or shortcomings.

² The legislation says that the Ministry of Natural Resources will retain the State Oceanic Administration "brand" (牌子), but it is unclear what that means in practice. 深化党和国家机构改革方案 [Plan for Deepening Reform of Party and State Structures] 新华 [Xinhua] March 21, 2018, www.gov.cn/zhengce/2018-03/21/content_5276191.htm#1

The MNR inherited the State Oceanic Administration's responsibility for "organizing and carrying out marine scientific surveys and investigations." For information on its other marine-related functions, see 自然资源部职能配置、内设机构和人员编制规定 [Regulations Regarding the Functional Configuration, Organization, and Staffing of the Ministry of Natural Resources] 自然资源部网站 [Website of the Ministry of Natural Resources] www.mnr.gov.cn/bbgk/sdfa/

³ For a useful discussion about the rationale for creating the National Fleet, see 朱建华, 李尉尉, 徐伟 [Zhu Jianhua, Li Weiwei, and Xu Wei] 建立国家海洋调查船队的思考 ["Thoughts on Establishing a National Marine Research Fleet"] 海洋开发与管理 [*Ocean Development and Management*] 2012, No. 9, pp. 6-9.

⁴ The Commission includes representatives from the National Development and Reform Commission, Ministry of Education, Ministry of Science and Technology, Ministry of Finance, and the Chinese Academy of Science. 国家海洋调查船队协调委员会 [Coordination Commission of the National Marine Research Fleet] 国家海洋调查船队 [Website of the National Marine Research Fleet] www.cmr.gov/home/plus/list.php?tid=13.

⁵ 陆琦 [Lu Qi] 国家海洋调查船队成立 ["The National Marine Research Fleet Has Been Founded"] 中国科学报 [*China Science Daily*] April 19, 2012, <http://news.sciencenet.cn/htmlnews/2012/4/262901.shtm>

⁶ 张建松, 岑志连 [Zhang Jiansong and Qin Zhilian] "实验3"号科考船上的"巴铁"科学家 ["'Pakistan Friend' Scientists Board the Scientific Research Vessel 'Shiyan 3'"] 新华 [Xinhua] January 21, 2018, http://sh.xinhuanet.com/2018-01/21/c_136911999.htm

⁷ The "high seas" comprise all waters outside of coastal state jurisdiction. See United Nations Convention on the Law of the Sea, Article 86.

⁸ Information in this table comes from 国家海洋调查船队 ["Profile of China's Marine Research Fleet"] 国家海洋调查船队 [Website of the China Marine Research Fleet], <http://www.cmr.gov/home/plus/list.php?tid=1>

⁹ The "First Island Chain" refers to the archipelago stretching from Japan to Indonesia via Taiwan, the Philippines, Malaysia, and Brunei. See 中国人民解放军军语 [*PLA Dictionary of Military Terms*] (Beijing: Academy of Military Science Press, September 2011), p. 952.

¹⁰ 韩永 [Han Yong] 科考: 从"海"到"岛" ["Scientific Investigation: Moving from the 'Seas' to the 'Oceans'"] 中国新闻周刊 [*China Newsweek*] November 26, 2012, pp. 32-35. From the late 1970s to the late 1990s, Chinese oceanographic research operations were guided by the mantra "thoroughly survey the China seas, make advances in the three oceans, and land on Antarctica" (查清中国海、进军三大洋、登上南极洲). This objective was declared at the State Oceanic Administration's December 1977 National Planning Meeting for Marine Science and Technology. 刘明 [Liu Ming] 党的十八大以来中国海洋科技发展政策 ["China's Marine Sci-Tech Development Policy Since the 18th Party Congress"] 中国海洋报 [*China Ocean News*] October 26, 2017, p. 2.

¹¹ John W. Garver, “China’s Push through the South China Sea: The Interaction of Bureaucratic and National Interests,” *The China Quarterly*, No. 132 (Dec., 1992), pp. 999-1028.

¹² 周超 [Zhou Chao] 用科研力量“主张”海洋权益--国家海洋局第二海洋研究所外大陆架划界工作 [“Use the Power of Scientific Research to ‘Claim’ Maritime Rights and Interests—On the Second Institute of Oceanography’s Work on the Extended Continental Shelf Boundary Delimitation”] 中国海洋报 [*China Ocean News*] February 26, 2016, p. 3. 中国东海部分海域二百海里以外大陆架划界案访谈 [“Discussion on China’s Project for Delimiting a Continental Shelf Extending Beyond 200 Nautical Miles in Some Parts of the East China Sea”] 中央政府网站 [Website of the Government of the PRC] August 16, 2013, http://www.gov.cn/gzdt/2013-08/16/content_2467982.htm

¹³ 朱彧 [Zhu Yu] “908 专项”实施具有里程碑意义——访国家海洋局党组成员、副局长陈连增 [“The Implementation of ‘Project 908’ was a Significant Milestone—An Interview with State Oceanic Administration Party Committee Member and Deputy Director, Chen Lianzeng”] 中国海洋报 [*China Ocean News*] October 29, 2012, p. 6.

¹⁴ The International Convention for the Safety of Life at Sea (SOLAS) requires all vessel larger than 300GT on international voyages to use the automatic identification system (AIS). When operating beyond the First Island Chain, PRC research vessels often transmit AIS. See Website of the International Maritime Organization, www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx

All AIS data cited in the report come from www.marinetraffic.com

¹⁵ “China’s Ice Breaker Returns after First Arctic Rim Circumnavigation,” *Global Times*, October 10, 2017, www.globaltimes.cn/content/1069635.shtml

¹⁶ “向阳红 01”科考船起航执行中国首次环球海洋综合科考 [“Research Vessel ‘Xiang Yang Hong 01’ Departs for China’s First Global Comprehensive Marine Survey”] 海洋世界 [*Ocean World*] 2017, No. 9, pp. 6-9.

¹⁷ According to the *PLA Dictionary of Military Terms*, the Second Island Chain extends from the Japanese home islands to Indonesia’s Halmahera and includes the Bonin Islands, Iwo/Volcano Islands, Mariana Islands, Yap Islands, and Palau Islands. See *PLA Dictionary of Military Terms*, pp. 952-953.

¹⁸ For a very rich analysis of China’s activities in the polar regions, see Anne-Marie Brady, *China as a Polar Great Power* (Cambridge: Cambridge University Press, 2017).

¹⁹ 王晶 [Wang Jing] “该船的探测能力世界一流” [“That Ship’s Survey Capabilities are World-Class”] 中国海洋报 [*China Ocean News*] October 19, 2012, p. 3.

²⁰ In February 2017, a team of scientists embarked on the *Kexue* completed China’s first “deep-sea, real-time scientific observation network” comprising 20 submerged buoys. Located in the Western Pacific, this network collects environmental information (temperature, salinity, and ocean current speed/direction) down to 3,000 meters, transmitting the data to China by satellite once every hour. Chinese scientists can access the data from apps on their cell phones. 张旭东 [Zhang Xudong] 我国首个深海实时科学观测网在西太平洋建成 [“China’s First Deep-Sea Real-Time Scientific Observation Network Is Set Up in the Western Pacific”] 新华 [Xinhua] February 7, 2018, www.xinhuanet.com/tech/2018-02/07/c_1122382482.htm

²¹ 高倩 [Gao Qian] 十年，引领深海综合观测系统技术创新——“白龙浮标”实现深海海洋气候实时观测 [“Ten Years, Leading Deep-Sea Comprehensive Observation System Technology Innovation—The ‘White Dragon Surface Buoy’ Achieves Real-Time, Deep-Sea Ocean Climate Observation”] 青岛海洋科学与技术试点国家实验室 [Website of the Qingdao National Laboratory of Marine Science and Technology] May 5, 2017, www.qnlm.ac/page?a=5&b=1&c=5&d=3&p=detail

²² 郑雅楠 [Zheng Ya’nan] 我科学家首次听到海洋最深处声音：在马里亚纳海沟布放万米全水深观测潜标 [“Chinese Scientists Hear Sounds from the Deepest Part of the Ocean for the First Time: They’ve Deployed a

10,000-Meter Whole-Depth Observation Buoy in the Mariana Trench”] 中国海洋报 [*China Ocean News*] December 28, 2017, p. 2.

²³ “海翼”水下滑翔机完成大洋第 45 航次观测任务 [“The ‘Sea Wing’ Glider Completes Observation Task as Part of the 45th Ocean Cruise”] 中国科学院网站 [Chinese Academy of Science Website] September 4, 2017, http://www.cas.cn/zkyzs/2017/09/117/yxdt/201709/t20170905_4613336.shtml

²⁴ The team tested an advanced underwater camera at depths of 7,000 and 10,000 meters. 张潇 [Zhang Xiao] 让西安成为“海上丝绸之路”的技术起点——西安“水下光学”硬科技全国领先 中科院西安光机所副所长李学龙 [“Let Xi’an Become the Technological Starting Point of the ‘Maritime Silk Road’—Xi’an’s ‘Underwater Optics Science and Technology Leads the Country, Says Deputy Director Li Xuelong”] 中国科学院西安光学精密机械研究所 [Website of the CAS Xi’an Institute of Optics and Precision Mechanics] February 13, 2018, http://opt.cas.cn/xwzx/tpxw/201802/t20180213_4951641.html

²⁵ 陈灏 [Chen Hao] “大洋一号”青岛起航 “潜龙”“海龙”将双双入海 [“‘Dayang 1’ Departs from Qingdao, ‘Qianlong’ and ‘Hailong’ Go Along] 新华 [Xinhua] March 20, 2018, www.xinhuanet.com/tech/2018-03/20/c_1122563001.htm

In late 2015, *Xiang Yang Hong 10* took the *Qianlong 1* and 2 on a research mission to the southwestern Indian Ocean. To “ensure the smooth completion of the tasking,” ten scientists from the CAS Shenyang Institute of Automation embarked with the ship. 沈阳自动化所两台大深度 AUV 将同时赴西南印度洋参加大洋第 40 航次科考任务 [Two Deep-Sea AUV’s Designed By Shenyang Institute of Automation Will Head to the Southwest Indian Ocean to Participate in the 40th Scientific Cruise”] 中国科学院沈阳自动化研究所网站 [Website of the CAS Shenyang Institute of Automation] November 5, 2015, www.sia.cas.cn/xxgk/szs/kxyj/kvjz/201511/t20151127_4474824.html

²⁶ It is important to distinguish between the motives animating individual scientists—which vary, and are deeply personal—and the motives of the state. This study only considers the latter.

²⁷ For early reporting on China’s decision to heavily invest in marine science, and the economic drivers behind this decision, see Jane Qiu, “China outlines deep-sea ambitions,” *Nature Online*, 6 July 2010, www.nature.com/news/2010/100706/full/466166a.html?s=news_rss

²⁸ This quote comes from an “internal publication” (内部刊物) now publicly available on the State Oceanic Administration website. See 康明乐 [Kang Mingle] 国家海洋局局长刘赐贵会见我驻牙买加大使董晓军 [“State Oceanic Administration Director Liu Cigui Meets with China’s Ambassador to Jamaica, Dong Xiaojun”] 国际海洋合作 [*International Marine Cooperation*] 2013, No. 5, P. 12, www.soa.gov.cn/bmzz/jgbmzz2/gjhzsgatbgs/201303/P020170118564524494372.pdf

²⁹ Chinese analysts and policymakers often describe the perceived competition for resources in international seabed areas as a “new ocean enclosure movement.” See, for example, 国家海洋局党组书记、局长刘赐贵在中国大洋协会成立二十周年庆祝大会上的讲话 [“Speech by State Oceanic Administration Party Secretary and Director Liu Cigui at Celebration Commemorating the 20th Anniversary of the Founding of COMRA”] 国家海洋局 [State Oceanic Administration Website] October 20, 2011, www.soa.gov.cn/xw/dfdwdt/jsdw_157/201211/t20121108_16409.html

³⁰ The State Council’s Outline for the National Marine Economy Development Plan (2003) called for China to “gradually build itself into a maritime power.” See 国海洋经济发展规划纲要 [Outline for the National Marine Economy Development Plan] 国家海洋局网站 [Website of the State Oceanic Administration] May 9, 2003, www.soa.gov.cn/zwgk/fwjgwywj/gwyfgwj/201211/t20121105_5261.html

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- ³¹ 胡锦涛在中国共产党第十八次全国代表大会上的报告 [Hu Jintao's Report at the 18th Congress of the Chinese Communist Party], 新华 [Xinhua] November 17, 2012, www.xinhuanet.com/18cpcnc/2012-11/17/c_113711665.htm
- ³² 习近平同志在中共中央政治局第八次集体学习时的讲话 (2013年7月30日) ["Xi Jinping's Speech at the CCP Politburo's 8th Collective Study Session (July 30, 2013)"] 《太平洋学报》 [Website of *Pacific Journal*] www.pacificjournal.com.cn/CN/news/news263.shtml
- ³³ 习近平 [Xi Jinping] 为建设世界科技强国而奋斗——在全国科技创新大会、两院院士大会、中国科协第九次全国代表大会上的讲话 (2016年5月30日) ["Struggle to Build China Into a World Sci-Tech Power"—Speech at the National Sci-Tech Innovation Meeting, Meeting of the Two Academies, and the 9th Congress of the China Association of Science and Technology (May 30, 2016)] 新华 [Xinhua] May 31, 2016, www.xinhuanet.com/politics/2016-05/31/c_1118965169.htm
- ³⁴ In April 2017, China issued the 13th Five Year Plan for Resource Exploration and Development in Deep-Sea Seabed Areas (《深海海底区域资源勘探与开发“十三五”规划》). This plan is not publicly available. See 王宏 [Wang Hong] 深海法助力我国建设海洋强国 ["Deep Sea Law Helps China Become a Maritime Great Power"], 法制日报 [Legal Daily] May 3, 2017, www.legaldaily.com.cn/government/content/2017-05/03/content_7131307.htm
- ³⁵ China has a Permanent Mission to the International Seabed Authority, which produces a periodical called *International Seabed Information*. Past issues of the periodical are available at 中华人民共和国常驻国际海底管理局代表处网站 [Website of the Permanent Mission of the PRC to the International Seabed Authority] <http://china-isa.jm.china-embassy.org/chn/dbcx/dbckw/gzhdxx/>
- ³⁶ "China Minmetals Corporation Signs Exploration Contract with the International Seabed Authority," Website of the International Seabed Authority, May 12, 2017, www.isa.org.jm/news/china-minmetals-corporation-signs-exploration-contract-international-seabed-authority
- ³⁷ 中华人民共和国深海海底区域资源勘探开发法 [PRC Law on Exploration and Development of Resources in Deep-Sea Seabed Areas] 新华 [Xinhua] February 26, 2016, www.xinhuanet.com/politics/2016-02/26/c_1118175002.htm
- ³⁸ 中国大洋49航次科考满载而归 ["China's 49th Ocean Research Cruise Returns with a Full Load"] 中华人民共和国中央人民政府 [Website of the Central Government of the PRC] August 13, 2018, www.gov.cn/xinwen/2018-08/13/content_5313507.htm
- ³⁹ The *PLA Dictionary of Military Terms* defines "naval strategy" (海军战略) as "the policies (方针) and approach (策略) for planning and guiding the overall construction and employment of the navy." See *PLA Dictionary of Military Terms*, p. 888.
- ⁴⁰ This theme was highlighted in the 2013 National Defense White Paper. Information Office of the State Council, *The Diversified Employment of China's Armed Forces*, April 2013. See also 吴胜利, 刘晓江 [Wu Shengli, Liu Xiaojiang] 建设一支与履行新世纪新阶段我军历史使命要求相适应的强大的人民海军——庆祝中国人民解放军海军成立60周年 ["Build a Powerful People's Navy That Is Compatible With the Requirements for the Military to Perform Historic Missions in the New Age and New Period"] 求是杂志 [Qiushi] No. 9, 2009, pp. 8-9. See also 吴胜利, 刘晓江 [Wu Shengli, Liu Xiaojiang] 牢记千钧重托 不负护航使命——写在人民海军执行远洋护航任务两周年之际 ["Keep Firmly in Mind the Heavy Responsibility and Do Not Fail the Escort Mission—Written on the Occasion of the Second Anniversary of the People's Navy's Conduct of Distant-Ocean Escort Tasks"] 求是杂志 [Qiushi] No. 24, 2010, p. 8. See also Andrew Erickson and Austin Strange, *No Substitute for Experience: Chinese Antipiracy Operations in the Gulf of Aden*, CMSI Red Book No. 10, November 2013, pp. 4-5.

⁴¹ State Council Information Office of the People's Republic of China, *China's Military Strategy*, May 2015, http://english.gov.cn/archive/white_paper/2015/05/27/content_281475115610833.htm

⁴² China's overseas support facility was formally opened in August 2017. See "China formally opens first overseas military base in Djibouti," *Reuters*, August 1, 2017, www.reuters.com/article/us-china-djibouti/china-formally-opens-first-overseas-military-base-in-djibouti-idUSKBN1AH3E3

⁴³ In 2007, the service routinized training operations in the Philippine Sea. Christopher H. Sharman, "China Moves Out: Stepping Stones Toward a New Maritime Strategy" *China Strategic Perspectives* No. 9, Center for the Study of Chinese Military Affairs, April 2015, pp. 13-17, <http://ndupress.ndu.edu/Portals/68/Documents/stratperspective/china/ChinaPerspectives-9.pdf>

⁴⁴ China's fear of American strikes from the seaward direction has roots going back to the First Gulf War and the Kosovo War. See 尚金锁, 吴子欣, and 陈立旭 [Shang Jinsuo, Wu Zixin, and Chen Lixu], 毛泽东军事思想与高技术条件下局部战争 [*The Military Thought of Mao Zedong and Local War under High-Tech Conditions*] (Beijing: PLA Press, 2002), pp. 248–49. This point is also mentioned in 师小芹 [Shi Xiaoqin], 论海权与中美关系 [*On Sea Power and Sino-U.S. Relations*] (Beijing: Military Science, 2012), p. 207.

⁴⁵ Information on recently-commissioned ships comes from the website of the Wuhu Shipyard Company: www.wuhu.com.cn

⁴⁶ Writing in late 2009, three PLAN experts from the Dalian Naval Academy and PLAN Headquarters Department of Navigational Assurance acknowledged, "We lack far-seas oceanographic bathymetry, seabed geology, and marine hydrological data in waters beyond the First and Second Island Chains. For long-distance navigation, warships primarily depend on collecting and using foreign-published charts." 李树军, 许春明, 王瑞 [Li Shujun, Xu Chunming, and Wang Rui] 海洋测绘履行海上多样化保障任务研究 ["Research on Ocean Mapping and Implementation of Maritime Diversification Support Tasks"] *军事运筹与系统工程* [*Military Operations Research and Systems Engineering*] March 2010, Vol. 24, No. 1, p. 15.

⁴⁷ In Chinese, the agreement is called 《国土资源部、中国人民解放军海军关于加强地质调查与海洋测绘合作的协议》). See 2009 年测绘工作大事记 ["Major Events in Surveying and Mapping in 2009"] 国家测绘地理信息局网站 [Website of the National Administration of Surveying, Mapping and Geoinformation] September 21, 2010, www.sbsm.gov.cn/zwgk/dsj/201009/t20100921_82464.shtml

This agreement and a second signed with the State Oceanic Administration (discussed below) were aimed at supporting the PLAN's expanding distant-ocean operations. 宋歆, 杨祖荣 [Song Xin and Yang Zurong] 党的十六大以来国防和军队建设成就述评 ["Commentary on the Achievements of National Defense and Military Construction Since the 16th Party Congress"] *解放军报* [*PLA Daily*] September 11, 2012, <http://cpc.people.com.cn/n/2012/0911/c83083-18974443.html>

⁴⁸ 赵峰 [Zhao Feng] 大力推进海战场环境保障体系建设 ["Energetically Advance Construction of Support System for the Ocean Battlespace Environment"] *人民海军* [*People's Navy*] July 23, 2018, p. 3.

⁴⁹ Tom Stefanick, *Strategic Antisubmarine Warfare and Naval Strategy* (Lexington: Institute for Defense & Disarmament Studies, 1987), pp. 228-235.

⁵⁰ At a December 2017 event organized by the Shandong Province Department of Science and Technology, a big stakeholder in the Transparent Ocean Project, Chinese officials repeatedly cited its importance for maritime defense. An official from the Shandong Province Department of Science and Technology, Xu Maobo (徐茂波), favorably compared the "Transparent Ocean" Project with DARPA's "Ocean of Things Program." See 省政府新闻办举行新闻发布会, 介绍"透明海洋"科技创新工程有关情况 ["The Provincial Government's Press Office Holds a Press Conference to Introduce the 'Transparent Ocean' Sci-Tech Innovation Project"] 山东省人民政府 [Website of the Shandong People's Government] December 25, 2017, www.shandong.gov.cn/art/2017/12/25/art_6883_230236.html

For more on the military implications of the Transparent Ocean Project, see Ryan Martinson and Peter Dutton, "Chinese Scientists Want to Conduct Research in U.S. Waters—Should Washington Let Them?" *The National*

Interest, November 4, 2018, <https://nationalinterest.org/feature/chinese-scientists-want-conduct-research-us-waters%E2%80%9494should-washington-let-them-34997>

⁵¹ Since 2015, the State Oceanic Administration’s National Marine Environment Forecasting Center—which is charged with “collecting, processing, and distributing real-time marine observation data”—has maintained a close working relationship with the PLAN’s Marine Hydrology and Meteorology Center. The two have achieved real-time sharing of marine observation data. Parts of the network are already operational, with some nodes capable of transmitting oceanographic data in real-time. See 国家海洋环境预报中心 [“Description of the National Marine Environment Forecasting Center”] 国家海洋局网站 [State Oceanic Administration Website] Accessed on March 19, 2018, www.soa.gov.cn/zwgk/bjgk/jsdw/gjhyhjybz/. See also 第一届军民融合海洋环境预报保障研讨会在京召开 [“The First Conference on Civil-Military Integration for Marine Environment Forecast Support Opens in Beijing”] 国家海洋局网站 [State Oceanic Administration Website] April 17, 2017,

www.soa.gov.cn/xw/dfdwdt/jsdw_157/201704/t20170417_55594.html 王嘉宁, 王凡, 张林林 [Wang Jianing, Wang Fan, and Zhang Linlin] 西太平洋深海科学观测网的建设和运行 [“Construction and Operation of Deep-Sea Scientific Observation Network in the Western Pacific”], *海洋与潮沼* [*Oceanologia Et Limnologia Sinica*], Vol. 48, No. 6, November 2017, pp. 1471-1479.

⁵² When it was established in 1958, the First Institute of Oceanography was called the “Fourth Ocean Research Institute of the Navy.” See 国家海洋局第一海洋研究所 [Website of the First Institute of Oceanography] www.fio.org.cn/about/yi-suo-jian-jie.htm

⁵³ 远洋探测的科考旗舰 [“Scientific Research Flagship for Distant-Ocean Monitoring”] *中国海洋报* [*China Ocean News*], October 13, 2016, p. 6.

⁵⁴ See 国家海洋局 [Website of the State Oceanic Administration] www.soa.gov.cn/zwgk/bjgk/jsdw/gjhyjdshyjis/

⁵⁵ The agreement between the PLAN and the State Oceanic Administration was called “Agreement on Strengthening Cooperation in a Number of Areas” 《关于进一步加强若干领域合作的协议》. 宋歆, 杨祖荣 [Song Xin and Yang Zurong] 党的十六大以来国防和军队建设成就述评 [“Commentary on the Achievements of National Defense and Military Construction Since the 16th Party Congress”] *解放军报* [*PLA Daily*] September 11, 2012, <http://cpc.people.com.cn/n/2012/0911/c83083-18974443.html>

⁵⁶ 王凌硕 [Wang Lingshuo] 海军与国家海洋局签署战略合作框架协议 [“The Navy and the State Oceanic Administration Sign a Strategic Cooperation Framework Agreement”] *解放军报* [*PLA Daily*] April 22, 2017, p. 3. www.81.cn/jfjbmap/content/2017-04/22/content_175452.htm

⁵⁷ The *Commander’s Handbook on the Law of Naval Operations* defines a military survey as “the collecting of marine data for military purposes and, whether classified or not, is generally not made publicly available. A military survey may include collection of oceanographic, hydrographic, marine geological, geophysical, chemical, biological, acoustic, and related data.” See *The Commander’s Handbook on the Law of Naval Operations*, August 2017, pp. 2-11, www.jag.navy.mil/distrib/instructions/CDRs_HB_on_Law_of_Naval_Operations_AUG17.pdf

⁵⁸ United Nations Convention on the Law of the Sea, Article 246.

⁵⁹ 牛晨斐, 毛志文, 康哲 [Niu Chenfei, Mao Zhiwen, and Tang Zhe] 别不信！从首艘国产航母到共享单车，都与这件事有关 [“Believe it! Everything from China’s First Indigenously-Built Aircraft Carrier to Bicycle Sharing All Have to Do with Civil-Military Integration”] *中国军网* [*China Military Online*] www.81.cn/jwsj/2018-03/08/content_7964600.htm Two researchers from the PLAN’s Naval Institute of Hydrographic Surveying and Charting also make this point in a late-2016 analysis. They write, “Marine environmental data has a very clear dual-use character. Due to differences in direction, objective, and uses, at present the marine environmental systems of military and civilian groups are constructed differently, have their own technical systems, and are independent of each other. In recent years military and civilians groups have conducted joint surveys and obtained large amounts of marine data, built relevant marine databases for basic science and special purposes, and constructed mechanisms for exchanging data. However, deep integration and applying civilian capabilities to the military, and information sharing mechanisms have not been perfected, and [the military] lacks the ability to obtain long-term, continuous, real-time information.” See 申家双, 周德玖 [Shen Jiashuang and Zhou Dejiu] 海战场环境特征分析及其建设策

略 [“Analysis of the Characteristics of the Maritime Battlefield Environment and Strategies for Its Construction”] 海洋测绘 [*Hydrographic Surveying and Charting*] Vol. 36, No. 6, November 2016, p. 34.

⁶⁰ Chinese reports on annual meetings between senior State Oceanic Administration and PLAN leaders suggest dissatisfaction with the progress in information sharing. For instance, at the February 2012 annual work meeting Admiral Ding Yiping also called for “researching a mechanism for normalizing information exchange and sharing,” suggesting that information sharing remained unsystematic. See 万诗鹏 [Wan Shipeng] 全面合作 体系合作 深度融合--丁一平出席海军与国家海洋局合作协议签署三周年座谈会并讲话 [“Full Cooperation, Systematic Cooperation, Deep Integration—Ding Yiping Attends and Speaks at Event Marking the Third Anniversary of the Signing of a Cooperative Agreement Between the Navy and the State Oceanic Administration”] 人民海军 [*People's Navy*] February 7, 2012, p. 1.

⁶¹ 中共国家海洋局党组 [Party Committee of the State Oceanic Administration] 实现中华民族海洋强国梦的科学指南——深入学习习近平总书记关于海洋强国战略的重要论述 [“The Scientific Compass for Realizing the Ocean Dream of the Chinese Nation—Deeply Study the Important Discourse of CCP General Secretary Xi Jinping on Maritime Power Strategy”] 求是 [*Qiu Shi*] August 31, 2017, www.qstheory.cn/dukan/qs/2017-08/31/c_1121561793.htm

⁶² 高悦 [Gao Rui] “海洋六号”船起航执行大洋第 29 航次科考任务 [“*Haiyang 6* Departs for China's 29th Ocean Research Cruise”] 中国海洋报 [*China Ocean News*] May 29, 2013, p. 1.

⁶³ Vision for Maritime Cooperation under the Belt and Road Initiative, *Xinhua*, June 20, 2017, www.xinhuanet.com/english/2017-06/20/c_136380414.htm

⁶⁴ The CAS Institute of Oceanology has conducted annual cruises to the eastern Indian Ocean since 2010. Sri Lanka is a common stop. See 斯里兰卡海洋科技人员登临实验 1 船参观和交流 [“Marine Science and Technology Personnel from Sri Lanka Board *Shiyan 1* for a Tour and Exchange”] 中国科学院南海海洋研究所 [Website of the CAS South China Sea Institute of Oceanology] April 25, 2016, www.scso.ac.cn/xwzx/snyw/201604/t20160425_4590821.html

⁶⁵ 方正飞 [Fang Zhengfei] “向阳红 10”船启航执行国际联合航次任务，为研究莫桑比克和塞舌尔的大陆边缘构造演化提供技术支持 [“*Xiang Yang Hong 10*’ Departs to Carry Out an International Joint Cruise, Providing Scientific and Technological Support for Research on the Tectonic Evolution of the Mozambique and Seychelles Continental Margin”] 中国海洋报 [*China Ocean News*] June 2, 2016, p. 1.

⁶⁶ The United Nations Convention on the Law of the Sea gives coastal states the right to participate in all marine scientific research in their EEZs. See United Nations Convention on the Law of the Sea, Article 249.

⁶⁷ 马尔代夫周边海域海洋动力环境联合调查圆满完成——为“海上丝绸之路”建设保驾护航 [“Joint Survey of the Marine Dynamic Environment in Waters Adjacent to the Maldives Satisfactorily Concludes—Providing Escort for Construction of the ‘Maritime Silk Road’”] 青岛海洋国家实验室 [Website of the Qingdao National Laboratory] www.qnlm.ac/ronum/page?a=0&b=4&c=43&p=detail

⁶⁸ Lu Qi, “The National Marine Research Fleet Has Been Founded”

⁶⁹ See “Profile of China’s Marine Research Fleet”

⁷⁰ 刘雪、张建松 [Liu Xue and Zhang Jiansong] 我国科考船新建在建数量均居世界首位 [“China is the Country Currently Building the Most Research Vessels in the World”] 新华 [*Xinhua*] October 21, 2017, www.xinhuanet.com/tech/2017-10/21/c_1121836064.htm

⁷¹ Eli Kintisch, “A Sea Change for U.S. Oceanography,” *Science*, March 8, 2013, Vol. 339, Issue 6124, pp. 1138-1143, <http://science.sciencemag.org/content/339/6124/1138.full?rss=1>

⁷² In the U.S., much out-of-area oceanographic research is conducted aboard vessels owned by the U.S. Navy and the National Science Foundation, but operated by civilian research institutions under UNOLS. Woods Hole Oceanographic Institution operates the 3,200-ton R/V *Atlantis* (delivered in 1998) and 3,000-ton R/V *Neil Armstrong* (2015), both of which are owned by the U.S. Navy. Scripps Institution of Oceanography operates the R/V *Roger Revelle* (1996, sister ship of the *Atlantis*) and R/V *Sally Ride* (2016, sister ship to the *Neil Armstrong*), both owned by the U.S. Navy. The U.S. Navy also owns the R/V *Thomas G. Thompson* (1990), sister ship of the *Atlantis*, and the 2,500-ton SWATH vessel R/V *Kilo Moana* (2003). They are operated by the University of Washington and the University of Hawaii, respectively. The National Science Foundation owns the R/V *Marcus Langseth* (2004, operated by Columbia University). NOAA's R/V *Ronald H. Brown* (1996), sister ship of the *Atlantis*, and the US Coast Guard's *Polar Star* (1976) also operate under the aegis of UNOLS. These nine vessels represent the U.S. equivalent of China's distant-ocean research fleet. A list of UNOLS vessels is available here: www.unols.org/ships-facilities/unols-vessels/historical-list-all-unols-vessels

⁷³ For an excellent account of the contributions made by civilian oceanographers during World War II, see Susan Schlee, *A History of Oceanography: The Edge of an Unfamiliar World* (London: Robert Hale & Company, p. 1973), pp. 281-316. During the Cold War, U.S. oceanographers helped established the theoretical foundation for the U.S. Navy's construction of the Sound Surveillance System (SOSUS), which exploited the attributes of deep-sea sound channels to track Soviet submarines. See Christopher Ford and David Rosenberg, *The Admirals' Advantage: U.S. Navy Operational Intelligence in World War II and the Cold War* (Annapolis: Naval Institute Press, 2005), pp. 36-38.

⁷⁴ China's approach to civil-military integration in marine science likely has both advantages and disadvantages. Chinese scientists are well funded, but this funding comes with strings attached. The classified nature of some of their work isolates them from the broader scientific community, and allows for the intrusion of political factors.

⁷⁵ 刘园园, 操秀英, 刘垠 [Liu Yuanyuan, Cao Xiuying, and Liu Yin] 科技界谈《关于全面加强基础科学研究的若干意见》 [“Scientists Talk about the ‘Opinions on Fully Strengthening Basic Scientific Research’”] 科技日报 [Science Daily Online], February 2, 2018 <http://news.sciencenet.cn/htmlnews/2018/2/402005.shtml>

⁷⁶ 吴秀霞 [Wu Xiuxia] 海军潜艇学院笪良龙委员: 要抢占海洋基础理论研究要地 [“Navy Submarine Academy Professor Da Lianglong: We Must Seize the Strategic Higher Ground with Respect to Basic Marine Theoretical Research”] 澎湃新闻 [Pengpai News] March 13, 2018, www.thepaper.cn/newsDetail_forward_2027371

⁷⁷ 肖天亮 [Xiao Tianliang, ed.], *战略学 [Science of Military Strategy]* (Beijing: National Defense Univ. Press, 2015), p. 155.

⁷⁸ 中华人民共和国国家安全法 [People's Republic of China National Security Law] 中华人民共和国国防部 [PRC Ministry of National Defense] http://news.mod.gov.cn/headlines/2015-07/01/content_4592594.htm In the section outlining “Tasks for Safeguarding National Security” (section 2), the law says that the military is tasked with “safeguarding the security of Chinese activities, assets, and other interests in outer space, international seabed areas, and the polar regions.”

⁷⁹ China is already establishing a precedent for doing so. On May 26, 2017, the PLAN frigate *Yangzhou* was ordered to steam 1,100 nautical miles to protect *Xiang Yang Hong* 10 from possible pirate attack while it surveyed waters near the Gulf of Aden. Six PLAN special operators were flown onto the ship, where they remained for 19 days. 张云智, 林健 [Zhang Yunzhi, Lin Jian] 第二十六批护航编队为我海洋科考船护航 [“The Navy's 26th Escort Task Force Escorts a Chinese Marine Research Vessel”] 人民海军 [People's Navy] June 20, 2017, p. 1.

⁸⁰ Image courtesy of www.marinetraffic.com

⁸¹ Ryan Martinson obtained a copy of this brochure at the December 2017 Marine Economy Forum in Zhanjiang, Guangdong.