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Chinese Mine Warfare

A PLA Navy 'Assassin's Mace' Capability

After a lengthy hiatus—lasting nearly six centuries—China is reemerging as a maritime power, this time with an emphasis on undersea warfare. Between 1996 and 2006, the Chinese navy took delivery of more than thirty submarines.[1] These vessels include two new classes of nuclear submarines—the advanced Song-class diesel submarines and the Yuan class of diesel boats—which, according to some reports, was a surprise for U.S. intelligence.[2] Above and beyond this ambitious naval construction program, the People's Republic of China (PRC) received during 2005–06 an additional eight formidable Kilo-class submarines (and associated weaponry), which were purchased in 2002, to add to the four it already operated. A new nuclear submarine base on Hainan Island may well herald a new era of more extended Chinese submarine operations.

Much discussion among East Asian security analysts now centers on Beijing's potential development and deployment of aircraft carriers. However, at least in the near term, this discussion amounts to a red herring. For the foreseeable future, China does not seek to "rule the waves" writ large but rather is seeking the much narrower and more realizable objective of dominating the East Asian littoral. While photos of a first Chinese carrier will no doubt cause a stir, the Chinese navy has in recent times focused much attention upon a decidedly more mundane and nonphotogenic arena of naval warfare: sea mines. This focus has, in combination with other asymmetric forms of naval warfare, had a significant impact on the balance of power in East Asia.

People's Liberation Army Navy (PLAN) strategists contend that sea mines are "easy to lay and difficult to sweep; their concealment potential is strong; their destructive power is high; and the threat value is long-lasting."[3] Key objectives for a Chinese offensive mine strategy would be "blockading enemy bases, harbors and sea lanes; destroying enemy sea transport capabilities; attacking or restricting warship mobility; and crippling and exhausting enemy combat strength."[4] For future littoral warfare, it is said that "sea mines constitute the main threat [主要威胁] to every navy, and especially for carrier battle groups and submarines."[5] Moreover, this emphasis corresponds to the PLAN evaluation that "relative to other combat mission areas, [the U.S. Navy's] mine warfare capabilities are extremely weak."[6] Chinese naval strategists note that of eighteen warships lost or seriously damaged since World War II, fourteen were struck by sea mines.[7] As the PLA's newspaper has stated, "When military experts cast their gaze on the vast sea battle area . . . submarines attacking in concealment with torpedoes and the ingenious deployment of mines are still the main battle equipment of a modern navy."[8] The prominent role of "minelaying" in contemporary Chinese military doctrine is highlighted by the fact that this term was used no less than three times in China's 2008 defense white paper.[9] While many countries are vigorously studying mine countermeasures, few are so brazenly pursuing offensive mine warfare.[10] Thus, for example, the 2006 edition of *Science of Campaigns (Zhanyi Xue),* an operationally and tactically focused Chinese doctrinal textbook, declares, "[We must] make full use of [units] . . . that can force their way into enemy ports and shipping lines to carry out minelaying on a grand scale."[11]

In tandem with submarine capabilities, therefore, it now seems that China is engaged in a significant effort to upgrade its mine warfare prowess. Submarines are large and difficult to hide, and various intelligence agencies of other powers are no doubt attuned to the scope and dimensions of these important developments. By contrast, mine warfare (MIW) capabilities are easily hidden and thus constitute a true "assassin's mace" (杀手锏 or 撒手锏)[12]—in the American metaphor, a "silver bullet" for the PLAN, a term some Chinese sources, including the PLAN itself,[13] apply explicitly to MIW.[14] Relying heavily on sea mines, the PLAN is already fully capable of blockading Taiwan and other crucial sea lines of communication in the western Pacific area. As Thomas Christensen writes, "The proximity of Taiwan to the mainland . . . Taiwan's massive trade dependence . . . the inherent difficulty in clearing mines, and the extreme weakness of American mine-clearing capacity, particularly in [the Pacific] theater . . . all make blockade a tempting . . . strategy for . . . China."[15] Indeed, sea mines, used to complement a variety of other capabilities, constitute a deadly serious challenge to U.S. naval power in East Asia. In demonstrating the above conclusions, this study directly challenges the findings of another recently published research article, which argues that PRC mine warfare capabilities have been exaggerated and would not prove decisive in a Taiwan scenario.[16] That study's conclusions may have been reasonable at some time in the past, but they are now quite obsolete and risk obscuring a major threat to U.S. naval forces operating in the Asia-Pacific region.

This paper will proceed in ten steps. First, there is a discussion of the Persian Gulf War as a catalytic moment for contemporary Chinese MIW. A second section develops this context further with an account of the little-known history of Chinese MIW. The next two sections consist of detailed descriptions of the PLAN mine inventory and the various means of delivery. A fifth section addresses the human factor in Chinese MIW development, outlining recent training and exercise patterns. The following section offers a provisional outline of the PLAN's evolving MIW doctrine. The seventh section brings prospective mine countermeasures (MCM) programs into the strategic equation, and the eighth discusses specific scenarios of concern, especially the Taiwan blockade scenario, aiming for a comprehensive net assessment of the MIW component in the future Asia-Pacific maritime security environment. The discussion of scenarios is followed by an evaluation of an alternative viewpoint concerning Chinese MIW potential. In the tenth, concluding, section, implications are discussed for U.S. defense and foreign policy.

A Catalytic Historical Moment for Chinese Mine Warfare

China effectively has no modern naval history. With the exception of the large Qing fleet that suffered utter defeat during the Sino-Japanese War in 1895, PRC military theorists are stymied by a paucity of domestic experience and firsthand knowledge concerning naval warfare. Most obviously, Chinese forces were conspicuously absent from the massive fleet engagements that swept across the Pacific and into China's littoral waters during the Second World War. No wonder defense analysts habitually describe China as a "continental power."

Since 1978, however, consistent with China's *kaifang* (开放) "open" orientation, PRC specialists have been assimilating foreign experiences in a systematic effort to develop naval analyses for planners. MIW campaigns figure prominently in these studies. According to a PRC textbook of mine warfare, 810,000 sea mines were laid during World War II, sinking approximately 2,700 ships.[17] Moreover, PLAN strategists keenly appreciate that in the same conflict Germany alone lost twenty-seven U-boats to Allied MIW.[18] Also of great interest to Chinese naval strategists is the 1945 U.S. mine campaign against Japan.[19] Noting the distinct contribution of this strategy to Japan's unconditional surrender, they observe that 12,053 mines were employed, causing the destruction of 670 Japanese ships.[20] Chinese naval analysts have also examined the Falklands War, positing that Argentina's failure to use sea mines to counter the Royal Navy constituted a major lost opportunity.[21]

Among the many military campaigns analyzed by PRC strategists, the Persian Gulf War (1990–91) was singularly important, however, in shocking the People's Liberation Army (PLA) out of a Deng Xiaoping–era malaise characterized by declining defense budgets, low technology, and poor readiness. According to David Shambaugh, "In the PLA's seventy-year history, only the Korean War produced such a thoroughgoing reassessment."[22] Describing the impact as a "jarring effect on the PLA," Shambaugh explains: "[PLA] planners had never imagined the application of the numerous new high technologies developed by the United States. . . . Nearly every aspect of the campaign reminded the PLA high command of its deficiencies."[23] There is a noteworthy caveat that has been overlooked in such analyses but has major implications for Chinese naval development, Chinese analysts having, not surprisingly, scrutinized all naval aspects of the 1990–91 conflict carefully.[24] That is, PRC writings concerning MIW almost universally cite the damage mines caused to two U.S. Navy warships during that war.[25]

PRC specialist Fu Jinzhu, noteworthy for his prolific writings on all aspects of MIW and MCM, published a detailed and comprehensive analysis of mine warfare in the Persian Gulf War in the March 1992 issue of the China Shipbuilding Industry Corporation (CSIC) journal 现代舰船 *(Modern Ships)*.[26] Fu concludes that MIW played an unexpectedly large role, demonstrating conclusively that mines are one of the most effective methods with which weak countries can defend against strong countries, though Fu is careful to state that strong countries can also employ mines effectively.[27] Fu contends that the successful MIW attacks against USS *Tripoli* and USS *Princeton* illustrate the "relatively feeble" character of U.S. MCM. He argues that this is particularly true given the apparent failures of Iraqi MIW, which Fu lists as inadequate planning and preparation, inability to lay a sufficient quantity of mines (Iraq laid "only" 1,100 mines), and inappropriate reliance on moored mines, as well as failure either to conceal MIW operations adequately or to conduct long-range MIW operations. While recognizing the distinctive role of civilian vessels in Iraqi MIW, Fu concludes that coalition air superiority hindered Iraqi MIW decisively by preventing air delivery of mines and by inflicting heavy losses on Iraqi MIW assets. In addition, Fu asserts that this historical episode fundamentally demonstrates the "extremely difficult nature of MCM" (反水雷艰巨性).

Similar themes are echoed in another lengthy examination of Gulf War naval operations.[28] This analysis emphasizes the irony that whereas the Persian Gulf War is universally considered a "high-tech war," a traditional weapon like the sea mine played a significant role. This commentary notes the impressive cost-effectiveness of MIW, describing it as "cheap price, beautiful substance" (价廉物美). It also argues that sea mines are particularly appropriate weapons for China, not only in a defensive sense, because of its long and complex coastline, but also in an offensive sense, affording opportunities to blockade enemy ports and break sea lines of communication.[29] Like Fu Jinzhu, this analyst emphasizes that Iraq's experience can be improved upon, because "sea mines should incorporate high technology" as well. Among the methods and technologies that must be prioritized are counter-MCM equipment, "intelligized" (智能化) mines, rapid laying of mines, and "high-volume carriers for mines" (多载体布雷手段). Like the piece mentioned previously, this second study does not appraise coalition MCM highly: "Despite deploying 13 vessels from four nations, this force proved insufficient, was plagued by wide discrepancies in the capabilities of each vessel, and made only slow headway [against Iraq's mines]."

A 2004 article written by Fu Jinzhu in the Chinese Society of Naval Architecture and Marine Engineering periodical 舰船知识 *(Naval and Merchant Ships)* hints at the extent to which the preceding and other related analyses have become conventional wisdom among PLAN strategists. It begins, "Everybody knows that during the 1991 Gulf War, Iraqi mines played an important role, mauling [a number of] U.S. Navy warships."[30] This piece analyzes MIW and MCM in the 2003 Iraq War and questions why the coalition MCM campaign was seemingly more effective then than in 1991. Noting that Iraqi mines caused no coalition casualties, Fu calls the 2003 MCM effort a qualified success. However, he notes that despite the introduction of various new systems (for example, the AN/AQS-24 mine-hunting sonar), coalition MCM still suffered numerous problems. He observes that in the first thirty-six hours of the MCM operation just six mines were discovered (out of approximately ninety that had been laid) and that the most modern MCM systems are still hindered by sea-floor clutter (i.e., false targets).[31] Returning to a theme of post–Gulf War analyses, Fu emphasizes Iraqi MIW failures that resulted from absolute coalition control of the relevant air and sea zones. Fu underscores the promise of MIW but notes the inherent difficulties of MCM, quoting the U.S. Navy officer in charge of MCM operations in Operation IRAQI FREEDOM as saying: "Even in the most optimal sea and combat operations environment, hunting and sweeping mines is slow, causing frustration and danger."[32]

In the long history of mine warfare, the 1991 Persian Gulf War appears to have made a distinct mark on PLAN development. Western defense analysts have demonstrated clearly that the Gulf War was a turning point in overall PLA development, spurring great activity by its revelation of the apparent weaknesses of the Chinese armed forces compared to the capabilities of U.S. forces. However, Chinese assessments of Gulf War MIW and MCM operations draw attention to a critical vulnerability in U.S. capabilities and operations. That is, as one Chinese analyst writes in 2004 in China's official Navy newspaper 人民海军 *(People's Navy)* on the possible role of MIW in a U.S.-China conflict,

> The U.S. will need to move supplies by sea. But China is not Iraq. China has advanced sea mines. . . . This is a fatal threat to U.S. seaborne transport. . . . [T]he moment conflict erupted in the Taiwan Strait, the PLA Navy could deploy mines. U.S. ships that want to conduct ASW [antisubmarine warfare] [would] have to first sweep the area clear. When the U.S. fought in the Gulf War, it took over half a year to sweep all Iraq's sea mines. Therefore, it [would] not be easy for the U.S. military to sweep all the mines that the PLA [might] lay.[33]

In addition to these detailed assessments of foreign mine-warfare experiences, moreover, China will be able to draw on some experience of its own.

Historical Development of Chinese Mine Warfare

Although the Persian Gulf War and other analyses of major MIW campaigns may give additional impetus to Chinese MIW, it would be wrong to discount China's rather extensive, if largely unknown, history in that realm. China's sea-mine development encapsulates the vicissitudes of its overall naval development—from ancient glory to subsequent failure to current resurgence.[34]

It is noteworthy that China claims in fact to have invented naval mines,[35] developing and producing them in the Ming dynasty (mid-1500s)[36] and deploying them widely thereafter.[37] As early as 1363, the Ming were said to have used a split-hulled minelaying ship in battle against the Han.[38] In 1558, Tang Xun published *Weapons Compilation,* which recorded in detail bottom-mine designs and methods of laying them to attack the pirates who operated in Chinese littoral waters from the fourteenth century to the sixteenth.[39] During the Qing dynasty, the Tianjin Sea Mine Academy was created,[40] as part of an ultimately unsuccessful attempt to restore China's naval prowess and thereby defend its territorial integrity.

Centuries later, during the Sino-Japanese War, the Red Army cooperated with the Kuomintang (that is, Nationalist) navy to lay mines against Japanese shipping on the Yangtze River.[41] Following the PRC's establishment in 1949, "navy officers discovered the unique battle operations characteristics of sea-mine weapons: the duration of threat is long, attack [is] conceal[ed], [and happens] unexpectedly."[42] The PLA used fishing boats to clear Shantou Harbor of mines in 1949.[43] In April 1950, the PLA had to establish a minesweeping regiment to clear sea mines that the Kuomintang had laid in the Yangtze. Under the guidance of Soviet experts, four landing warships refitted as minesweepers successfully completed the mission in October of that year.[44]

Western and Chinese strategists are equally familiar with the allied minesweeping operation at Wonsan.[45] Chinese sources show ample awareness of North Korea's success in laying three thousand mines and thereby temporarily denying the U.S. Navy access to local littoral waters.[46] Allied forces succeeded in sweeping or destroying only 225 of these mines, and at heavy cost. Four U.S. minesweepers and one fleet tugboat were lost, and five destroyers were severely damaged. Mines also sank the South Korean minesweeper *YMS-516* and damaged several other South Korean ships.[47] Rear Admiral Allan Smith, U.S. Navy, who led the advance force at Wonsan, summarized this episode: "We have lost control of the seas to a nation without a Navy, using pre–World War I weapons, laid by vessels that were utilized at the time of the birth of Christ."[48]

The PLA engaged in its first MIW operations during the Korean War—a fact largely overlooked in Western accounts. In February 1953, Beijing's Naval Command Headquarters ordered a small contingent to create mine barriers to prevent American amphibious infiltration of communist territory. On 6 April a force of five ships reached the Qingquan [*sic*] River's mouth and attempted to lay mines according to Soviet doctrine (though a variety of environmental factors forced adaptation and tactical innovation).[49] After this modest beginning, communist combat operations in the Korean War gave

Chinese MIW early impetus. The PLAN introduced Soviet sea mines and simultaneously resolved to begin to manufacture copies of them.

National policy formulated during the Korean War dictated the purchase of various types of foreign minesweepers after the conclusion of that conflict. A 1951 policy, which would have lasting influence on PLAN development, called for China to "obtain from the Soviet Union the technology transfer rights to manufacture naval vessels," to "transition from copy production [of vessels] to semi-indigenous production," and finally, to proceed "step-by-step from semi-indigenous production [of vessels] to complete [indigenous] production."[50] Accordingly, the PRC obtained and refitted World War II minesweepers and acquired from the Soviet Union several minesweepers built in 1948. Augmenting this initiative, China simultaneously pressed fishing vessels into service to sweep mines and started construction of its first dedicated minesweeper. As a result of a 1953 Sino-Soviet accord,[51] Moscow transferred the plans and kits of Models 6605 and 6610 base minesweepers, which were subsequently assembled and constructed by the Wuchang Shipbuilding Factory. These ships would begin serial production in the 1960s.[52]

In the mid-1950s, as directed by the 1956–67 Defense Science and Technology Development Plan,[53] China began to develop a naval mine infrastructure. Beijing established a Special Sea Mine Committee (水雷专业委员会), which directed these efforts, and a Water Weapons Research Institution (水中武器研究机构), responsible for relevant data collection and analysis.[54] In 1958, Sha'anxi Province's Fenxi Machine Factory began indigenous production of China's first mines, types M 1–3, which were copies of Soviet models.

In 1956, the PRC began design work on its first indigenous minesweeper, Model 057K, at the First Product Design Office of the Shipbuilding Industry Management Bureau of the First Ministry of Machine Building Industry.[55] This first-generation harbor minesweeper was built under the supervision of CSIC's 708 Research Institute, primarily at shipyards at Qiuxin, Zhonghua, and Jiangxin.[56] In 1962, after extended sea trials, the first vessel was delivered to the PLAN. China would later deploy this ship to Vietnam, along with a ship of Model 058, the design work of which began in 1967. Accepted by the PLAN in 1972, this vessel was constructed of low-magnetic-signature steel and incorporated degaussing equipment (which reduces magnetic signature).[57] Roughly fifty Type 312 drone minesweepers were developed in the 1970s[58]—based on East German "Troikas"—for riverine missions; some of these too would serve in Vietnam.[59]

Sea-mine development continued throughout the Cultural Revolution (1966–76), spared perhaps by its relatively close alignment with Mao's doctrine of People's War. Efforts to create a remote "Third Line" defense infrastructure capable of surviving Soviet nuclear attack devastated China's military manufacturing and imposed tremendous inefficiencies, some of which persist to this day.[60] A number of modular, highly simplified, shallow-water mines, such as the C-4 and C-5 bottom mines, were developed.[61] Mines from this era were typically plagued by long development times; many later required upgrades to their fuses and general reliability. It is unclear what, if any, role these shallow-water mines play in China's order of battle today.

On 9 May 1972, the U.S. Navy mined North Vietnam's Haiphong Harbor. China responded immediately to a request from Hanoi for assistance, formally condemning the blockade on 12 May.[62] Chinese discussions of the unusual deployment into a war zone that followed note that Chinese MCM at that time lacked experience; moreover, they candidly concede, the Cultural Revolution was taking a major toll on the capabilities that did exist.[63] Later that month a PLAN mine investigation team (中国水雷调查工作队) arrived in Haiphong and began to analyze captured U.S. mines. Between that July and August 1973, the PLAN sent twelve minesweepers, four support vessels, and 318 men to Vietnam.[64] Sustaining severe injuries and at least one death, China's minesweepers sailed 27,700 nautical miles and cleared forty-six American mines, using acoustic triggering, divers, and other methods.[65] These mine-clearing efforts, at the close of the Vietnam War, familiarized the PLAN with U.S. MIW techniques and hardware. Lessons that the Chinese took from America's mine warfare against North Vietnam included the tactic of laying aerial mines at night to increase surprise and the psychological warfare gambit of "laying many mines and saying little or conversely laying few mines and saying a lot" (布多说少, 布少说多).[66] China subsequently used its MCM experience to help the Khmer Rouge in Cambodia during 1974–75.[67]

In the 1970s, the PLAN solidified its capacity to produce basic, Soviet-type equipment. This was an era of recovery; PLAN development capabilities were to advance significantly during the 1980s. Many previously envisioned assets would undergo successful development and production; assets produced earlier would be improved by the incorporation of new technology. China's first indigenously developed sea mine, the moored M-4 mine, entered active service in 1974; improved variants emerged in 1982 and 1985. The C-3, China's first indigenous mine with sweeping resistance, entered active service in 1974. Following fuse improvements, a C-3B variant was produced in 1986. In 1975 the design of the C-2 deepwater bottom mine, China's first sea mine to use transistor technology, was finalized. Subsequent variants would improve fuse sensitivity. A new MCM vessel, the Model 082 harbor minesweeper, was called for in 1976. Construction began in 1984, and in 1987 the ship entered active service.[68]

Deng Xiaoping's rise to power in 1978 heralded defense budget cuts to foster economic development but also a "reform and opening up" (改革开放) policy that encouraged the PLAN to seek foreign technology and ideas comprehensively, for the first time in decades. As part of a "strategic transition" (战略转变) by the mid-1980s from the partially obsolete People's War doctrine to a focus on fighting limited, local wars under high-technology conditions, and of a more general shift from a continental focus to maritime territorial defense, the PLAN made the development of dedicated minelaying assets a priority. Following previous Soviet efforts, China began development of a dedicated minelaying vessel. In 1988, after a lengthy design and testing process initiated in 1981, a Type 918 minelayer, hull number 814, joined the fleet.[69] Hull 814 reportedly boasts a multidirectional hoist for non-pier loading, a mechanized mine-transport system, and advanced fire-control radar, and it can carry three hundred sea mines. It is slow and relatively easy to detect and thus seems to lack an operational purpose; it likely serves as a technological test bed. Perhaps this is why only one Type 918 has been constructed to date.[70]

Photo 1. Wochi-Class Mine Countermeasures Ship. Jane's Fighting Ships *lists six of these, which are apparently built at two shipyards, and mentions that they are similar to, but five meters longer than, the older T-43 Soviet-designed minesweepers that China built previously.*

It would be a mistake to dismiss PLAN minesweeper development, however. Qiuxin Shipyard is reported to have launched a "new class" of six-hundred-ton minesweepers on 20 April 2004.[71] A daily newspaper published by the political department of the PLA's Guangzhou Military Region reports that in 2005 the PLAN made "achievements of development of training and operational methods for new equipment represented by new-type minesweepers."[72] Since 2005 the PLAN has taken delivery of two new, indigenously built types of MCM vessels: six of the Wochi class, and an as-yet singleton Wozang class.[73] Of particular interest, China Central Television's military channel, CCTV-7, broadcast in early 2007 a feature on a Chinese MCM exercise, showing footage of the Wozang deploying a tethered, remotely operated vehicle (ROV) for underwater mine hunting, an apparent first for the PLAN.[74] According to one mine warfare expert, this ROV may not have sonar, but it seems able to deploy mine-neutralization charges and likely has a cutter that can sever mooring lines for mines—rather like the U.S. Navy's Mine Neutralization System. Judging by appearance, however, it does not seem to have been derived directly from Western MCM systems.[75] An East Sea Fleet minesweeper squadron[76] conducted similar ROV-assisted MCM in 2008.[77] Deploying mine-hunting unmanned underwater vehicles (UUVs) on a wide scale would indicate a major new step for China's MCM capabilities, which heretofore have been considered relatively unsophisticated.

Photo 2. East Sea Fleet Minesweeper Squadron Commander Zhang Jianming with Mine-Hunting Remotely Operated Vehicle. *This remotely operated, tethered mine-hunting vehicle, superficially similar to the Italian PLUTO system, has a cutting device in front of the "bubble" that can sever mine mooring cables, has a camera inside the "bubble," and can also probably deploy explosive charges to neutralize bottom mines from the black metal racks on its underside.*

A more direct legacy of the Deng-era modernization was a PLAN effort to accelerate undersea warfare technology development. This effort actively sought assistance from abroad, including, notably, torpedo technology from the United States. In the domain of MCM, China is said to have acquired advanced sweeping technologies from Israel.[78]

Significantly, China began to develop rocket mines in 1981, producing its first in 1989.[79] In the post-Tiananmen era, this focus has been bolstered by large increases in military spending and by an increasingly powerful economy and robust national science and technology infrastructure. Contrary to conventional wisdom, as represented in the

United States by a major 2002 treatise on twenty-first-century naval warfare development published by the National Defense University,[80] rocket mines, with their evolving variants, have been part of the PLAN's arsenal for two decades.

China's Sea-Mine Inventory

China's current mine inventory includes a wide array of lethal weaponry. Published, unclassified inventory estimates range from fifty thousand to a hundred thousand individual weapons.[81] It is worth noting, however, that mines stocks are easily hidden; therefore, these estimates must be treated with considerable caution.

Order of Battle

A recent PRC article claims that China has over fifty thousand mines, consisting of "over 30 varieties of contact, magnetic, acoustic, water pressure and mixed reaction sea mines, remote control sea mines, rocket-rising and mobile mines."[82] See table 1 for a reported list of current PRC sea mines. These range from the more primitive moored mines to sophisticated bottom and rocket-propelled mines.

Moored Mines. The classic sea mine, which has been available to militaries since World War I, remains a potent weapon, as the damage to the warships USS *Tripoli* and *Samuel B. Roberts* in 1991 and 1988, respectively, demonstrates.[83] A moored mine floats beneath the surface of the ocean, tethered to the bottom by an anchor. It typically detonates upon direct physical contact with a ship or through relatively primitive influence mechanisms. Moored mines, such as China's EM 31 and EM 32 models, are limited by the length of their mooring cables or chains to waters shallower than two hundred meters.[84] These mines' cables and simple detonation criteria make them relatively easy to sweep with even unsophisticated minesweepers—once their presence is known.[85]

Drifting Mines. Also known as "free-floating" mines, these have been developed and produced in large numbers by the PLAN. China's military has reportedly manufactured—despite international legal concerns—at least three types of drifting mines, as one of its large-volume categories of traditional mines. The current status of production, inventory, and deployment is unclear, however.

Drifting mines are envisioned as being used primarily to attack surface ships. Developed by CSIC's 710 Research Institute in Yichang, Hubei Province,[86] and produced by Dalian Crane Factory, the Piao-1 automatic, stabilized, deep-floating mine has large and small models. It is used to attack medium and small surface ships, and it can be laid by military vessels or ordinary civilian ships. The Piao-1 was reportedly put into active service in 1974. Its laying depth is two to twenty-five meters, its operational life is two years, and its blast radius is ten meters. Piao-1 reportedly is easily concealed, its production cost

Model	Fuse	Type	Laying Platform	Case Depth (Meters)	Mission/ Target
C-1 500 **1000** 沉	Audiofrequency, magnetic induction	Bottom	Surface ships, aircraft Surface ships, submarine torpedoes	6–30 6–60	Attack surface ships & submarines
C-2 500 **1000**	Magnetic induction, infrasonic (<20Hz)	Bottom	Surface ships, submarines	6–50 6–100	Attack large & medium ships in littoral sea
C-3 500 **1000**	Audiofrequency magnetic induction	Bottom	Surface ships, submarines, aircraft	6–50 6–100	Attack large & medium surface ships, submarines
C-4	Magnetic induction, infrasonic (<20Hz), pressure	Bottom	Naval ships, civilian craft, hand	5–15	Attack medium & small ships, "People's War at sea"
C-5	Ultrasonic, pressure	Bottom		5–15	Attack medium & small ships

Table 1. PRC Sea Mine Order of Battle.

Sources: Data for this table derived from Lin Changsheng, "Hidden Dragon in the Deep," pp. 22–33; Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," pp. 152–61; *Jane's Underwater Warfare Systems,* available at www.janes.com; and Mason, "Naval Mine Technologies."

Dimensions/ Warhead	Life (Years)	Dates	Variants	Technology	Institutes
495 kg; 300 kg charge; 533 MM diameter 1080 kg; 700 kg charge; 533 MM diameter	4	Active service 1965		Copied Soviet noncontact deep bottom acoustic induction mine	710 Research Institute; Xia'an East Wind Instrument & Meter Plant; Fenxi Machine Factory
533 MM diameter	2	Development began 1965; sea trials 1966; design plan finalized 1975	Numerous improvements to solve silt burying reducing sensitivity, etc.	China's 1st sea mine to use transistor technology	Designed, 710 Research Institute, Vanguard Instrument & Meter Plant; produced, Fenxi Machine Factory
533 MM diameter	2	11/1974 active service	1982 fuse improvements; 12/1986 C-3B with 200 M maximum laying depth	China's 1st indigenously developed sea mine with sweeping & natural interference resistance	Designed, 710 Research Institute; produced, Shanghai Vanguard Instrument & Meter Plant
Small, light modular design	4	1976 design plan finalized		Strong sweeping-resistance capacity	Designed, 710 Research Institute; manufactured, East Wind Instrument & Meter Plant
Small, modular, short cylindrical lower section, hemispherical upper section: 210 kg	4	1973 development succeeded; 1975 active service		National Technology Achievement Prize in 1978 for assisting Khmer Rouge seizure of power in Cambodia, 1974–75	Designed, 710 Institute; manufactured, East Wind Instrument & Meter Plant

Model	**Fuse**	**Type**	**Laying Platform**	**Case Depth (Meters)**	**Mission/ Target**
C-6	Magnetic induction, pressure, infrasonic (<20Hz) audiofrequency			10–300	
EM-52	Ultrasonic (>20kHz) magnetic induction Three fuses: on duty, combat action (acoustic), explode (water pressure)	Rocket propelled straight rising	Surface ships	2–200	ASW/ antisurface warfare (ASUW)
EM-53	Acoustic/magnetic, magnetic influence	Bottom influence, remote control		6–60	Defend mine battle arrays, blockade bays, straits, & channels
EM-54					Selects target, e.g., aircraft carrier of proper tonnage
EM-55	Active, acoustic, passive				
EM-56	Acoustic, seismic, pressure	Mobile	Submarine possible shore-based launch	45 max 13 km start-off capability, floating launch option	ASUW
EM-57 **500** **1000**	Acoustic, magnetic	Bottom influence, remote control Advanced range 730 km	Air, surface ships	6–100	ASW/ASUW
MAFOS-1		Automatic search and identify type			
M-1 锚	Contact	Large moored	Surface ships, submarines	12–263	Large surface vessels
M-2	Contact	Medium moored	Surface ships, submarines	15–110	Blockade channels & harbors
M-3	Contact	Large moored	Surface ships, submarines	12–430	Attack submarines

Dimensions/ Warhead	Life (Years)	Dates	Variants	Technology	Institutes
				Copied Italian MR-80 Series	
Short, thick torpedo shape, length 3.7 M, diameter 0.45 M, 629 kg, 140 kg charge	1	Development initiated 1981, rigorous tests & prototype revision completed 1987, succeeded 1989	Improvements to increase laying depth (goal 500 M), charge ongoing since 1994	5 seconds to surface at maximum planned depth of 200 M, 80% strike probability against ships in range, marketed by China	Developed under 710 Institute management
		Development initiated 1978; military received prototype in 1986		Three function states: deactivated, combat, detonate for maximum tactical flexibility	
					Developed by China Ship Research Office
			More advanced version of EM-52	Marketed by China	
380 kg				Marketed by China	
300 kg charge 700 kg charge			500 kg 1000 kg	Marketed by China	
	1	Active service 1962; discontinued	M-1B, added noncontact fuse	Copied Soviet	Fenxi Machine Factory
	1	Active service 1964; discontinued	Added noncontact fuse	Copied Soviet	Fenxi Machine Factory
	1	Active service 1965; discontinued	Added noncontact fuse	Copied Soviet	Fenxi Machine Factory

Model	Fuse	Type	Laying Platform	Case Depth (Meters)	Mission/ Target
M-4	Acoustic, ultrasonic (>20kHz)	Moored	Surface ships, submarines	200	Blockade deepwater seas, attack medium-sized ships & submarines
M-5	Contact, timing, audiofrequency	Rising		200	
Piao-1/2 漂	Contact	Drifting, medium size automatic stable depth	Hand, small boat, fishing boat	2–8+	Attack medium & small ships
Piao-3	Acoustic, contact	Drifting	Submarines, surface ship	2–7 oscillates (+/- 1m)	ASUW
PMK-1	Influence, timing, audiofrequency	(Rocket?) Propelled Torpedo	Surface ship, submarines	200–400 (1000 M anchor depth)	ASW/ASUW
PMK-2	Passive, active, acoustic	(Rocket?) Propelled warhead encapsulated torpedo	Air, submarines, surface ship	400 M (Anchor depth 100–1000M) close-tether capable	ASW
T5	Acoustic, magnetic induction, pressure	Self-navigating			
Te 2-1 特	Remote control “safe/combat/ detonate” functions	Remote control		6–65	
Type 500 500型		Deep training mine	Aircraft, esp. PLAN Aviation		Practice minelaying over sea
Xun-1 训1	Can select among C-1, -2, and -3 fuses	Bottom training mine	Submarines		Practice sub-launched minelaying

Dimensions/ Warhead	Life (Years)	Dates	Variants	Technology	Institutes
600 kg	2	Design finalized 11/1973; active service 1974	M-4A 1982, increase buoyancy & fuse stability; M-4B 11/1985, fuse circuit integration improvements	China's 1st indigenously developed mine; 1st noncontact deepwater ultrasonic mine	Designed, 710 Research Institute; manufactured Fenxi Machine Factory
Elongated projectile, low volume, 125–150 kg	2		China's original Piao-1 lacked the capacity to distinguish between enemy and friendly platforms, was difficult to use, and may have been discontinued		Designed, 710 Research Institute; produced, Dalian Crane Factory
130 kg	Limited maximum in-water life				
350 kg				Russian made	
110 kg TNT equivalent				Russian made, based on MPT-1M thermal torpedo	
		Development initiated 1978		Assistance from Shanghai Jiaotong University & Naval Engineering Academy	Shanghai Vanguard Instrument & Meter Plant, Shanghai Electric Equipment Automation Research Institute, Navy Test Base
		Design plan finalized 12/1987	Retrievable		710 Institute, Fenxi Machine Factory, Naval Aviation Division
		Development succeeded 11/1982	Floats to surface after exercise		710 Research Institute, Fenxi Machine Factory

is low, it possesses the capacity to resist sweeping, and it can drift at a predetermined depth.

The Piao-2 small, automatic, stabilized, deep-floating mine was also designed by the 710 Research Institute and produced by the Dalian Crane Factory. Piao-2's exterior is a lengthened projectile, its volume is relatively small, its net weight is 125–50 kilograms, it floats at a fixed water depth, and it is primarily used to attack medium and small surface ships. Piao-2 can break down into sections in order to facilitate laying by hand, by such simple platforms as small boats and fishing boats. Piao-2 was originally designed for littoral warfare and blockading sea-lanes. There are also indications that China has

Photo 3. Piao Drifting Mine. *The PLAN has produced large numbers of free-floating mines, although the current status of production, inventory, and deployment is unclear.*

developed a third-generation drifting mine, the Piao-3, that oscillates at a depth of between two and seven meters.[87] Such drifting mines might be particularly useful for denying surface vessels access to waters east of Taiwan, particularly those too deep for rising mines.

According to some Chinese sources, the PLA has already halted development of drifting mines, because they are difficult to control.[88] But a 2007 Chinese textbook on mine warfare contains an extensive discussion of drifting mines.[89] Also, an image of what appears to be a modern sea mine, labeled as a "drifting mine," recently appeared on CCTV-7.[90]

China's actual actions and calculus concerning the development of drifting mines remain ambiguous, however. The editor of the Shanghai Institute of International Studies journal 国际展望 *(World Outlook)* notes that "drifting mines . . . can be used to attack both navigating ships and anchored ships at such installations as bridges and ports. Drifting mines are not restricted by water depth or sea area, may frequently float out of the maritime battle space, and can injure nonbelligerent countries' ships. Therefore, international treaties ban the use of drifting sea mines. Of course, actual conditions are really not so ideal."[91] Indeed, drifting mines are clearly unlawful under the widely recognized law of armed conflict, primarily because of their indiscriminate nature: they can just as easily destroy civilian merchants as legitimate military targets. Also, they are impossible to keep track of. Saddam Hussein was roundly condemned for using them in the Gulf War (1990–91). Only drifting mines that became inert shortly after release could possibly be lawful—but even then, the fact that they contain dangerous chemicals and remain adrift would make them questionable at best.[92]

China's most recent known equivalent to an operations-law handbook notes that the 1907 Hague Convention (VIII) Relative to the Laying of Automatic Submarine Contact Mines (关于敷设自动触发水雷公约) restricts sea-mine use but that signatories have violated these restrictions extensively in World War II, "thereby seriously undermining the rules of the Convention."[93] Ultimately, these Chinese analysts conclude that national interests inevitably trump legal norms. One could therefore imagine the PRC using a definition of "territorial integrity defense" to claim exemption from such international norms in a conflict over Taiwan.[94]

Bottom Mines. As their name implies, these mines lie directly on the bottom of the ocean and detonate when they sense passing ships' magnetic, electric, acoustic, or pressure signatures that satisfy their triggering criteria.[95] These mines are dangerous and effective weapons, as the damage to USS *Princeton* in 1991 during DESERT STORM attests. Some of the PLAN's rudimentary bottom mines, such as the Types 500 and 1000, are assessed as having a ship-counting feature and can let up to fifteen ship signatures pass before detonating. They also have activation-delay mechanisms that allow their placement up to 250 days before arming, and self-destruction timers that can be set for up to five hundred days.[96] China's C-series bottom mines have evolved from mid-1960s development of relatively shallow moored mines to post-1975 development of deeper, multiple-fused variants of increasing sophistication.[97] Bottom mines like China's EM-11 and EM-53 are significantly harder to detect and remove from waters than are moored mines.[98] In 1991 one mine professional wrote, "It is now virtually impossible to sweep a mine which requires magnetic, acoustic, and pressure influences properly sequenced in time."[99] The 710 Research Institute is reported to have recently developed with Pakistan a new-generation bottom mine with sensitive fuses.[100] Due to their limited sensing ranges and charges, bottom mines are confined to waters of two hundred meters and shallower.[101]

Remotely Controlled Mines. Some mines can be deactivated by coded acoustic signals to allow the safe passage of friendly vessels, and reactivated to oppose the transit of enemy vessels. Research on this capability is evident in Chinese technical publications.[102] China is thought to be able to control its EM-53 and -57 bottom influence mines in this manner.[103] Remotely controlled mines are well suited to defensive mining purposes, but they could be useful in offensive operations as well.

Submarine-Launched Mobile Mines. China possesses an inventory of mines, such as the EM-56, that travel autonomously to their final target area.[104] Called "self-navigating mines" (自航水雷) in Chinese, these mines are simply torpedo bodies that carry mine payloads to waters inaccessible by other means. Typically derived from obsolete torpedoes (e.g., earlier models of China's *Yu* series) and launched from submarines, they travel along a user-determined course for a set period of time. When they arrive at their programmed destination (perhaps in the middle of a harbor), the torpedo's engine shuts off and the weapon sinks to the bottom, where the warhead is controlled by a fuse similar to that of any other bottom mine. Like most mines, these are limited to shallow waters.

Rising Mines. Another class of mines, known as "rising mines," can be used in deep waters. A Northwest Polytechnic University dissertation on rocket rising mines states that they "can be used in deep water [for] large control of sea" and are suited for the conditions of China's maritime environment.[105] Such a mine is moored but has as its floating payload a torpedo or explosive-tipped rocket that is released when the system detects a suitable passing ship. The torpedo, or rocket, rises from depth to home in on and destroy its intended target, typically a submarine. As one source notes, "The so-called 'directional rocket rising sea mine' is a type of high technology sea mine with accurate control and guidance and initiative attack capacity. . . . Attack speed [e.g., against a target submarine] can reach approximately 80 meters per second."[106] Rising torpedo mines such as the PMK-2, which China has imported from Russia, are said to be capable of being laid in waters as deep as two thousand meters.[107] Improvements in cable materials might extend maximum anchor depth even deeper. China has likewise acquired Russia's earlier PMK-1 version, and it could be working to reverse-engineer indigenous variants. China has also developed, and now offers, at least two rising mines for export.[108] Its EM-52 rocket rising mine, of which Iran purchased an unknown quantity in 1994,[109] reportedly has an operating depth of at least two hundred meters.[110]

Recent focus on rising-mine development indicates the existence in the PRC of "a new understanding of the art of sea mine warfare: it is essential to implement effective sea mine warfare over a vast range of deep sea areas [and to] develop and equip rocket sea mines capable of . . . mobile attack."[111] The PLA is augmenting its existing inventory of 1970s and '80s mines, designed to defend littoral areas against Cold War superpower attack; most of these weapons "can only be deployed in shallow seas," and only a fraction of them can be deployed in medium depths. The PLA has "started to outfit vertical rocket rising sea mines, and is energetically developing directional rocket sea mines, rocket rising guided missile sea mines and rocket assisted propulsion sea mines."[112]

Russian Influence

Lingering defense-industrial-complex inefficiencies are unlikely to restrain China's sea-mine development prospects, because what the nation cannot develop indigenously it likely has already procured from Russia. China has obtained Russian sea mines, technology, and quite probably engineers to bolster its indigenous MIW programs.[113] Since the end of the Cold War MIW technology has rapidly proliferated, "compounded by the availability of ex–Soviet bloc expertise in mining technology and employment on the world market."[114] An article in China's leading naval publication refers to Russia as "the world's 'sea mine kingdom.'"[115] Fu Jinzhu believes that Russia's sea-mine achievements surpass even those of the United States and United Kingdom.[116] Chinese analysts cite three factors explaining Russia's prowess in MIW: the existence of natural (geographical) barriers amenable to MIW, the ability to fight off superior naval opponents, and the ability to produce large numbers at low cost.[117] Obviously, this analysis amounts to an argument for robust Chinese MIW. Moreover, Chinese strategists have studied Russian and Soviet MIW campaigns in considerable detail.[118] These analyses examine the role of mines in such historical campaigns as the Russo-Turkish wars and the Russo-Japanese War. A plethora of articles examine the vital role played by the approximately eighty thousand mines laid by the Soviet Union in the Second World War.[119] Along the same theme, an extremely meticulous analysis that appeared recently in *World Outlook* contains a detailed map of Soviet, German, and Finnish minefields laid in the Gulf of Finland during 1941.[120]

China has combined useful new hardware with a sophisticated understanding of the history of Soviet mine development and doctrine. Chinese analysts note that Soviet interest in sea mines actually waned under Premier Nikita Khrushchev but was subsequently reinvigorated in the late 1960s, as it was realized that for conventional-war scenarios mines would play ever greater roles.[121] Another Chinese source emphasizes that Russia "has continuously paid great attention to the development of high-speed undersea rocket technology."[122] Russian rocket mines (e.g., the PMK-1), according to this and other Chinese analyses, are ideal for their intended purpose of targeting U.S. nuclear submarines. It is said that these weapons, which close for a kill at fifty meters per second, attack SSNs (nuclear-powered attack submarines) too rapidly to be engaged by countermeasures. They are also rated as highly effective against the monohull construction of U.S. submarines. By deploying such weapons, it is said, even comparatively old diesel submarines can challenge nuclear submarines—a traditional Soviet strategy. PLAN training apparently using Romeo or Ming submarines to lay EM-52 rocket rising mines in enemy ports, for example, suggests a wartime mission for these older submarines and could explain China's retaining them.[123] There are reports of Russian scientists working on Chinese MIW programs.[124] In this domain of warfare, Russia's wide-ranging assistance has been a natural fit for PLA priorities, yet the true scope of this collaboration remains unknown.

Research Vectors

The PLAN constantly seeks foreign equipment, technology, and expertise to support its rapid MIW development. But China is not content simply to acquire advanced Russian and other foreign mines. As part of its larger scientific and technological revolution, China has achieved a profusion of promising MIW research results. Ongoing research foci confirm that China is keenly interested in developing and enhancing the effectiveness of deepwater rising mines.[125] China began to develop rocket rising mines in 1981, producing its first in 1989. Researchers at Qingdao Submarine Academy have recently calculated how many mobile mines are necessary to blockade given sea areas.[126] Indeed, there is extensive research on submarine-launched mobile mine (SLMM) effectiveness,[127] especially in relation to obstacles or countermeasures.[128] Scientists at China's Naval Aviation Engineering and Dalian Naval academies have developed methods to predict rocket-propelled-mine attack probability.[129]A variety of additional studies have analyzed launch platform stability,[130] underwater rocket propulsion,[131] and launch trajectory.[132] Like other countries, China models mine warfare extensively. Areas include "mine blockade warfare,"[133] MCM,[134] and warship magnetic fields.[135] Some key mathematical models underpinning Chinese MIW and MCM are "based on fifty years of PLAN research and that of foreign navies."[136]

China's 710 Research Institute has been at the center of sea-mine development for decades. In recent years, researchers there have studied fuse-triggering[137] and imagery issues;[138] designed a USB-based "large capacity internal recorder" for sea mines;[139] and, in partnership with a university and a multinational corporation, developed and implemented a "sea mine depth measurement and control system."[140] Of particular note, they advocate the utilization of "national military standards" (国家军事标准) in mine software development.[141] In a similar vein, a student at Harbin Engineering University calls for the development of a reliable "military automatic test system" (军用自动测试系统) to ensure weapons readiness.[142] Additional sea-mine research examines such issues as target tracking,[143] blast radius[144] and maximization,[145] as well as damage to ships.[146] Researchers at one of China's top technical universities have analyzed the extent to which targets can react to and evade deepwater rising mines,[147] and they suggest using the passive signatures of target vessels to aim the mines.[148]

Submarines have attracted particular attention as launch platforms for rising mines; an article by Dalian Naval Academy researchers suggests significant PLAN interest in SLMMs.[149] A 705 Institute researcher advocates acquisition of an encapsulated torpedo mine, similar to the U.S. Cold War–era Captor, which could be laid in very deep waters to attack passing submarines.[150] Technical efforts are validated through field testing:

> Submarine testing of a certain new type of mine was being conducted in the South China Sea. Testing area senior engineers Zhang Zhaokui and Jin Shujun in succession spent more than two months working inside a cramped torpedo launch compartment, precisely gathering each group of data. The Navy's Military Training Department later compiled that extremely valuable technical reference data into an operations handbook, thus providing a scientific basis for the use of the new equipment.[151]

Fusing is another major area of PRC research. Mine designers addressed the problem that early mines were easy to sweep by creating more sophisticated fusing systems. China is retrofitting its older mines into modern, highly capable versions that are virtually impossible to sweep.[152] This preserves the operational relevance of China's vast reserves of otherwise obsolete mines. The resulting "smart," or "intelligized," mines are more resistant to MCM and can selectively target specific ship types.[153] One significant research vector is digital fusing,[154] using neural networks as a means to improve resistance to sweeping.[155] Researchers at the 710 Research Institute and Naval Engineering University discuss methods for improving pressure sensitivity in mine fusing.[156] Other research involves improved methods for detecting weak magnetic fields of ships.[157] China's M series of anchored mines illustrates this evolution: while the first two variants of early 1960s vintage are no longer in use—presumably because they are easily swept—the M-4A and -B versions were upgraded in the 1980s to incorporate newer, more sophisticated fuses. Advanced fuses provide further utility for even more capable bottom mines. Using these and other measures, the PLAN constantly adapts to the increasing sophistication of foreign MCM.[158] As the PLA's newspaper reports:

> The testing area not only supports shooting at targets, the collection of a great deal of scientific research data also depends on them. In testing for design finalization of a new type of mine, after release the mine did not operate according to the stated goals, and the measurements and recordings by its associated "black box" were blank. Yet the target range's measurement instruments with the same interface recorded all sorts of data with perfect clarity. The conclusion from the target range's scientific analysis was that there was a flaw in the design of the mine's "brain," its electronic system. Thus, the target range sent the mine back to be "melted down as scrap." A year later, a smart mine with excellent performance was finally assessed as up to standard.[159]

Aerial minelaying is a topic of increasing interest. It is noteworthy, for example, that two of five universities involved in a collaborative project to develop a textbook on mine warfare that was published in 2007 are affiliated with aerospace research, including the Northwest Polytechnic University and the Beijing University of Aeronautics and Astronautics.[160] The Research Institute of Pilotless Aircraft has studied mine-parachute trajectory parameters.[161] Space technology has been applied to parachute design.[162]

Researchers at Northwest Polytechnic University and Zhongbei University have recently published several studies that model the impact of an air-dropped mine hitting the water.[163] Another Chinese specialist has created sophisticated mathematical models to determine the optimal parameters for aerial minelaying.[164] Here, as in other areas, efforts are made to use field testing to determine optimal approaches in practice:

> The testing area adopted a series of measures for close contact and cooperation with R&D organizations and units participating in the testing. It worked hard to establish a big scientific research pattern for new equipment, a three-dimensional, R&D, testing, and use pattern. A certain type of air-dropped torpedo had overall technical indices which were at the world's advanced level. But there was always the regret that a certain small component would easily catch hold of the parachute, and when that happened the mine would plunge straight into the water and break up. In light of this inadequacy, the testing area joined with the scientific research organization and the industrial organization in a focused effort which resolved this difficult problem.[165]

PRC analysts follow all aspects of U.S. Navy development carefully and are constantly seeking U.S. vulnerabilities.[166] Widespread Chinese mine-detection research,[167] including work at Qingdao Submarine Academy on probabilistic MCM decision making[168] and at Naval University of Engineering on pressure-mine triggering parameters,[169] could also be applied in this area. Disturbingly, there is some discussion of a theoretical nature in PRC naval analyses concerning the fielding of tactical nuclear weapons on sea mines—for example, in the 2007 textbook on mine warfare mentioned above.[170] One such analysis, in the context of Russian MIW, notes that nuclear sea mines could sink adversary nuclear submarines from a range of two thousand meters, while other nuclear mines could destroy an aircraft carrier or other major surface vessel from seven hundred meters.[171] A second article finds that a nuclear payload is one logical method to increase the destructive power of sea mines,[172] while a third argues that nuclear MIW is especially promising for future deepwater ASW operations. It concludes: "At this time, various countries are actively researching this extremely powerful nuclear-armed sea mine."[173] An article in the July 2006 issue of the PLAN periodical 当代海军 *(Modern Navy),* in the context of discussing potential future PLA Navy use of sea mines, also notes the potential combat value of nuclear-armed sea mines.[174] There is additionally evidence of related basic research, including a study on large explosions under water.[175] Such weapons, in addition to violating the 1971 Seabed Treaty, could contravene the PRC's no-first-use declaratory policy and undermine its historically centralized control of nuclear weapons. While there is no direct evidence of the existence of such naval tactical nuclear weapons programs in China, it will be important to monitor closely for any sign of work in this direction.

Less destructive, but potentially much more useful operationally, are apparent efforts by Chinese researchers to develop sea mines that are capable of downing aircraft, especially helicopters.[176] One PRC analysis explains that helicopters are ideal for MCM because of their seeming invulnerability. However, it further suggests, during MCM operations helicopters typically fly at speeds of from eight to twenty-five knots and altitudes of eighty to a hundred meters and that this provides the opportunity for an "anti-helicopter rocket rising mine" (反直升机火箭上浮水雷).[177] The mine would be triggered by the helicopter's acoustic signature.[178] According to another source, "It is presently known that the [710] Research Institute is in the advanced stages of developing a 'rocket rising guided missile sea mine.'"[179] The 2007 mine warfare textbook appears to discuss such a "rocket-type mine" (导弹式水雷), which would target surface ships in this new way.[180] This mine seems considerably more complicated than the anti-helicopter mine and may be able to strike surface ships as well as maritime patrol and other aircraft. According to this conception, a missile is launched into the air by a sea mine and then held aloft by a parachute until it can lock-on to the target. The author claims that this more advanced mine has not yet entered the stage of engineering development but that the commitment of the PLAN to this weapon is "unwavering . . . [so that] it is only a question of when development will succeed."[181]

With regard to these programs, it is worth noting that diagrams outlining both these antiair-mine concepts are portrayed in a 2002 Chinese naval encyclopedia.[182] In another potential mine warfare innovation, China is reported to be pursuing a "rocket-delivered sea mine" (火箭助投水雷) with 380-kilometer range that could be used to close adversary ports in a matter of hours.[183] Together, these discussions amount to substantial hints that China may well now be on the cutting edge of global sea-mine technology development.

Mine Delivery Platforms

China can deliver its mines by surface warships, submarines, aircraft, and converted civilian merchant or fishing vessels. The PLAN practices with all such platforms.[184]

Surface Warships

Many of the PLAN's surface ships are equipped to lay mines, including the four *Sovremmeny* destroyers (which can carry up to forty mines), twelve Luda-class destroyers (thirty-eight mines), and approximately twenty-seven Jianghu-class frigates (up to sixty mines). China would not use its most advanced frigate (Jiangkai II) or destroyer (Luyang II/Luzhou) classes to lay mines, and indeed they do not seem to be equipped for that mission. Many of the PLAN's hundreds of "obsolete," older, and smaller gunboats (e.g., the Shanghai and Hainan classes), minesweepers, and torpedo boats can carry and lay a handful of mines each. The PLAN's dedicated mine warfare vessel (hull 814) can reportedly carry up to three hundred mines.[185] The advantages of using surface warships to lay mines include their large carrying capacities, their trained crews, and the relative

Model	Platform Type	Mine Carrying Capacity	Current Number	Remarks
Coastal Minesweeper Type 082	Surface ship	10 M-1s or 8 C 1000s	2	Minelaying rails
Fleet Minesweeper Type 5, 10 (T43)	Surface ship	10 M-1s or 8 C 1000s	37	Minelaying rails
Haiju-Class Submarine Chaser Type 037 I	Surface ship	12 M-1s or C 500s	2	Minelaying rails
Houxin-Class Submarine Chaser Type 037	Surface ship	12 M-1s or 8 C 1000s	?	Minelaying rails
Huanghe-Class Landing Ship Type 037	Surface ship	60 M-1s or 51 C 1000s	?	Minelaying rails
Jianghu-Class Type 1 Model 053-H	Surface ship	Up to 60	12	Minelaying rails
Jianghu-Class Type 2 Model 053-HI	Surface ship	Up to 60	7	Minelaying rails
Jianghu-Class Type 3 Model 053-HG	Surface ship	Up to 60	3	
Jianghu-Class Type 5 Model 053-H II	Surface ship	Up to 60	3	Minelaying rails
Luda-Class Type 1 Model 051	Surface ship	38	10	Minelaying rails
Luda-Class Type 2	Surface ship	12 M-1s or 20 C 1000s	4	
Luhai-Class 167	Surface ship	18 M-1s or 30 C 1000s	2	
Luhu-Class 112, 113	Surface ship	18 M-1s or 30 C 1000s	2	
Patrol Craft Type 037 IS	Surface ship	12 M-1s or C 500s	2	?
Shantou-Class Fast Gunboat Type 101	Surface ship	8 M-1s or 6 C 1000s	?	Minelaying rails
Sovremenny DDG	Surface ship	24 M-1s or 40 C 1000s	2	Minelaying rails

Table 2. PLAN Minelaying Platforms Order of Battle.

Sources: Data for this chart derived from Hai Lin, "Taiwan's Own Military Affairs Experts' Forecast," pp. 17, 18; *Jane's Fighting Ships,* available at www.janes.com; and Sinodefense.com.

Model	Platform Type	Mine Carrying Capacity	Current Number	Remarks
Wolei Mine Warfare Vessel	Surface ship	200 Ms	1	Minelaying rails
Golf-Class SSB	Submarine	40	1	
Han-Class SSN	Submarine	28	4	
Kilo-Class Type 636	Submarine	24 AM-1s	10	
Kilo-Class Type 877	Submarine	24 AM-1s	2	
Ming-Class SS Type 035	Submarine	28–32	11	
Ming Improved Type Type 035 G SS	Submarine	28–32	8	
Romeo-Class Type SS33	Submarine	28	8	
Shang-Class SSN	Submarine	28 (?)	2	Capacity likely similar to Han's
Song-Class SS	Submarine	24–30	13	Capacity likely similar to Kilo's
Yuan-Class SS	Submarine	24–30	3 (+ more being built)	Capacity likely similar to Kilo's
H-6 Bomber	Aircraft	Up to 18 (?)	Estimates vary—possibly 100	
JH-7/7A Fighter-Bomber	Aircraft	Up to 12 250 kg equivalents (?)	Estimates vary—possibly 100	

simplicity of command and control. Disadvantages include a lack of stealth, limited speed, and consequent vulnerability.[186]

Photo 4. Laying a Training Bottom Mine. *A crane, adequate deck space, GPS, and a low sea state are the conditions required to lay mines such as this bottom mine exercise shape.*

Submarines

Chinese naval strategists appear to put a high value on submarine delivery of mines. For example, one analysis notes that "during both world wars, all countries' submarine forces undertook submarine mine-laying—the effectiveness appears to have been outstanding."[187] Its author further states that "[submarines operating] in sea areas and bastions controlled by the enemy can lay offensive mines, creating a surprise attack for enemy shipping and a threat of long duration."[188] All of the PLAN's submarines can carry mines, including the twenty or so obsolescent and noisy Romeos, which can carry twenty-eight. The approximately nineteen similar but newer and less noisy Mings can carry up to thirty-two, and the ten to twelve units of the modern Song class may carry as many as thirty. The Kilos, of which China has twelve, can carry twenty-four mines. The three or more new Yuans can probably carry up to thirty, and the four remaining nuclear-powered Han-class vessels twenty-eight.[189]

PLAN submarines are said to use influence mines of the Chen-1, -2, -3, and -6 types, "appropriate for use in the sea area immediately outside of harbor mouths"; the T-5 mobile mine, "appropriate for port channels and sea areas immediately outside a port"; and the Russian-produced PMK-1 and the Chinese-developed Mao-5 rocket rising mines, "appropriate for waters up to 15 kilometers outside a port."[190] As the following photo indicates, the advanced PMK-2 has been added to this lineup as well. Mine belts (潜艇外挂布雷舱)—external conformal containers designed to carry and release large numbers of mines—can be fitted to submarines. One source states, "For the past few years related PLA experts have expressed pronounced interest in submarine mine belts . . . . The PLA very probably has already developed submarine mine belts."[191]

Photo 5. Submarine Mine. *PMK-2 propelled mine being loaded onto Song-class diesel submarine at Qingdao.*

Having systematically analyzed the advantages and disadvantages of various minelaying platforms, Chinese analysts appear to have concluded that submarine delivery of mines is optimal for offensive mining missions, especially at long range. The advantages of using submarines to lay mines include their stealth, their ability to lay mines precisely, and their ability to penetrate difficult targets (perhaps by using mobile mines). It is additionally noted that the high accuracy and effectiveness of submarine delivery enable the planting of fewer mines to achieve the same effect.[192] According to one analysis, "The restrictions imposed on submarines by air and naval forces are relatively small, [so] penetrating the enemy's rear area to lay mines is much easier."[193] Also, according to another report, this platform "has the highest qualities of stealth and potential for surprise . . . [because] a vessel set at a distance of 10–15 km outside of a harbor, in a sea area with a depth of about 40 m, will be capable of launching an effective mobile mine to penetrate a sea port."[194] *Campaign Theory Study Guide,* written by Chinese National Defense University scholars, envisions using submarines, through "the timer feature of sea mine weapons and covert means, [to] lay mines in the enemy's main ports and important channels so that they will start to function after the blockade goes into effect . . . start[ing] about 10 days before the blockade goes into effect . . . 1–2 days in advance would be appropriate" and to replenish mines surreptitiously when enemy ASW forces confront inclement weather or leave coverage gaps.[195]

Disadvantages of submarine minelaying include limited payload, slow transit speed, and high opportunity costs (since mines must be carried at the expense of torpedoes or cruise missiles). Another disadvantage, as with surface warships, would be an opponent's ability to detect a mass egress from port. One recent Chinese analysis claims that submarine minelaying exercises are increasing in volume and sophistication,[196] and this theme is explored in greater detail below.

Aircraft

Beijing's more than a hundred H-6 bombers, though obsolete for many missions, can each carry twelve to eighteen 500 kg sea mines.[197] Whether the H-6 would be assigned to this mission is unknown, but it has recently been used in a variety of minelaying drills.[198] China's limited inventory of H-5 bombers could also be pressed into a mining role against Taiwan. China's more than one hundred JH-7/7A fighter-bombers can each carry up to twenty 250 kg bombs.[199] According to *People's Navy,* such aircraft can conduct minelaying in "near seas" (近海)—that is, out to the First Island Chain, which extends from the Japanese islands through Taiwan and the Philippines.[200] All these aircraft, and more, could just as easily carry mines, which might be nothing more than gravity bombs fitted with magnetic or other fuses.[201] According to one source, "the PLA's current inventory of *Chen*-1 through *Chen*-6 influence mines and the *Mao*-1 through *Mao*-5 moored mines are appropriate for aircraft delivery."[202] To this category can be added the sophisticated PMK-2. The advantage of aerial mining, as the U.S. military has understood since 1944, is the ability rapidly to emplace large numbers of mines and reseed minefields. The primary disadvantages are the difficulties in establishing air superiority and the opportunity costs of using modern aircraft to perform the mining mission.

Although earlier analysts examined China's ability to lay mines via surface ships and submarines, no analysis has seriously considered whether China could sow its mines by aircraft. Aerial mining has enjoyed dedicated platforms since the PLAN created an aviation branch with a minelaying bomber division in April 1949.[203] A mainstay of Chinese maritime periodicals offers detailed accounts of how the United States used aerial mines to hasten Japan's defeat in World War II and later to paralyze North Vietnamese shipping.[204] A professor at the PLA Air Force (PLAAF) Command College makes similar points concerning the value of aerial MIW in an article in China's most prestigious military journal, the PLA Academy of Military Science publication 中国军事科学 *(China Military Science)*.[205] Several Chinese technical papers discuss in minute detail the more esoteric aspects of accurately placing naval mines by aircraft.[206] In the context of discussing PLA Navy aviation capabilities, Vice Regimental Commander Zhu Guanghong, North Sea Fleet, recently stated that "seaplanes have excellent performance at super-low altitude. They can carry out . . . harbor mine-laying missions."[207] A North Sea Fleet aviation force shipboard aircraft regiment has even been credited with making PLA aviation ASW history by for "the first time using an exercise mine from a helicopter to hit an acoustic target" (首次直升机使用操雷打声靶).[208] Both Gidropribor.com and *Jane's* currently discuss Chinese and Russian-equivalent mines in the context of their being laid from aircraft.[209] A rather lengthy recent article in a Chinese naval journal discusses which mines in China's inventory can be laid by air.[210] Finally, *Campaign Theory Study Guide* advocates "concentrated mine-laying from the air," particularly in "areas which submarines find hard to enter."[211] It stipulates that "the mine-laying blockade force group" usually includes "naval forces and Air Force bombing aviation."[212] It is thus quite clear that China grasps the utility of aerial MIW and is considering how specifically to employ it in combat.

Civilian Vessels

Complementing the robust capabilities described above are the thousands of Chinese fishing and merchant vessels that could be pressed into service. In 2003, Rong Senzhi, Deputy Commander, Yantai Garrison District, advocated in a journal affiliated with the Academy of Military Science that civilian vessels be utilized for minelaying and minesweeping.[213] China's 2008 defense white paper lists "mine-sweeping and mine-laying" as one of four primary PLA Navy Reserve forces.[214] According to one article, "China currently has 30,000 iron-hulled mechanized fishing trawlers (each vessel can carry 10 mines), and there are another 50,000 sail-fishing craft (each can carry 2–5 sea mines)."[215] *Science of Campaigns* (2006) is quite explicit on this point: "Mine-laying missions are usually assigned to submarine and aviation forces with relatively good concealment, but privately owned boats can also assume . . . mine-laying missions."[216] Chinese writings frequently mention the incorporation of civilian shipping into naval service for such

Photo 6. People's Militia Laying Mines. *These two civilian fishing vessels, which are ubiquitous in the seas around China, practice deploying bottom mines as part of a larger "People's Militia" exercise at the PLAN base in Sanya in December 2004. Such exercises occur regularly at various PLAN bases. GPS would allow accurate placement of mines in defensive minefields around Chinese ports, even by militia forces such as these.*

functions as MIW.[217] A 2005 article describes, with photos, the use of fishing vessels as minelayers as part of larger "People's Militia" exercises that occur regularly at various PLAN bases.[218]

One Chinese source describes "fishing vessels with a displacement of around 100–200 tons" as ideally suited for MIW because they offer sufficient numbers, "small targets," reasonable mobility, and unsuspicious profiles.[219] Fishing vessels of this size easily have the endurance to range the entire East Asian littoral, including especially all waters surrounding Taiwan. Only "minor modifications" are needed to "install simple mine-laying equipment. . . . Fishermen are very familiar with the sea" and may therefore exploit "topographical conditions, surface features, and darkness."[220] Another Chinese source observes, "The PLA has effectively organized and commands motorized fishing trawlers, which during war time can be equipped with minelaying rails, and, relying on an excellent disguise, can execute mine warfare." The same source concludes, "This non-conventional type of mine delivery platform, although unable to plant many mines, when used in large numbers or for reseeding, can also produce a large number of minefields."[221] It is perhaps not surprising to see one of China's prominent naval strategists, Senior Captain Li Jie of the PLAN's Naval Military Studies Research Institute, writing on the subject of new developments in undersea weaponry for the PLA-sponsored journal *China Militia* as recently as May 2008.[222] In addition, an extensive legal basis has been developed to support the mobilization of civilian vessels in wartime, including the National Defense Transportation Regulations, which were promulgated in 1995, and the National Defense Law of the People's Republic of China of 1997. This legislation was apparently updated again in 2003, according to a PLA Navy article.[223] MIW could thus support the ultimate "People's War at Sea."[224] China, therefore, has all the physical elements required to perform aggressive MIW, including a large inventory of increasingly capable mines and a wealth of platforms from which to lay them. But this is only part of the story. Hardware is ineffective without the human capital and experience that can be cultivated only through training and exercises.

China's Increasingly Realistic Mine Warfare Exercises

The PLAN places a premium on exercises involving sea mines.[225] Bernard Cole, an expert on the PLAN, has noted that unlike their counterparts in many other navies, Chinese surface combatants annually practice minelaying but expresses uncertainty regarding how extensive the exercises actually are.[226] Newly available data indicate that the PLAN is in fact making serious efforts to expand such exercises and make them realistic.[227] Recent Chinese MIW exercises have involved submarine, air, surface, and even civilian platforms extensively. Such exercises are documented in some detail in the PLA Navy's official newspaper, *People's Navy*.

China's navy considers minelaying from submarines to be "the most basic requirement of submarine warfare."[228] Minelaying has become an integral component of recently enhanced PRC submarine force training[229] in which crews strive to conduct a wider variety of increasingly challenging exercises attuned to local environmental, hydrographic, and weather conditions.[230] In particular, China's navy views submarine-delivered mining as a critical aspect of future blockade operations.[231] By 2002, minelaying had become one of the most common PLAN submarine combat methods. Accordingly, crews train to handle submarines loaded with large quantities of mines.[232] Drill variants include "hiding and laying mines in deep water"[233] in combination with such operations as torpedo launch.[234] Broad, deep minelaying against port targets is also emphasized,[235] with the assumption that penetrating enemy defenses is a prerequisite.[236]

PLAN officers recognize the challenges inherent in "penetrating the enemy's antisubmarine forces and laying mines behind enemy lines." According to one captain, "Secretly penetrating the combined mobile formation deployed by the enemy's antisubmarine forces is a prerequisite to fulfilling the mine-laying task."[237] There is some evidence that China may rely on centralized control of its submarines conducting offensive mining missions. In carrying out offensive mine blockades, notes one PRC analysis, "most submarine forces operate primarily in a single-submarine, independent mode, and if there is a shore-based submarine command post to handle command and guidance of the submarine for its entire course, it will not only ensure its concealment but also improve the strike effectiveness of the mines . . . that are laid."[238]

The Chinese navy is working hard to improve the quality of its submarine officers and sailors, including their proficiency in MIW. Midlevel command students at Qingdao Submarine Academy study minelaying intensively.[239] Submarine flotillas have practiced "difficult new tactics like 'minelaying in great depth,'"[240] and continue to set new depth records using such techniques as the "'deep concealed mine laying' combat method" ("大深度隐蔽布雷" 战法).[241] China's official radio has cited PLAN submarine detachment torpedo and mine officer Chao Chunyi for achieving sixteen research results in underwater minelaying training, cutting mine-loading time in half, and developing a mine movement control device.[242] Ma Lixin, the commander of Song submarine 314, and a celebrity in China's naval press, recently led an East Sea Fleet submarine detachment in "develop[ing] tactical innovations." In the previous year, Ma had researched and developed over ten new operational methods, "including how to carry out a blockade and how to lay mines using conventional submarines." In early 2005 Ma "led his unit to participate in live exercises at sea. . . . [T]hey arrived at a designated area to . . . [lay] mines."[243] In an early 2005 mine exercise, Ma was charged with evading "enemy" ASW airplanes, a minefield, and—most difficult of all—an adversary submarine, in order to lay mines in a nearby area. He used his mastery of the local environment, adopted a minimum-noise navigation speed, eluded the "enemy" submarine and shore radar, and accomplished the minelaying mission on time.[244] Naturally, handling mines safely aboard submarines is an important research area at Qingdao Submarine Academy.[245] Another analysis discusses the inherent safety issues involved with laying mines through bow torpedo tubes—the customary method in modern submarines.[246] One of the most interesting articles surveyed to date details the 12 March 2006 "test launching" (水雷试射) of what appear to be SLMMs by a "new type of submarine" (新型潜艇) in the South Sea Fleet. Although it was the first such test by this type of submarine, with little room for error, great accuracy was reportedly achieved.[247]

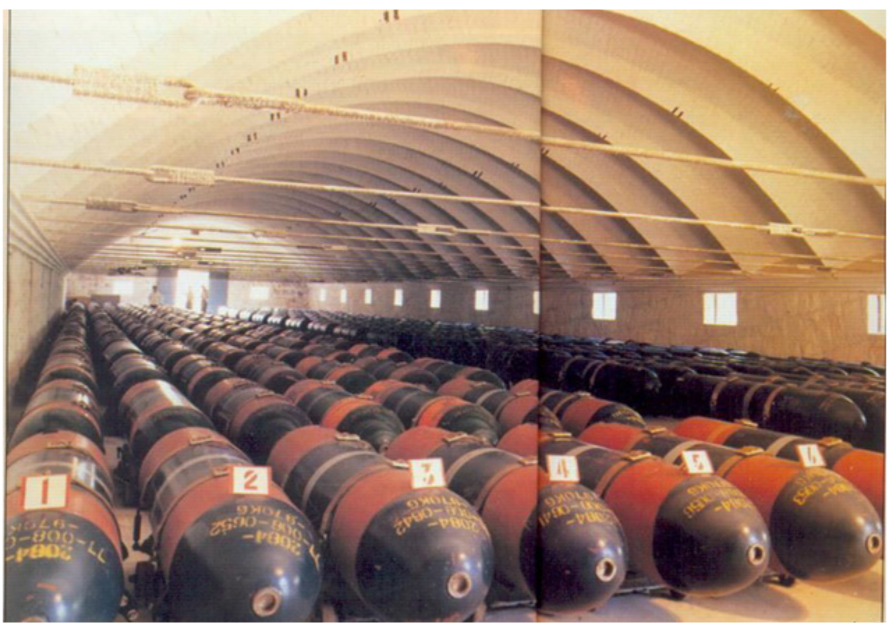
China's air components practice mine operations with increasing frequency, scale, and diversity. The 1997 U.S. Department of Defense report on PLA development mentions that China's military aircraft practice laying mines by air.[248] Training programs of East and South Sea Fleet aviation regiments have recently included minelaying,[249] incorporating different types of aircraft[250] and conditions of enemy air blockade.[251] A South Sea Fleet exercise in August 2002 entailed dropping mines from bombers in an unfamiliar location under "realistic" conditions against opposition forces. The exercise involved a combat aircraft group consisting of three bomber sections, an electronic-jamming aircraft, and escort fighters. The electronic-warfare aircraft jammed the enemy's radar, while the combat-aircraft group employed minimum-altitude tactics, quickly dispensing several tens of mines and torpedoes.[252] Another source, probably reporting on the same exercise, discusses "Red force" bombers conducting a minelaying mission over the South China Sea being intercepted and attacked by "Blue force" fighters.[253] Starting in March 2006, a South Sea Fleet bomber regiment practiced laying "mine blockades far out at sea" (远海布雷封锁).[254] On 6 June 2006, as part of "a simulation training event on carrying out a missile attack on a deep-sea island under poor weather conditions" (复杂气象条件下远海岛礁导弹打击模拟演练), a South Sea Fleet Naval Aviation air regiment "laid sea mines" (海上布雷). Its pilots were also trained in "laying mines far out at sea in the fog" (雾天远海布雷).[255] Also in 2006, a South Sea Fleet Naval Aviation air regiment practiced "laying mines at sea in the rain" (雨天海上布雷).[256] In late August 2008, four recently retrofitted South Sea Fleet aviation force warplanes simulated "offensive mine-laying in ports and sea lanes" "under a complex electromagnetic environment" and various weather contingencies.[257] In early January 2009, an East Sea Fleet H-6 bomber regiment, in accordance with the new Outline for Military Training and Evaluation, "applied new combat methods to training in deep defense penetration in distant seas and completed the low-altitude offensive mine-laying mission." The regiment "explored some new combat methods, such as . . . nighttime large-armada offensive mine-laying."[258] Also in 2009, CCTV-7 stated that PLA Naval Aviation "water aircraft" "are capable of carrying out . . . minelaying."[259]

A disturbing component of PLAN minelaying is the prospect of civilian cooperation to supplement military assets. For the past few years, each navy unit has organized militia units—which constitute "an important force in future maritime warfare"—into training equipment, management, applications, and safeguard groups to give them experience and develop new methods "to fulfill mission requirements." China's 2008 defense white paper explicitly mentions that reserve forces are likely to be involved in mine warfare (both laying and sweeping).[260] An East Sea Fleet exercise using civilian vessels includes a focus on clearing various types of mines.[261] A Chinese maritime periodical offers perhaps the first photo available showing the use of civilian ships for MIW. In December 2004, the Sanya navy militia's emergency repair and minelaying detachments[262] mobilized six civilian ships and conducted a drill that involved (among other activities) reconnaissance, "minelaying by fishing boats," and non-pier and at-sea supply of naval vessels in battle.[263] In early July 2006, the PLAN's first reserve minesweeper squadron, established in Ningbo, Zhejiang Province, in September 2005,[264] conducted a month of training in the East China Sea. Following an "emergency recall order" (紧急征召命令), two hundred PLAN reserve officers and enlisted personnel prepared sixteen requisitioned fishing boats within half a day. Two principal officers led training in seven areas, including "shift of a command post [指挥所转移], air defense dispersal [防空疏散], minesweeping [扫雷], [and] countering special combat operations [反特种作战]." Coordinated by the East Sea Fleet party committee, the experimental effort was supported by a wide variety of local organizations and drew "reserve enlisted personnel from among local fishermen and retired military personnel." It was organized with attention to economic realities: "To keep one high-horsepower fishing boat tied up at a pier for one day costs several thousand RMB [hundreds of dollars]. The loss of one fishing trip costs over 100,000 RMB [USD 12,500]."[265] Later in 2006, Penglai City (Shandong Province) established a minelaying militia combat detachment, with assistance from fishery departments and companies. This was in accordance with the PLA General Staff Department's "Opinion on Restructuring Militia Forces" (关于调整民兵组织的意见).[266] In March 2007, an East Sea Fleet minesweeper unit conducted joint MCM operations with fishing boats outfitted with minesweeping devices.[267] Continuing this pattern, in December 2008 a Navy Reserve squadron practiced rapid minelaying under difficult conditions.[268]

Another report details the equipment requirements (e.g., cranes) for remote port loadouts of mines, presuming the difficulty during a conflict of relying on wharves at major naval bases, which perhaps would have been destroyed by enemy precision-guided munitions strikes.[269] This training imperative is described in multiple publications as a "non-pier" (无马头) exercise. According to *People's Navy,* on 15 August 2006, a North Sea Fleet submarine flotilla began using a newly researched and developed "special-purpose floating raft vehicle for loading mines/torpedoes into submarines" (潜艇装雷浮筏专用车). This mobile (perhaps towed) platform from which mines can be loaded into torpedo tubes has significant storage and hoisting capacity. It is credited with improving loading speed sixfold while improving concealability, perhaps by allowing rendezvous with a submarine in coastal waters away from a standard pier location.[270]

Improvised exercises have also been carried out recently by sea-mine depot officers.[271] A South Sea Fleet torpedo and sea-mine depot has been tasked with "four transformations" to improve high-speed, long-distance mobile-mine transport.[272] An East Sea Fleet torpedo and sea-mine depot has conducted independent, mobile all-weather exercises designed to ensure high-speed transport of sea-mine components during air raids. Officers helped to develop appropriate detection systems and testing instruments. They exploited terrain, weather, and darkness for camouflage.[273] A North Sea Fleet logistics support base has formed a "technical service team" for submarine mines and has mastered "urgent refueling in the field without a dock."[274] On 16 March 2006, "rookies" (新号手) at a North Sea Fleet torpedo and sea-mine depot conducted "night training in torpedo and sea mine emergency support" (夜间鱼雷应急保障训练), suggesting that such emphasis on realistic conditions is normal for this unit. An administrative officer

Photo 7. Mine Depot with Warshot and Training Mines. *The bands on the ninety-eight mines on the left side of the image indicate that they are exercise shapes, and could support a robust exercise program. The solid colors on the similar number of mines to the right suggest that they are warshots.*



reports that in late November 2006, the Guangzhou Support Base (South Sea Fleet) provided mobile emergency resupply of mines from a "temporary supply site" (临时补给阵地) over five hundred kilometers from base.[275] The Naval Engineering University has recently provided significant assistance in improving sea-mine management, technical support, and spare parts.[276]

MIW is a major surface fleet mission. The PLAN has stressed speed,[277] automation and electronics,[278] and "all-weather" minelaying capabilities.[279] Jianghu-class frigates have conducted minelaying as part of ASW training.[280] Captains of minesweepers train at a special center at Lushun naval base.[281] Minesweeping units have recently practiced laying various types of moored and deep bottom mines as part of fast-paced, confrontational exercises. One South Sea Fleet minesweeping unit has recently participated in over ten such exercises, in which it "achieved 26 scientific research results" as part of a larger effort to keep abreast of a "new global revolution in military affairs" that includes "network-centric training" and "the intelligization of sea mines."[282] Indeed, the PLAN apparently views minesweepers equipped with "torpedo" (mobile) mines as a viable ASW platform that illustrates the potential for "old equipment + networks + talent" to "thoroughly convince" those who believe that "it is not possible to establish a platform for informatized exercises on old equipment."[283] In 2002, a North Sea Fleet unit including minesweepers 813 and 811 attacked submarines with "both foreign and domestic torpedo sea mines" with a "100% success rate."[284] More recently, all three of China's fleets have trained with what appear to be advanced mobile mines. In December 2005, North

Photo 8. PLAN Minesweepers.

Sea Fleet sailors were photographed hoisting a "new type of sea mine," possibly into a submarine.[285] The mine's similarity to U.S. Mark 25 Mod 2 mines reflects the influence of U.S. and Russian technology in PLAN mine development.[286]

There remains substantial room for improvement in Chinese MIW. Malfunctions still sometimes occur during mine exercises.[287] Equipment support materials are sometimes only available in foreign languages (e.g., Russian) and must be translated or otherwise analyzed.[288] Also, political work still consumes some time, albeit perhaps less than ever before.[289] There is apparently still some resistance to PLAN policies of making exercises mimic actual combat conditions.[290] There is even evidence from MIW exercises that the PLAN continues to experience challenges in shifting to a modern, professional organization.[291] But PLAN leaders clearly understand that hardware advances are incomplete without related human-capital improvements.[292] PLAN officers are determined to improve MIW capabilities,[293] devise new training methods,[294] and to practice more flexible sequences.[295] At the beginning of 2001, South Sea Fleet minesweeper 814 reformed its noncommissioned officer preparation by implementing "training for different grades and levels" to make it commensurate with previous experience and thereby avoid unnecessary repetition.[296] Minesweeper 852 introduced competition and examinations to improve crew evaluation.[297] At the end of April 2005, a PLAN minesweeper unit practiced sweeping and laying mines in an "unfamiliar sea area," under all weather conditions, with the goal of "training as you will fight."[298]

Certain units are hailed for training innovations. A South Sea Fleet minesweeper unit's "flagship," hull 809, was rewarded for achieving repeated PLAN firsts.[299] The unit established a "night training implementation leading small group" to increase the challenges of training. The unit's officers used Global Positioning System (GPS), radar, and hand-held location systems (including compasses and sextants) to arrive, in an unfamiliar area, at a point within two meters of the required position.[300] Utilization of multiple navigation systems appears to hedge against any one system's becoming unusable under combat conditions. In 2000, in order to prepare for modern high-technology war, minesweeper 809 established a "warfare and training methods discussion group" that studied counters for electronic interference, high-performance enemy sea mines, over-the-horizon missile attack, and potential opponents' concepts, as well as the employment of both deployed and future Chinese equipment. Since 2001, minesweeper 809 has developed twelve new tactics to "counter-electronically jam" (抗电子干扰) advanced enemy mines and over-the-horizon missile attack.[301] In 2003, *People's Navy* reported that ship 809 had conducted the PLAN's first MIW exercise (实布实扫水雷) involving opposing forces and had cleared more mines under realistic conditions during peacetime than any other PLAN ship. By 2003, minesweeper 809 was routinely and successfully clearing all types of mines in day or night, in all types of weather, and making decisions on the spot in a wide variety of uncertain and realistic conditions.[302] Similarly advanced, according to media reports, is minesweeper 804. This ship has exercised with a remotely

Photo 9. PLAN Mine Countermeasures Ship 804. *This is one of China's most modern mine countermeasures ships. This ship has exercised with a remotely operated mine-hunting underwater unmanned vehicle and using what appear to be sophisticated, high-frequency active digital sonars.*

operated mine-hunting underwater unmanned vehicle, described as a "new type of mine clearing device" and using what appear to be sophisticated, high-frequency, active digital sonars.[303]

PLAN scientists are also evaluating the possibilities for using new simulation systems for mine warfare exercises.[304] In 2006, an East Sea Fleet minesweeping squadron gave monetary incentives to advanced units and individuals who worked hard to become talented personnel.[305] PLAN experts have published numerous academic papers and attended foreign MCM exercises (e.g., in Singapore, 2007).[306]

As the above-cited minesweeper operations suggest, effective MIW requires effective mine countermeasures. China particularly lags behind the West in MCM technology, although researchers are studying previous Western approaches, including the use of underwater rocket bombs (RBUs).[307] The PLAN is aware of this shortcoming and preparing accordingly.[308] While its talented young MCM/MIW officers may not match those of its submarine force, they too are being nurtured.[309] Its detailed arrangements for emergency contingencies are based on the premise that suffering damage during future wars is inevitable.[310] Perhaps this is why crews train to operate multiple weapons systems, and for executive officers (XOs) to perform the roles of commanding officers.[311] In a 10 April

2005 North Sea Fleet ASW exercise, for instance, a "sea mine squad" reportedly practiced launching rockets and depth charges from a "submarine-hunting ship."[312] In recounting a major June 2005 East Sea Fleet minesweeper formation exercise, analysts invoke China's Vietnam minesweeping legacy to emphasize that a "minesweeper is regarded as the 'dare-to-die corps' of maritime warfare; its role is vital."[313] Mines are playing an increasing role in Red-versus-Blue training, a relatively new domain for the PLAN. In 2002, in the South China Sea, an "underwater vanguard boat" confronted ASW ships, aircraft, and an underwater minefield blockade. It escaped after firing "a new type of Chinese-manufactured torpedo."[314]

Photo 10. Console on Mine Countermeasures Ship. *This operator's console, probably from Mine Countermeasures Ship 804, features a joystick and the ability to observe camera images remotely. It could be the location from which the mine-hunting UUV previously pictured is operated.*

Some exercises have assumed "that 'enemy vessels' had mined a certain sea area to block our warships from passing."[315] MCM and MIW assets seem to be virtually interchangeable, in that PLAN minesweepers regularly practice laying mines.[316] Minesweeper ship training has recently included "daytime deep water minesweeping," "nighttime minesweeping," and "passing through a composite minefield" for single ships.[317]

A Preliminary Conception of PLAN Mine Warfare Doctrine

Combining the historical development of Chinese mine warfare, its present capabilities, and the considerable training activities outlined in the preceding section, it is possible to sketch the broad outlines of contemporary PLAN MIW doctrine. One likely forum for dissemination of such doctrine is China's MIW/MCM journal *Sea Mine Warfare and Ship Self-Defense* (水雷战与舰船防护).[318] The existence of such a professional publication in itself suggests a decisive commitment to this warfare specialty. The doctrinal outline that follows represents only a preliminary sketch, given the continuing opacity of all Chinese military programs, including MIW. The following thirteen points are derived from phrases that appear repeatedly in Chinese MIW writings, where they are treated as having major strategic and tactical significance.[319]

1. <u>"易布难扫" *(Easy to Lay, Hard to Sweep).*</u> This simple formulation of the advantages of offensive mining is used universally in PRC writings on mine warfare. It reflects a strong conviction, based on historical analyses and trends in naval warfare, that MIW possibilities have significantly outpaced MCM development and will continue to do so.[320] This is a core motivating principle for Chinese MIW, but it is also built on specific assessments that mine countermeasures represent a critical vulnerability of the U.S. Navy. However technically superior the U.S. Navy may be in MCM to the PLAN, the basic calculus that MCM will remain arduous and resource-intensive for all navies does not change.

2. <u>"不惹人注意" *(Not Attracting Attention).*</u> MIW and MCM are among the least glorious components of modern naval warfare. Dropping a mine overboard hardly creates the same exhilaration as launching in a fighter from an aircraft carrier. Moreover, the platforms involved generally do not inspire admirers of great ships. In navies around the world, mine warfare is a less favored career route than others. In addition, these weapons are fundamentally difficult to monitor with any confidence, since they are very easily hidden. Chinese naval strategists are aware of these peculiarities and are keen to use the mundane aspects of MIW to their advantage—betting that their own robust offensive capabilities will not be countered and therefore can be exploited in the event of war.[321] Finally, unlike the development of aircraft carriers, to give the most obvious contrast, advances in sea mines will not conflict with China's professed strategy of "peaceful development" or trigger arms races with potential adversaries, such as Japan.

3. <u>"四两可拨千斤" *(Four Ounces Can Move One Thousand Pounds).*</u> The asymmetric nature of mine warfare is reflected in this expression, common to many Chinese MIW analyses.[322] The aphorism also suggests, however, that MIW is capable of inducing major strategic effects well beyond actual combat losses inflicted on the adversary.[323] One Chinese naval analyst contends that MIW imposes "huge psychological pressure" on

the enemy.[324] This conclusion echoes notions in the U.S. Navy: "[Mines are such] highly effective psychological weapons [that the] mere suspicion that they might be present is usually sufficient cause to shut down a port or shipping channel, disrupt battle plans, and force the re-routing of personnel, weapons, and supplies."[325] Consistent with this approach, *Science of Campaigns* discusses the employment of "decoy minelaying" for the purpose of confusing the enemy and causing him to waste limited MCM resources.[326]

4. "控在一定时间一定海区" *(Sea Control at a Specific Time in a Specific Sea Area).* PLAN leaders recognize that they cannot challenge the U.S. Navy symmetrically for absolute sea control. A 2005 article in *China Military Science* by a scholar from Nanjing Naval Command and Staff College outlines a Chinese notion of "sea control" that is described as distinct from the American conception: "For military circles in China, command of the sea means one side in a conflict having control over a specific sea area for a specific period of time."[327] The U.S. Navy is said to seek total mastery of the seas; the PLAN conception is much narrower. MIW could logically play a decisive role in such a strategy, given its strong potential for impeding the adversary's momentum and also for channeling the adversary into selected sea areas.

5. 巨大数量 *(Huge Numbers).* Vast quantities of sea mines offer the PLAN a variety of operational possibilities, particularly given the important psychological effects of even comparatively obsolete sea mines under the right circumstances. Persian Gulf War analyses by PLAN strategists cited above suggest a clear realization that relatively low numbers of laid mines (1,100) inhibited Iraqi MIW.[328] Recall that the same analyses call for developing methods for "high-volume carriers for mines."[329] Moreover, we have cited above a Chinese report discussing submarine mine belts.[330] A Chinese analysis of the U.S. mine blockade of Japan in 1945 concludes that the "high number of mines" was a critical factor.[331] Estimates of the number of mines currently required to blockade Taiwan vary between seven and fourteen thousand,[332] which amounts to a relatively small proportion of available estimates of PLAN aggregate sea-mine stocks. *Science of Campaigns* emphasizes the importance of having sufficient numbers of mines so that a specified number can be held in reserve to replenish minefields during the course of a "joint blockade campaign."[333]

6. "先制" *(First Control).* The concept of "first strike," which permeates PLA doctrine, is especially relevant to mine warfare. This phrase, which appears often in Chinese writings concerning MIW, suggests a strong preemptive tendency. Surreptitiously laying sea mines might give the advantage of surprise. According to an article in *Naval and Merchant Ships,* "mines have become an important component of the 'first to control' . . . combat operations."[334] Another article from the same periodical observes that "refitted civilian ships are particularly suited for offensive mine-laying operations *before* the enemy has figured out one's strategic intentions."[335] PRC MIW expert Fu Jinzhu alludes

starkly to the preemption issue when, in an appraisal of Taiwan MIW, he asserts, "Since Taiwan's minelaying capability is already known, it ought to be easily removed."[336] Yet another article in *Naval and Merchant Ships,* from 2005, hints even more directly at preemption: "If minelaying cannot be done rapidly, it will probably be impossible to accomplish MIW missions before the outbreak of war."[337]

7. 高低技术 *(High and Low Technology).* PLAN writings commonly cite the cost-effective nature of MIW. A typical graphic, from a 2004 *Naval and Merchant Ships* article, juxtaposes the costs of Iraqi mines in the Persian Gulf War, $1,500–$10,000, with the costs to repair U.S. Navy ships damaged by them, which ranged as high as ninety-six million dollars.[338] Nevertheless, it is also important to recall the mid-2004 statement from *People's Navy* that "China is not Iraq. . . . It has advanced sea mines."[339] As already noted, China has acquired and now produces some of the world's most advanced and lethal mines. Used in combination, high- and low-technology MIW will make the MCM challenge that much more complicated and difficult for any prospective opponent.[340] The PLAN seeks to maximize its MIW capabilities through fuse retrofits and prioritization of the most advanced mines for the most challenging missions.

8. 潜载雷为隐蔽, 空载雷为多快 *(Submarine Delivery for Concealment, Air Delivery for Speed and Quantity).* Chinese strategists have carefully considered the comparative advantages of various laying platforms. Their analyses of Iraqi MIW in the Gulf War emphasize the extensive vulnerability of surface ships engaged in minelaying.[341] Submarine delivery is viewed as ideal for mine strikes against hard targets, such as ports and bases, because of the unparalleled stealth qualities of submarines.[342] "The submarine's most notable characteristic is its high degree of stealth, which assures that [submarine-laid] minefields remain far more dangerous to the enemy than [fields] sown by aircraft or surface vessels."[343] The preceding section of this study suggests a high level of training activity focusing on submarine MIW operations. While submarines can deliver mines with great precision, however, their load-outs are not very large, and their sortie rates are low. Aircraft, by contrast, can deliver mines with much greater speed and efficiency, potentially also reaching waters too shallow for submarines.[344] Chinese analysts also understand the factors that influence the efficacy of laying particular types of mines in particular locations.[345] Dalian Naval Academy experts cite such factors as "water depth, seabed geology, seabed form, tide, current, wind, wave, degree of transparency of seawater, temperature of seawater, salinity of seawater, ocean organisms, various noises, earthquakes, [and] magnetic storms."[346]

9. 军民联合 *(Civil-Military Integration).* PRC historical analyses point to numerous examples, ranging from World War II to the Persian Gulf War, of civilian vessels executing MIW and MCM missions during wartime. Chinese analysts additionally point out that civilian vessels actually cleared mines from waterways during the Chinese civil war.[347]

According to a 2004 article in *Modern Navy:* "Organizing quick and effective civilian ship participation in warfare is an important guarantor of victory in naval warfare." It continues, "China's coastal [civilian] ships are now an abundant resource . . . [and thus constitute] a huge maritime war force." Finally, it is argued that MIW/MCM missions should receive first priority when making modifications to upgrade civilian ships for combat.[348] Exercise activity noted in the preceding section suggests that these ideas are not simply theoretical. Moreover, civil-military integration for MIW/MCM is consistent with China's strategic culture.[349]

10. "水下卫士" *(Undersea Sentry).* Although U.S. aircraft carriers are taken seriously in China,[350] there is evidence that PLAN strategists are equally or more concerned with U.S. SSNs.[351] Whereas PLAN submarines might not fare well in head-to-head combat with U.S. Navy submarines, MIW is viewed as potentially effective for coping with this threat.[352] Even Navy Militia minelaying is viewed in this context, albeit likely in coastal waters.[353] Chinese analysts note that the Soviets revived mine warfare during the late Cold War in part to counter American SSNs. Indeed, one Chinese survey of ASW explains how new mines emerged in the 1980s "that are more appropriate to the requirements of modern anti-submarine warfare."[354] A detailed Chinese analysis of Russian rocket mines concludes, "These weapons will attack SSNs too rapidly for countermeasures to engage, and are also rated to be highly effective against the mono-hull construction of U.S. submarines."[355] Chinese strategists note that "submarines are acutely vulnerable to mines, because passive sonar is not likely to be effective in locating mines, and because submarines have very limited organic MCM capabilities."[356] Moreover, the surprise nature of the mining threat is likely to reduce the efficacy of the submarine's countermeasures.[357] ASW is repeatedly emphasized as a mission in a Chinese textbook on mine warfare published in 2007[358] and already practiced in Red-versus-Blue confrontational exercises.[359] *Campaign Theory Study Guide* calls explicitly for the formation of "anti-submarine mine zones."[360] In so doing, China could draw on advanced Russian mines, such as the PMK-2, specifically designed to target U.S. submarines, as well as indigenous variants. Sea mines, therefore, potentially give the PLAN affordable "poor man's" ASW capabilities that it could not otherwise obtain, providing a stopgap measure until Beijing can put a more robust ASW posture into place. U.S. submarines are highly survivable, but adversary war planners may consider a "mission-kill" damaged submarine equivalent to a destroyed one.[361]

11. "水雷管理的信息化" *(Mine Management "Informatization").* The integration of information technology has become a major goal of contemporary Chinese military reforms, and this goal also applies to mine warfare.[362] The implications for logistics management practices, a priority for the PLA since the Korean War, are particularly salient. Chinese naval analysts emphasize the importance of transporting large quantities

of different types of mines efficiently.[363] Additional reports suggest that the PLAN takes MIW logistics seriously—for example, revamping depot leadership,[364] improving information flow[365] and logistics management,[366] regularly culling obsolete weapons from the sea-mine inventory,[367] and training officers and enlisted in technical checks and deployment preparation.[368] Recognizing the vital role of logistics in MIW, in March 1994 the Navy Logistics Department's "Navy Rear Services Depot Vocational Administration Regulations" stipulated high-level training for cadres and soldiers specializing in sea-

Photo 11. Exploiting Information Technology. *Chinese technicians use a computer, with an exercise mine in the immediate background. Computers could greatly increase the accuracy of mine allocation, placement, and feature settings (such as activation delay, ship counters, and other variables), thereby optimizing their effectiveness.*

mine technology in all aspects of their work, including monitoring inventories, repairing, and discarding obsolete weapons.[369] The PLAN Ordnance Support Department has issued and implemented further regulations such that "the time to rotate from one mine war-readiness level to another has been reduced."[370] As of 2008, for one South Sea Fleet sea mine depot

> to know exactly the inventory in the depot is no longer enough for the electronic "housekeepers," they should also be good at designing well-conceived and detailed support plans under various complicated conditions. In fact, the support plans automatically produced by the system are so precise that they can not only show the specific model of any piece of ordnance, but can also tell the environment, weather, current and tide of the waters where support is needed.[371]

A Qingdao Logistics base reportedly has drawn on "good working relationships with about 20 schools inside and outside of the military, about 30 research organizations inside and outside of the military, and about 40 equipment production factories" to make great progress in solving practical problems associated with developing and maintaining equipment appropriate to support realistic training under informatized conditions. A resulting "'Automatic Mine Checking System' and 'Navy Ship Equipment Automatic Maintenance and Repair System' . . . earned military-wide first- and second-class awards for rear services equipment technological advances."[372] The PLAN has also developed a "simulation training system for mine clearance craft."[373] A plethora of articles in the Chinese journal *Sea Mine Warfare and Ship Self-Defense* demonstrate the strong Chinese conviction that mine warfare cannot be effective without weapons that work reliably.[374]

12. 布扫雷互相支持 *(MIW/MCM Mutual Support).* Chinese naval strategists are cognizant of China's traditional weakness in MCM and of resulting vulnerabilities. It is observed that "it will be extremely easy for an enemy to sow large numbers of mines among the many islands and numerous harbors . . . along China's southeast coast."[375] Chinese MCM will not reach the technological level of Western MCM in the near future. Although new platforms and technologies are now entering China's inventory of MCM capabilities, the basic approach is likely to remain different from that of the West.[376] Nevertheless, the exercise activity noted in the preceding section does suggest a reinvigorated commitment to MCM, as do the several new-type minesweepers that have entered the PLA Navy in the last few years (see above). Moreover, a major research effort in MCM seems to be under way.[377] This research includes advanced methods, such as employment of helicopters for MCM,[378] and UUVs.[379] *Science of Campaigns* observes that Chinese naval bases are likely to be targets of adversary mine warfare.[380] There also seems to be a fundamental conviction that a synergistic relationship exists between MCM and MIW—that China's mine countermeasures will fundamentally support robust mine warfare. One *People's Navy* article endorsed this and related capabilities as vital "sharp double-edged swords."[381] Indeed, to support minesweeping and minelaying exercises during March–September 2005, the PLAN "organized systematic training, observation, and exchanges with regard to the entire processes of ships' operations of sweeping and hunting for mines."[382] Reflecting their importance in Chinese mine warfare, civilian vessels are also participating in MCM exercises.[383]

13. 卫星航海 *(Satellite Navigation).* Knowing the precise location of mines is vital for creating and maintaining safe passages through or around minefields and for future clearing or reseeding efforts. A significant problem in past MIW campaigns has been that of friendly-fire casualties. Communications and navigation errors in wartime have frequently led MIW practitioners to destroy their own ships.[384] It is worth considering

Photo 12. Minesweeping Exercise. *Crewmembers on a PLAN East Sea Fleet mine countermeasures ship handle a towed noisemaker used to sweep acoustically triggered mines in May 2008. Already in the water is a marking buoy. Mine rails are visible on the deck to the right of the crane.*

how the advent of GPS technologies could enhance the future effectiveness of MIW if this technology enables much more accurate laying of fields (or MIW operations by less experienced cadres), as well as the transmission of information on the parameters of those fields to friendly units.[385] Mentions of GPS-related training activities in PLAN reports, including MIW and MCM exercises at night and in bad weather, may indicate that this new technology could become a significant MIW enabler.[386] This may also be suggested by a minesweeper unit's development of a "recording instrument" that "raises the accuracy and battle operations capacity of sea mine sweeping and laying."[387]

Threat and Response? Trends in Western Pacific Mine Countermeasures

This study has focused on the capabilities, training, and doctrine of Chinese mine warfare. However, sound strategic analysis must also examine the forces on the other side of the ledger—namely the mine countermeasures forces that may be tasked with countering the Chinese MIW threat.

At present, the prospects for American MCM forces rapidly countering Chinese MIW are not promising. The majority of U.S. Navy MCM assets are currently far from the fight. The nearest effective such units are two (soon to be four) minesweepers in Sasebo, Japan. They are only a day and a half from Taiwan. But even their arrival would not appreciably alter a worrisome situation. The bulk of U.S. mine-hunting assets are based in San Diego, California, having recently moved from Texas.[388] In addition, helicopter MCM assets that could reach the theater faster would face severe threats if they attempted to operate in contested airspace.[389] *Campaign Theory Study Guide,* for instance, calls on campaign commanders to "organize maritime and air mobile strength and island and coastal firepower to initiate multi-round, multi-directional attack in order to resolutely shatter the enemy's mine sweeping and barrier clearing attempt."[390]

To be sure, the U.S. Navy is currently in the midst of one of the most radical transitions in the history of its MCM programs. This transformation will, over the next decade, involve the decommissioning of all specialized U.S. Navy MCM vessels and their replacement by the Littoral Combat Ship (LCS). This ship is designed to enhance efficiency through "modular" engineering—the ability to accept different modules for different mission packages. The LCS type—the first unit, USS *Freedom* (LCS 1), was commissioned in November 2008—possesses improved "organic" mine locating and neutralization capabilities, including advanced sonar systems and unmanned underwater and -surface vehicles, which perform mine-locating missions. LCS carries MH-60S helicopters equipped with the Airborne Laser Mine Detection System to discover mines. It would destroy any mines so detected with either supercavitating projectiles fired from a specialized helicopter-mounted machine gun or with a fiber optic–guided, expendable, explosive UUV.[391] Other surface vessels and submarines will also be given enhanced sonar systems that will allow them to detect and avoid mines more effectively.

These changes constitute a shift from dedicated MCM vessels to "organic" mine countermeasures, a transition designed to address major trends in the field. The most traditional form of MCM is the use of simple devices to sever anchor chains on moored mines. Bottom mines, however, require a more advanced method, mimicking the triggering signals that passing ships create. Thus, helicopters tow sleds, and minesweepers tow drogues, which create magnetic and acoustic signals that satisfy detonation criteria, causing the mines to explode harmlessly. But, as mentioned previously, this mine-removal method is becoming less viable as the logic circuitry and software of bottom mines become increasingly sophisticated and harder to deceive. The current practice, therefore, is to search for bottom mines via high-resolution sonar and then destroy them with explosive charges. This method, known as "mine hunting," is a time-consuming and arduous process, requiring not only extremely accurate bathymetric mapping but also the painstaking investigation of every minelike object on the seabed in the area of concern. This requires advanced, expensive technology, specialized training, and high levels of localization accuracy.[392]

The U.S. Navy is on track to fund up to seven LCSs through fiscal year 2010, toward an eventual total of fifty-five vessels,[393] a plan strongly endorsed by Secretary of Defense

Robert Gates.[394] On the face of it, the commitment to LCS can be viewed as a strong commitment to MCM. After all, LCS will incorporate the most advanced MCM technology available, and the number of ships eventually deployed should exceed the current dedicated MCM inventory. The concept of LCS, moreover, as a relatively inexpensive ship built to venture into the shallows for high-intensity combat, is generally conducive to the mine countermeasures mission.[395] However, the experimental nature of LCS, and indeed the entire "modular" enterprise, brings a degree of risk in terms of crew proficiency and training, as well as the serviceability of the ship and its modules. Unfortunately, even if this transition reaches its optimal projected efficiency, the U.S. Navy will still be hard pressed to counter effectively the threat outlined in this study. Projected LCS numbers would certainly be adequate for another DESERT STORM, and even for opening the Strait of Hormuz in the event of a major conflict with Iran. But this projected order of battle will fall well short of what is required to combat the PLAN's hundreds, potentially even thousands, of delivery platforms for its large stockpile of mines. A credible response might entail increasing the LCS outlay significantly, producing a force prepared to accept significant attrition in paving the way for strike groups into potentially heavily mined western Pacific zones. Given current financial constraints, however, such a force is unlikely to materialize.

Taiwan's prospects for countering Chinese MIW are even more bleak, as its MCM forces are weak and extremely vulnerable to air and missile strikes. In contrast to Republic of China Air Force (ROCAF) aircraft, which are protected by revetments (though the runways from which they operate could easily be rendered unusable), Taiwan MCM forces are exposed and would likely be PLA priority targets. Taiwan possesses just a dozen mine warfare vessels. Four of these are the refurbished *Yung Yang*–class minesweepers, originally built in the United States in the mid-1950s. A Chinese source assesses these four ships as having "a definite detection capability for magnetic, magnetic influence, acoustic, and other detonators on conventional sea mines. These vessels' USQS-1 sonar . . . has the capability to detect moored mines, but cannot detect [bottom] mines."[396] Taiwan's order of battle also includes four smaller, but more modern, German-built MWV 50 *(Yung Fung)* mine hunters.[397] The same Chinese source claims that these vessels' mine-hunting sonar has not performed well but notes that their remotely operated explosive-emplacing mine-neutralization equipment has some significant capability.[398] Finally, Taiwan has four old U.S.-built *Adjutant*-class minesweepers that *Jane's* assessed in 1996 as having "more or less come to the end of their useful lives."[399]

In short, Taiwan has, at most, eight minesweepers that could attempt to counter Chinese mines. It is quite possible that none of these vessels are adept at actuating bottom mines, particularly those with modern fuses. Taiwan's ability to create safe passages through minefields, consequently, is very much in doubt. One assessment published in a PRC journal concludes that if Taiwan MCM forces were sent into battle, it would be a case of "pulling one's jacket off to reveal one's raggedness." This same analysis also observes that "if the Taiwan Navy loses command of the air and sea, then using aircraft or warships to sow mines becomes impossible" and would thereby cause its "fishing vessels . . . [to] commit suicide in the process of [trying to] lay defensive minefields." The analysis adds that Taiwan's navy "has no way to clear the specialized mines that might be part of an eastern coast blockade."[400]

These limitations in the combined ability of the United States and Taiwan to respond would doubtlessly prompt Washington and Taipei to seek other allies that could contribute to the effort. An obvious source for assistance would be Japan, with its twenty-six MCM vessels—it is illustrative of Tokyo's strong commitment to MCM that all these craft are of 1980s or newer vintage.[401] The February 2005 joint declaration by the United States and Japan that "encourag[ing] the peaceful resolution of issues concerning the Taiwan Strait through dialogue" is a "common strategic objective" offers some reason to believe that Tokyo might consider limited military support, such as mine clearing, in certain scenarios.[402] However, growing economic interdependence between Japan and China, the enduring pacifist undertones in Japanese politics (and the attendant inexperience of Japanese leaders in handling military-political crises), not to mention China's potential for retaliation (perhaps including the use of sea mines), all militate against bold action by Japan to counter Chinese mine warfare. Nevertheless, it is clear that Chinese naval strategists appreciate the important place of Japan in the overall Pacific MIW balance. A recent issue of *Naval and Merchant Ships,* for example, carried a nine-page spread devoted solely to analyzing Japanese MCM developments.[403]

It is also worth noting that PRC researchers intensively monitor U.S. Navy[404] and other Western[405] MCM trends and capabilities. PLAN researchers strive to understand research projects under way at the most advanced U.S. research institutes, such as the Naval Undersea Warfare Center in Rhode Island.[406] Chinese analysts are closely watching the U.S. Navy transition from specialized to organic MCM platforms and are probing for resulting strategic vulnerabilities.[407] Chinese researchers are following various overseas UUV designs and developments closely.[408] They are particularly interested in combat capabilities for UUVs—for example, the ability to deploy for long periods near enemy harbors to perform reconnaissance and possibly engage targets.[409] They are acutely aware that helicopter MCM is central to U.S. doctrine, and they follow minutely the details of the development and testing of new systems.[410] They are also very interested in the capabilities of *Virginia*-class submarines, especially their mine countermeasures.[411]

Having analyzed the prospects for direct counters to the PLAN's MIW development, it is possible to evaluate the strategic significance of Chinese MIW.

Scenarios

For that purpose, we now turn to examining the roles that Chinese MIW could assume within the most important scenarios for conflict in East Asia. Naturally, there is a tendency to focus on the Taiwan issue in this regard. However, analysts of Chinese defense policy must grapple with a variety of plausible scenarios, in view of Beijing's growing geostrategic weight in the maritime domain.

Little attention is paid to the maritime dimensions of China's potential role in a future conflict on the Korean Peninsula. However, given Korea's proximity to North China, such a conflict would impinge directly upon China's security interests. If Beijing looks to signal its equities in the early stages of a developing crisis without immediately resorting to the large-scale use of force, mine warfare might logically suit its purposes.[412] The PLAN could lay minimal minefields extending from the tip of the Shandong Peninsula toward North Korea's southwestern islands, not far from the thirty-eighth parallel.[413] A slightly more ambitious campaign, but nevertheless within PLAN capability, would be to lay mines in patterns extending directly eastward from Qingdao, one of China's largest naval bases, toward the South Korean coast. Either step could signal, with some subtlety, a determination to protect Pyongyang, and either would not only severely constrain U.S. Navy operations in the Yellow Sea but put considerable pressure on Seoul. Shallow water depths throughout this area underline the comparative simplicity of such campaigns.

A second set of scenarios to consider encompasses China's strategic interactions with Southeast Asia, particularly nations bordering the South China Sea. Here again, diplomatic tendencies are at present strongly positive, but the potential for conflict remains. Vietnam, the Philippines, Malaysia, and Indonesia all rely heavily on seaborne trade through shallow waters and constricted passages. All these countries, therefore, would be vulnerable to PRC mining, whatever the specific scenario.[414] Indeed, *Science of Campaigns* envisions the use of sea mines in the context of "Offensive Operations against Coral Reef Islands."[415] In a conflict over the Spratly Islands, Beijing could choose to reinforce its claims to specific islands with carefully limited minefields as an alternative to a prolonged, expensive, and potentially more provocative surface warship presence. Of all the states of Southeast Asia, Vietnam is plainly most susceptible to pressure from Chinese MIW.[416]

A third and more likely set of scenarios concerns conflict between the PRC and Taiwan. Although cross-strait relations have improved impressively since March 2008 with new leadership in Taipei, conflict in this delicate relationship cannot, unfortunately, be ruled out for the foreseeable future. To understand the possible role of Chinese mine warfare in these scenarios, it is useful to consider "minimal" and "maximal" alternatives. There are a variety of political and strategic reasons why Beijing might opt to minimize the military aspects. Foremost among them would be the desire to limit casualties and physical damage to Taiwan, so as not to stiffen the islanders' resistance. In this respect, MIW could be much more useful than a large missile barrage, which could very well kill many Taiwanese. The "grey zone" of hostile actions without major casualties—and thus no catalyzing casus belli to energize public opinion—would likely place Washington (and perhaps Tokyo) on the horns of a dilemma regarding intervention.

In this scenario, the major targets would be Taiwan's ports, most of which are highly susceptible to mining, given the shallow waters that surround most of Taiwan.[417] Major combat would be largely restricted to the suppression of Taiwan's navy and air force. *Campaign Theory Study Guide* states that Taiwan's military envisions the following scenario: "Naval and air blockade will be the inevitable combat phase, and using sea mines to combat the blockade will be the most cost efficient method. Within 4–6 days in the first phase, Taiwan will face a blockade of 5,000–7,000 sea mines; in the second phase, 7,000 more sea mines will be added to the blockade; the two phases will employ less than 15,000 sea mines, enough to cut off Taiwan's domestic and international sea transportation and supply routes."[418] Over approximately two days, the ports of Kaohsiung, Keelung, Taichung, and Hualian could be systematically closed off by air-dropped mines.[419] A Taiwan analyst has concluded that "it is possible to blockade a naval base or a medium-sized harbor by laying 100 aerial non-contact underwater mines, with the cost being equivalent to that of one anti-ship missile."[420] Simultaneously, or even to a limited extent beforehand, using mines with time-delayed activation, China's submarines, surface warships, and converted civilian merchant vessels could sow the waters adjacent to Taiwan with a variety of mines. In this scenario, the PLAN could reserve its most advanced platforms and rocket rising mines for Taiwan's eastern ports. Simultaneously, Beijing would warn outside powers to stay away, claiming that the waters east of Taiwan—a logical place for the United States and its allies to amass naval forces—had been "intensively mined," with drifting mines, and perhaps, again, with rocket rising mines. Given the fissures already present in Taiwan's society, the vulnerability of its economy to a blockade, and the likely sophistication and flexibility of PRC political goals (e.g., no forces from the mainland need be based on Taiwan), this scenario would have a reasonable chance of success. A combination of factors could make it attractive to Beijing, including the great physical distance involved, the irreducibly time-intensive nature of mine-clearing operations,[421] the likely sophistication of Chinese mines, the possibility that China would be able to reseed minefields, and the limited U.S. MCM forces available.

Major drawbacks of the above scenario from Beijing's perspective are that it not only depends on a rapid collapse of will in Taipei but would give the United States and its allies a chance to seize the initiative after the PLA's opening moves. A "maximal" PLA strategy—an amphibious invasion, with aggressive and wide-ranging preemptive strikes against U.S. (and possibly Japanese) forces—would, on the other hand, preclude these possibilities, perhaps by decapitating Taiwan's leadership before the assault.

If Beijing determined that Washington would indeed intervene on Taiwan's behalf, it might also strike out aggressively against U.S. forces in the Pacific. Options available could include the mining via submarine of waters off U.S. bases in Okinawa, other parts of Japan, Guam, and even perhaps Hawaii. One Chinese study on ASW suggests that mine warfare against adversary submarines is best conducted by laying "mines in the egress routes proximate to the enemy's bases . . . thus limiting the ability of enemy submarines to get out to the ocean."[422] Such ranges are well within the endurance limits of PLAN submarines, which could mine the necessary channels with mobile mines, provided that they were able to reach them undetected.[423] With regard to long-distance offensive MIW operations, it is perhaps noteworthy that Chinese naval analysts have evaluated the "success" of German submarine mining efforts along the American coast during World War II. The waters around Japan's southern Ryukyus are also susceptible to Chinese offensive mining operations. Another article suggests: "On the basis of a great quantity of research, the PLA believes that U.S. nuclear submarines are very quiet, [are] difficult to . . . counterattack . . . [and] must [be] restrained."[424] According to that analysis, this concern has been a major impetus for Chinese research on mobile mines; while mining operations in the vicinity of Guam are also suggested, the priority would be laying "[mobile] sea mines in each channel of the Pacific [Ocean's] First Island Chain, thereby forming together [a] blockade line [and] preventing U.S. nuclear submarines from entering China's nearby sea areas."[425]

Chinese researchers have also looked specifically at how mines might be used to support amphibious operations,[426] as well as how to counter adversary use of antilanding mines.[427] According to the *Science of Campaigns,* MCM operations are a vital component of the envisioned amphibious campaign.[428] Like the waters to the west, north, and south of Taiwan, those around the southern Ryukyus are susceptible to PRC offensive mining.[429] Mining these waters could keep U.S. surface warships and fast attack submarines in the deeper water east of Taiwan, where China could in turn concentrate its more capable weapons systems, including advanced diesel submarines. PLA analysts apparently contemplate using naval mines to establish such a sanctuary inside the First Island Chain, where PLAN ships and submarines could operate without fear of U.S. submarine attack.[430] Therefore, the focus of MIW in the second (maximal) scenario would be on interdicting opposing naval forces, whereas the emphasis in the first (minimal) scenario would be on closing Taiwan's ports.

Evaluating an Alternative View

Works examining the specific role of Chinese MIW within East Asian conflict scenarios are rare, so it is worth reflecting on one, published by Michael Glosny in the spring 2004 issue of *International Security* (hereafter IS), which comes to dramatically different conclusions than does this study. Glosny's study is profoundly useful, because it highlights the importance of undersea warfare within Taiwan Strait scenarios. It is also laudable for bringing rigorous methodological tools to bear on these complex questions. Unfortunately, however, its analysis, which concludes that the blockade threat to Taiwan is "overstated," is based on questionable assumptions that are by now clearly outdated.

Most important, the 2004 IS study vastly underestimates the volume and rapidity of a Chinese MIW campaign. Its author does this by assuming away most of China's available MIW platforms, leaving only a certain percentage of East Sea Fleet submarines. China's vast air forces (PLA Navy aviation forces and the PLA Air Force itself) are said to be irrelevant, because they cannot achieve "air dominance."[431] Likewise, PLAN surface assets are removed from the MIW equation, because "they would be very vulnerable to attack without air dominance." China's vast merchant marine and fishing fleets are not factored in, because "they would have trouble laying advanced mines, and it would be extremely complicated [to employ merchant ships for MIW]." Having narrowed the field of mine-delivering assets from thousands of candidate platforms to fewer than one hundred PLAN submarines, the IS author then reduces that number further, suggesting that only East Sea Fleet vessels could be involved (and not those from the other two major fleets), and finally trims this number again to reflect the customary readiness rates of various submarine fleets. In the end, he concludes that over a six-month period the PLAN could lay a maximum of 1,768 mines, more likely between 858 and 1,248 mines.[432] That these numbers are similar to the approximately one thousand that Iraq laid in the 1991 Gulf War and considerably less than the roughly three thousand figure North Korea achieved at Wonsan, both in far more asymmetric contexts, suggests that estimates in the 2004 IS study are well off the mark. As the present study amply demonstrates, Chinese MIW is robust and would not resemble either Iraqi or North Korean efforts in its scope or breadth.

Indeed, the conclusions of the 2004 IS study collapse when the air-dominance assumption is questioned. We contend that the PLA could destroy or render unusable the entire Taiwan air force within a number of days, if not hours.[433] Even making "heroic assumptions" about the survival of the ROCAF, it is well within the realm of possibility that the PLA Navy's aviation forces (and the PLAAF) would fly mine warfare missions in contested airspace, accepting a certain level of loss to hostile fire.[434] This study presents considerable evidence that the PRC is serious about mobilizing civilian craft for MIW. The assertion in the 2004 IS study that such an operation would be "complicated," though logical in theory, ignores the reality that Chinese planners have been considering this scenario for nearly six decades. Compared to challenges faced by the U.S. military, which simultaneously runs complex operations in almost every corner of the globe, the problem of equipping and organizing a large armada of civilian ships for MIW in close proximity to the Chinese coast is relatively simple, especially given the advent of GPS and related navigation technologies. Finally, we envision comprehensive involvement by each of the PLAN's fleets (and indeed the PLAAF as well) in a Taiwan scenario.

Other major flaws in the 2004 IS study concern Taiwan's ability to resist a Chinese MIW campaign. Contrary to conventional wisdom that merchant shipping to Taiwan would be halted by the simple announcement of a PRC blockade, its author presents historical data to argue that "shipping companies in wartime made huge profits by entering dangerous areas. . . . Merchant shippers continued to sail." However, the historical examples presented (Croatia, Lebanon, and the Iran-Iraq War) hardly approximate the lethal combat environment that would likely accompany a Chinese blockade of Taiwan.[435] If the world wars are better guides in this respect, the author of the 2004 IS study badly misunderstands the motives of merchant mariners and shippers.[436] Some shippers, driven by profit, might persuade their skippers to slip vessels through a PRC blockade, but the notion that merchant shipping will continue at the peacetime rate is unsound. Another problem with the quantitative models presented in the 2004 IS study is that they do not factor in attrition to Taiwan's mine countermeasures (or antisubmarine) capabilities. It is patently clear that the very ballistic missiles, cruise missiles, and other precision weapons that make the ROCAF's survival dubious portend the same for Taiwan's naval forces, especially under condition of surprise attack—for which the latter appear to be much less well prepared than is the ROCAF. A final problem with the 2004 IS study is its appraisal of Taiwan's will to fight, comparing it at various points to that of Britain or Germany during the world wars.[437] Even if Taipei does have some trappings of statehood, neither Britain nor Germany had an officer corps that was openly sympathetic to some of the adversary's goals—a bizarre situation that the author of the 2004 IS study recognizes.[438]

Perhaps the most unfortunate aspect of the 2004 IS study is that it is restricted to a China-Taiwan conflict, with no assessment of military involvement by either the United States or any allies. Although not stated directly by its author, the implication seems to be that if Taiwan is capable of coping with the MIW (and submarine) threats posed by the PRC, the U.S. Navy can defeat the Chinese MIW challenge easily. In fact, as the present study demonstrates at length, Chinese MIW is substantially geared toward major combat against a superior opponent—that is, the U.S. Navy and allied forces. There is no sense in obscuring this clear and present danger.

Policy Implications

This study elucidates a little-known aspect of Chinese naval development. It reveals that Chinese MIW represents a dynamic and ambitious sector within a PLAN that is plainly making rapid strides toward modernization.[439] It demonstrates that China's MIW draws extensively on the assimilated lessons of foreign experiences, as well as a surprisingly rich and relevant indigenous history.

China's mine inventory is not only extensive but likely contains some of the world's most lethal MIW systems. Indeed, China is on the cutting edge of mine warfare technology and concept development, and it already fields systems that advanced nations—the United States, for one—do not have in their arsenals. PLA strategists understand the human dimension of modern warfare, and this is evident in Chinese MIW. Indeed, Chinese naval periodicals reveal an increasingly impressive training regimen, one that goes beyond rote, scripted exercises. The present study points to a preliminary outline of a Chinese MIW doctrine that emphasizes speed, psychology, obfuscation, a mix of old and new technologies, a variety of deployment methods—and that additionally targets very specific U.S. Navy platforms and doctrines.

Beijing's military modernization program is a comprehensive effort, striking in both breadth and focus. Chinese MIW is noteworthy because it is one of a few warfare areas that could, in conjunction with other capabilities, suddenly and completely upset the balance of power in the western Pacific. Taiwan's MCM force is minimal and could be destroyed in preemptive strikes. Japan's MCM fleet is robust, but Tokyo remains a major "wild card" politically in a cross-strait conflict. Most fundamentally, U.S. and allied MCM forces are not sized or configured to "fight their way in" by operating in areas in which sea and air control are contested. Even in uncontested waters, MCM forces make operationally significant changes only slowly. Accordingly, Chinese MIW represents a point of major leverage for Beijing, wherein the asymmetry between Chinese offensive and U.S. defensive capability appears to be greater than in nearly any other warfare area, even antiship cruise missiles, submarines, and information warfare.

Given this significant challenge to U.S. maritime power, the following recommendations are offered for Navy and national policy makers:

- At a tactical level, all U.S. Navy warships should be fully prepared to operate effectively in waters that might be mined. The Navy's ongoing shift from dedicated MCM forces to organic capability residing in each warship indicates that this requirement has been recognized. This is particularly important for the submarine force, as fast attack submarines would doubtless be the first in the fight. There is strong evidence that the PRC is pursuing ASW primarily through the strategy of deploying advanced, deepwater mines. But rapid U.S. Navy deployment into combat is fraught with risk if the mine warfare threat is not addressed properly beforehand, and doing that will require painful resource- and training-priority trade-offs. For the surface fleet, the Littoral Combat Ship represents the future of U.S. Navy MCM, and the modules that support this combat skill set ought to receive the highest procurement priority. But the platform flexibility gained by modularity cannot be allowed to come at the cost of lower training standards, let alone marginalization of the MCM mission. Finally, Chinese technology appears set to render U.S. Navy helicopters and maritime patrol aircraft as feasible targets of MIW. It is not too early to start making the tactical adjustments to meet this emerging and unprecedented threat.

- At the operational level, it is apparent that U.S. Pacific Command lacks adequate MCM assets, and over the last decade this vulnerability may well have encouraged China's MIW program. The 2005 Base Realignment and Closure Commission's decision to move the mine countermeasures center from Ingleside, Texas, to San Diego, California, is a commendable first step toward remedying this discrepancy. Sending some of these units to Pearl Harbor or even Guam would be a justifiable second step, one that would also serve as a useful deterrent against any Chinese adventurism. Maintaining these "legacy" ships in the force and at a high state of readiness until new organic systems are in place and proven effective is crucial. In addition, a major reactivation of U.S. offensive mining programs, including a renewed emphasis on aerial laying of mines by the Air Force, should be considered for a deterrent role, in order to ensure that Chinese leaders understand the likely devastating consequences for China of all-out mine warfare against the United States. Exercises and war games, large and small, should incorporate significant MIW components, including a quantitatively and qualitatively significant adversary, extensive geographic parameters, both military and paramilitary targets, and the potential for high U.S. Navy casualties to proficient Chinese offensive MIW. In short, they should address the realities of this Chinese asymmetric maritime challenge.
- At the strategic level, it is imperative that U.S. military and diplomatic leaders understand that China *already* possesses more than enough capability to blockade Taiwan.[440] Moreover, China's ability to punish the U.S. military in a Taiwan conflict has increased radically over the last decade, in part because of the developing naval mine threat but due to other capabilities as well. As with so many aspects of the Chinese military challenge, geography appears to be the trump card. In this case, there is simply no way in which the United States or its potential allies can deploy forces adequate to interdict effectively a full-scale Chinese MIW campaign, which, as this study demonstrates, could be vast in scope. Once mines were deployed, the dangers to U.S. forces in-theater could be considerable. Given this threat, and particularly other major military commitments related to the global war on terror and

continuing military operations in the Greater Middle East, Washington seemingly has little choice but to adopt a cautious strategy concerning the Taiwan issue and face the uncomfortable truth that it cannot feasibly defend Taiwan militarily over the long term. A negotiating process, already reinvigorated between Taipei and Beijing since 2008, before the fact of Taiwan's military vulnerability is demonstrated in battle, is absolutely in the U.S. strategic interest. While supporting such a diplomatic solution, Washington should help Taipei strengthen its MCM capabilities and encourage Tokyo and other regional allies to maintain effective mine countermeasures forces as a hedge against the worst case. However, allied assistance in the MCM arena is no panacea and must not become a crutch, inhibiting the vital development of extensive U.S. Navy capabilities in this area.

This issue of China's naval expansion, particularly in mine warfare, is here to stay. The challenge before us is to grasp the serious challenges in Beijing's rapid maritime development, while also effectively preparing our naval forces in case of unexpected turbulence in this most vital relationship.

Notes

1. Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress,* Congressional Research Service [hereafter CRS] Report to Congress, Order Code RL33153 (Washington, D.C.: Library of Congress, updated 8 October 2008), p. 12.
2. See, for example, Bill Gertz, "Chinese Produce New Type of Sub," *Washington Times,* 16 July 2004, available at www.washtimes.com.
3. 王慧 [Wang Hui], "攻击航母的武器装备" [Weaponry and Equipment for Attacking Carriers], 当代海军 [Modern Navy], no. 10 (2004), p. 34. Identical phrasing is also found in other sources, for example, 刘复森 [Liu Fusen] and 王丽 [Wang Li], "美航母七大致命弱点" [Seven Big Weak Points of U.S. Carriers], 人民海军 [People's Navy], 9 December 2004, p. 3. For additional PRC analyses of the significance of mine warfare, see 崔峰, 尹小功 [Cui Feng and Yin Xiaogong], "有效的海战武器—水雷" [An Effective Naval Warfare Weapon: The Sea Mine], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2001); 傅金祝 [Fu Jinzhu], "水雷技术发展研究" [Sea Mine Technology Development Research], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000); "现代水雷综述" [Modern Sea Mine Summary], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (1999); and 夏立新 [Xia Lixin], "现代水雷的发展趋势" [Modern Sea Mine Development Trends], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (1999). For a recent discussion of sea mine trends, see 廉斌 [Lian Bin], 中国船舶重工集团公司第七一〇研究所 [710 Research Institute, CSIC], "现代水雷武器的技术特点与发展趋势" [The Technological Characteristics and Development Trends of Modern Sea Mine Weapons], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2006).
4. 迎南 [Ying Nan], "攻势布雷的兵力运用和特点" [The Military Employment and Characteristics of Offensive Mine Warfare], 舰船知识, [Naval and Merchant Ships], no. 40 (September 1999), p. 10.
5. 王伟 [Wang Wei], "历久弥新话水雷" [Enduring and Yet Fully Relevant: A Discussion of Sea Mines], 国防 [National Defense] (November 2002), p. 58. See also 傅金祝 [Fu Jinzhu], "水雷战 不容忽视" [Mine Warfare Must Not Be Ignored], 现代舰船 [Modern Ships], no. 156 (November 1998), p. 1.
6. 候建军 [Hou Jianjun], "美国海军水雷战装备" [U.S. Navy Mine Warfare Equipment], 当代海军 [Modern Navy], no. 6 (2003), p. 27.
7. 河山 [He Shan], "'弗吉尼亚'号能否成为新世纪海上霸主" [Can the *Virginia* Class Become the New Century's Maritime Hegemon?], 当代海军 [Modern Navy], no. 10 (2004), p. 21.
8. Shao Delun, Gao Chunzhan, and Xu Feng, "Underwater Firing Range: Torpedoes Become

'Smarter' in Drills: A Naval Testing Area Takes Aim at the Future Battlefield and Probes Ways to Enhance the Effectiveness of New Equipment," 解放军报 [Liberation Army Daily], 26 November 2006, OSC CPP20061129705003.

9. Information Office of the State Council, People's Republic of China, "China's National Defense in 2008," January 2009, pp. 33, 51, available at www.fas.org/nuke/guide/china/doctrine/wp2006.html.

10. 腾兆新, 张旭, 钱江 [Teng Zhaoxin, Zhang Xu, and Qian Jiang], "基于理想方案布雷方案评估" [Evaluation of Minelaying Plans Based on Ideal Plans], 兵工学报 [Acta Armamentarii] (November 2007), pp. 1405–408.

11. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, 战役学 [Science of Campaigns] (Beijing: 国防大学出版社 [National Defense Univ. Press], 2006), chap. 12. There is also a 2000 edition, but this study will refer only to the more sophisticated 2006 edition.

12. The term "assassin's mace" is best translated in colloquial English as "silver bullet." It is widely used in the Chinese strategic-studies literature. There is little evidence that it refers to specific hidden capabilities or "black" programs. An intelligent discussion of this issue is found in Alastair Iain Johnston, "Towards Contextualizing the Context of a *Shashoujian* (Assassin's Mace)" (August 2002, Harvard University Faculty of Arts and Sciences), available at www.people.fas.harvard.edu/.

13. 闾勇政, 张庆洲 [Lu Yongzheng and Zhang Qingzhou], "北海舰队某潜艇支队 砍掉12个不实用的战法" [A Certain North Sea Fleet Submarine Flotilla Discards 12 Impractical Combat Methods], 人民海军 [People's Navy], 11 December 2006, p. 3.

14. 孙文德 [Sun Wende], "高科技海上杀手—水雷" [High Tech Maritime Assassin's Mace: The Sea Mine], 金属世界 [Metal World], no. 5 (2001); "航母的三大杀手: 潜艇, 水雷, 反舰导弹" [Three Assassin's Maces for an Aircraft Carrier: Submarines, Mines, and Antiship Missiles], 舰船电子工程 [Ship Electronic Engineering], no. 5 (May 2001), p. 80; 宜恒, 新华 [Yi Heng and Xin Hua], "航母煞星: 对付航母的六大撒手锏" [Six Trump Cards to Cope with Aircraft Carriers], 国际展望 [World Outlook], no. 3 (February 2001), pp. 60–61; 任道南 [Ren Daonan], "潜艇布雷" [Submarine Minelaying], 现代舰船 [Modern Ships] (February 1998), p. 26.

15. Thomas J. Christensen, "Posing Problems without Catching Up: China's Rise and Challenges for U.S. Security Policy," *International Security* 25, no. 4 (Spring 2001), p. 29.

16. Michael Glosny, "Strangulation from the Sea?" *International Security* 28, no. 4 (Spring 2004), pp. 125–60.

17. 韩鹏, 李玉才 [Han Peng and Li Yucai, eds.], 水中兵器概论 (水雷分册) [Outline of Undersea Weaponry: Sea Mine Volume] (Xian: Northwest Industrial College Press, in cooperation with Beijing University of Aeronautics and Astronautics, Harbin Industrial College, and Harbin Engineering College, 2007), p. 1. For estimates of 1,100,000 and 3,700 respectively, see 熊武—主编 [Xiong Wuyi, chief ed.], "水雷" [Sea Mine], 当代军人辞典 [Modern Soldier Dictionary] (Beijing: 新华出版社 [Xinhua], 1988), p. 432. For an estimate of 2,500, see 陆建勋 [Lu Jianxun, ed.], 海军武器装备 [Naval Weaponry and Equipment] (Beijing: Atomic Energy, 2003), p. 108.

18. 陈冬元 [Chen Dongyuan], "神秘的水下卫士—反潜水雷的发展" [The Mysterious Underwater Sentry: Developments in Antisubmarine Mines], 国防科技 [Defense Science] (January 2001), p. 42.

19. Wang Wei, "Enduring and Yet Fully Relevant," p. 58. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 1. Interestingly, Chinese analysts have also studied Japan's aerial sea-mine operations during the Pacific War: 闻舞, 边磊 [Wen Wu and Bian Lei], "目标冲绳: 二战间日本仅有记载的一次航空布雷行动" [Target Okinawa: Japan's One Attempt at Air-Dropping Mines during the Second World War], 环球军事 [Global Military] (March 2007), pp. 54–56.

20. Ying Nan, "Military Employment and Characteristics of Offensive Mine Warfare," p. 10.

21. 史滇生 [Shi Diansheng], 世界海军军事史概论 [A Survey of the World's Naval War History] (Beijing: Sea Tide, 2003), p. 521. Royal Navy MCM operations in preparation for landings in the Falklands are also reviewed in丁一平 [VADM Ding Yiping, PLAN], 世界海军史 [World Naval History] (Beijing: Sea Tide, 2000), p. 771.

22. David Shambaugh, *Modernizing China's Military: Progress, Problems, and Prospects* (Berkeley: Univ. of California Press, 2002), p. 74.

23. Ibid., p. 69. See also Paul H. B. Godwin, "Change and Continuity in Chinese Military Doctrine," in *Chinese Warfighting: The PLA Experience since 1949,* ed. Mark A. Ryan, David M. Finkelstein, and Michael A. McDevitt (London: M. E. Sharpe, 2003), p. 46.

24. See, for example, 茹呈瑶, 夏银山 [Ru Chenyao and Xia Yin Shan], "海湾战争中的水雷和反水雷" [Mine and Counter-mine in the Gulf War], 现代舰船 [Modern Ships], no. 64 (April 1991), pp. 51–58; and 陈书海, 陈颖涛 [Chen Shuhai

and Chen Yingtao], "水雷: 多国部队海上的唯一障碍" [Sea Mines: The Coalition Forces' Single Naval Obstacle], 舰船知识 [Naval and Merchant Ships], no. 141 (June 1991), pp. 28–29.

25. This holds true for articles of scientific nature—for example, 田路, 陈伏虎, 钟铁城 [Tian Lu, Chen Fuhu, and Zhong Tiecheng], "反水雷技术的发展概况和声系统实现构想" [A Survey of MCM Technology and Sonar Development], 声学与电子工程 [Acoustic and Electrical Engineering] (April 2004), p. 17; and 刘忠 [Liu Zhong], "网路雷阵及其被动定位原理" [Mine Array Networks and Passive Location Principles], 海军工程大学学报 [Journal of Naval University of Engineering] 13, no. 6 (December 2001), p. 20. It holds true also for naval reference materials, such as in 陆建勋 [Lu Jianxun], ed., 海军武器装备 [Naval Weaponry and Equipment] (Beijing: Weapons Industry, 2003), p. 108, as well as in the conventional military press—for example, "对付航母战斗群的九个招术" [Nine Tactics for Coping with Aircraft Carrier Battle Groups], 当代海军 [Modern Navy] 3, no. 90 (March 2001), p. 33.

26. Unless otherwise indicated, material in this paragraph is derived from 傅金祝 [Fu Jinzhu], "海湾战争中的水雷战" [Mine Warfare in the Gulf War], 现代舰船 [Modern Ships], no. 75 (March 1992), pp. 30–33.

27. The statement as written is somewhat ambiguous. This could be interpreted as Fu's suggestion that China, as a "strong country," should also engage in mine warfare. Another possible interpretation is that Fu is emphasizing that strong states—the United States, for example—have employed mine warfare extensively and could do so against China in the future.

28. Unless otherwise indicated, material in this paragraph is derived from 沈游 [Shen You], "海湾战争中舰船装备'十思'" [Ten Reflections on Naval Equipment Deployed in the Gulf War], 现代舰船 [Modern Ships], no. 67 (July 1991), p. 10.

29. For doctrinal statements that embody this bifurcation, see "172. How Does One Determine the Main Cover Targets in a Naval Base Defense Campaign?" and "191. How to Attack and Block the Enemy's Unloading Harbors in a Maritime Traffic Sabotage Campaign?" in 薛兴林 [Bi Xinglin], ed., 战役理论学习指南 [Campaign Theory Study Guide] (Beijing: National Defense Univ. Press, 2002). For a discussion of offensive and defensive uses of mines, see 傅金祝 [Fu Jinzhu], "防御布雷和攻势布雷" [Defensive and Offensive Mining], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2008).

30. 傅金祝 [Fu Jinzhu], "伊拉克水雷失效的哪般" [What Explains the Failure of Iraq's Mines?], 舰船知识 [Naval and Merchant Ships] (August 2004), p. 45. A similar article that highlights U.S. MCM weaknesses is 大鹏 [Da Peng], "难说谁胜谁负" [It Is Difficult to Say Who Won and Who Lost], 当代海军 [Modern Navy] (June 2003), pp. 14–15.

31. Fu Jinzhu, "What Explains the Failure of Iraq's Mines?" p. 45.

32. Ibid.

33. 刘夏森 [Liu Xiasen], "台海战争一旦爆发: 美国真敢出兵吗?" [If a Taiwan Strait War Erupted: Would the U.S. Really Dare to Dispatch Troops?], 人民海军 [People's Navy], 21 August 2004, p. 3.

34. "八, 中国海军援越水雷战" [China's Navy Assists Vietnam with Sea Mine Warfare], in 金玮 李杰 [Jin Wei and Li Jie, eds.], 水雷战舰艇 [Modern Sea Mine Warships], 舰船知识丛书 [Naval Ship Series] (Beijing: 中国人民公安大学出版社 [Chinese People's Public Security Univ. Press], 1999), chap. 8, p. 117.

35. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 1; Joseph Needham and Robert Temple, *The Genius of China: 3,000 Years of Science, Discovery and Invention* (New York: Prion, 1998).

36. "水底龙王炮" [The Underwater Dragon King Cannon], in 军事大辞海·上 [Great Military Dictionary], 熊武一, 周家法 总编 [Xiong Wuyi and Zhou Jiafa, chief eds.] (Beijing: 长城出版社 [Great Wall], 2000), vol. 1, p. 564; "混江龙" [The All-Capable River Dragon], in Xiong Wuyi and Zhou Jiafa, chief eds., *Great Military Dictionary* (Beijing: Great Wall, 2000), vol. 2, p. 2787; "水雷" [Sea Mine], in 刘秋霖, 刘健, 王亚新等 编 [Liu Qiulin, Liu Jian, Wang Yaxin et al., eds.], 中国古代兵器图说 [Illustrations of China's Ancient Weapons], (Tianjin: 天津古籍出版社 [Tianjin Ancient Book], 2003), p. 408; "China's Navy Assists Vietnam with Sea Mine Warfare," in Jin Wei and Li Jie, eds., *Modern Sea Mine Warships,* p. 116.

37. Srikanth Kondapalli, *China's Naval Power* (New Delhi: Institute for Defence Studies and Analyses, 2001), p. xvii.

38. Stephen Turnbull, *Fighting Ships of the Far East: China and Southeast Asia 202 BC–AD 1419* (Oxford: Osprey, 2002), pp. 33–35.

39. 林长盛 [Lin Changsheng], "潜龙在渊: 解放军水雷兵器的现状与发展" [The Hidden Dragon in the Deep: The Present Situation and Development of PLA Mine Weaponry], 国际展望 [World Outlook], no. 9 (May 2005), p. 22. This article is perhaps the most comprehensive analysis to date of PRC sea-mine capabilities. Although this is a PRC source, Lin is actually a former Taiwanese military officer who recently spent time in the United States on a research fellowship. While Lin

includes frank analysis of continued PRC weakness in such areas as ASW, he also offers more recent details unavailable in other publications. Some are currently impossible to confirm and will be referred to accordingly in this article. For Lin's background, see William Chien, "U.S. Military—Iraq," *VOA News Report,* 22 April 2003, available at www.globalsecurity.org/ and www.1n0.net/2004/12-22/0442319087-7.html. Lin's other publications include "Counting China's ICBMs," *Studies on Chinese Communism* 37, no. 7 (July 2003), pp. 80–90.

40. 王广仁 [Wang Guangren], "东局子史话" [A History of the Eastern Bureau, Part 4], 汽车运用 [Automobile Applications] 102, no. 4 (2001), p. 49.

41. 胡胜利 [Hu Shengli], "国共两党军队合作布水雷考" [Kuomintang–Chinese Communist Cooperation in Inspecting the Laying of Sea Mines], 江淮文史 [Jianghuai Literature & History], 2001, no. 2.

42. Unless otherwise specified, material in the PRC sea-mine history, development, and research sections to follow is derived from 凌翔 [Ling Xiang], 第六章 "扬威海上的中国水雷战舰艇" [Chapter 6: Raise Mighty Chinese Sea Mine Warfare Ships on the Sea], in 当代水雷战舰艇大观 [Modern Sea Mine Warships Spectacle], 当代军舰大观系列丛书之五 [Modern Warship Spectacle Book Series, vol. 5] (Beijing: World Knowledge, 1995), pp. 152–61 (p. 152 for this reference).

43. 汪光鑫, 陈逸静 [Wang Guangxin and Chen Yijing], "东海目击: 军民联合海上扫雷演练" [On the Scene in the East China Sea: A Joint Military-Civilian Mine Sweeping Exercise], 舰船知识 [Naval and Merchant Ships] (January 2001), pp. 5–6.

44. For the Yangtze and Shantou operations, see also "China's Navy Assists Vietnam with Sea Mine Warfare," p. 92.

45. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 1; 曾筱晓, 董爱群 [Zeng Xiaoxiao and Dong Aiqun], "日本曾在朝鲜战争中出兵" [Japan Dispatched Troops to the Korean War], 环球军事 [Global Military], no. 20 (2002), p. 29.

46. 张宝善 [Zhang Baoshan], "水雷封锁—打击'台独'图谋的一种选择" [Mine Blockade: An Option to Foil the Conspiracy of "Taiwan Independence"], 现代舰船 [Modern Ships], no. 149 (April 1998), p. 10; 王维广 [Wang Weiguang], "'水中伏兵'—水雷" ['Underwater Ambush': Sea Mine], 国防 [National Defense], no. 4 (1996), pp. 36–37.

47. Gregory K. Hartmann with Scott C. Truver, *Weapons That Wait: Mine Warfare in the U.S. Navy* (Annapolis, Md.: Naval Institute Press, 1991), pp. 80, 106.

48. Edward J. Marolda, "Mine Warfare," *Naval History and Heritage Command,* www.history.navy.mil/wars/korea/minewar.htm.

49. Unless otherwise indicated, information in this paragraph is derived from 林有成 [Lin Youcheng], "忆赴朝鲜西海岸清川江口布设水雷" [Recollection of Laying Sea Mines at the Qingquan River's Mouth on Korea's Western Seacoast], 军事历史 [Military History], no. 5 (2003), pp. 65–66. The seventeen soldiers from China's Huadong Military Region were unsure of the depth at which their Soviet-manufactured moored buoyant mines should be laid and found that the methods suggested by their Soviet navy adviser were "inappropriate for immediate mission conditions." They were forced to improvise, and in the process learned the value of basing their methods on actual conditions.

50. Srikanth Kondapalli, "China's Naval Equipment Acquisition," *Strategic Analysis* 23, no. 9 (December 1999).

51. Soviet guidance and assistance were secured by the February 1950 Treaty of Friendship, Alliance, and Mutual Assistance. The Chinese Communist Party launched its first Five-Year Plan for industrial and agricultural development and production in 1953. By soliciting extensive Soviet aid and focusing on the development of heavy industrial plants and equipment, China doubled its industrial capacity within five years and established a comprehensive, if rudimentary, military-industrial base. Soviet advisers were withdrawn in September 1960 following deterioration of the bilateral relationship.

52. Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," p. 158.

53. Deng Liqun et al., eds., *China Today: Defense Science and Technology* (Beijing: National Defense Industry, 1993), vol. 1, p. 32.

54. 海林 [Hai Lin], "岛内军事利物利载防务专家预测—2010年台岛困死水雷阵: 解放军水雷战战力评估" [Taiwan's Own Military Affairs Experts' Forecast: In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array: An Evaluation of the People's Liberation Army's Sea Mine Warfare Combat Strength], 国际展望 [World Outlook], no. 9 (May 2005), p. 16.

55. Kondapalli, *China's Naval Power,* pp. 98–99.

56. Kondapalli, "China's Naval Equipment Acquisition."

57. Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," p. 159.

58. Kondapalli, *China's Naval Power,* pp. 98–99.

59. 竹繁 [Zhu Fan], "中国海军出国扫水雷" [China's Navy Goes Abroad to Sweep Mines], 炎黄春秋 [Yanhuang Chunqiu], no. 4 (1997), p. 35.

60. Preparation for "early war, big war, and all-out nuclear war" caused Mao to order roughly half of military production dispersed among a "Third Line" network in China's vast interior. This process, which occupied much of the 1960s and '70s and may have consumed as much as half of defense expenditures, dispersed scarce human and material resources and further challenged China's then-limited transportation infrastructure. The Cultural Revolution threw all but the most highly prioritized weapons programs into disarray, dividing bureaus into rival factions and even threatening rail links critical to the development of advanced weapons systems.

61. Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," pp. 154–55.

62. Qiang Zhai, *China & the Vietnam Wars, 1950–1975* (Chapel Hill: Univ. of North Carolina Press, 2000), p. 203.

63. 蔡朋岑 [Cai Pengcen], "人民海军援越扫雷始末" [The People's Navy's Minesweeping Operations in Support of Vietnam from Beginning to End], 舰载武器 [Shipborne Weapons] (March 2007), p. 34.

64. Zhu Fan, "China's Navy Goes Abroad to Sweep Mines," p. 35.

65. 雷冬 [Lei Dong], "中国海军扫雷纪实 (二): 援越扫雷扬军威" [A Record of PLAN Minesweepers (Part 2): Helping Vietnam Raise Impressive Military Minesweeping Strength], 现代舰船 [Modern Ships] (October 2004), pp. 32–34.

66. Cai Pengcen, "People's Navy's Minesweeping Operations in Support of Vietnam from Beginning to End," p. 34.

67. Zhu Fan, "China's Navy Goes Abroad to Sweep Mines," p. 37; Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," p. 155.

68. Information in this paragraph from Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," pp. 153–54, 160.

69. Ibid., p. 160.

70. Observations concerning hull 814 are derived from Lin Changsheng, "Hidden Dragon in the Deep," p. 32.

71. Mikhail Barabanov, "Contemporary Military Shipbuilding in China," *Eksport Vooruzheniy,* 1 August 2005, OSC CEP20050811949014.

72. "Chronicle of Events of Military Training," *Guangzhou Zhanshi Bao,* 27 December 2005, pp. 1, 3, OSC CPP20060224318002.

73. *Jane's Fighting Ships,* 9 February 2009, www.janes.com.

74. See post 38 of 1 March 2007 by "Xinhui" in the "PLAN Mine Warfare Threat" section of the China-Defense.com Forum, at www.china-defense.com.

75. George Pollitt, Johns Hopkins Applied Physics Laboratory mine warfare expert, e-mail exchange with authors, February 2009.

76. A *zhidui* (支队) is a division-leader level organization (using the PLA's fifteen-grade structure, which is based on army terminology). The best English translation is "flotilla." A *dadui* (大队) is a regiment-leader level organization; the best English translation is "squadron" for naval vessels and "group" for PLAN aviation, coastal defense, marine corps, and maintenance troops. For a detailed explanation of these and related terms, see Office of Naval Intelligence, *China's Navy 2007,* pp. 4–5.

77. 郑振麒, 方立华 [Zheng Zhenqi and Fang Lihua], "反水雷作战趟出实战化训练新路—东海舰队某扫雷舰大队创造4项海军记录" [Anti-Mine Operations Set Out on a New Path of Training Made Realistic to Actual War: A Certain East Sea Fleet Minesweeper Squadron Sets Four Navy Records], 人民海军 [People's Navy], 31 October 2008, p. 1.

78. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 18.

79. Lin Changsheng, "Hidden Dragon in the Deep," p. 26.

80. Thomas R. Bernitt and Sam J. Tangredi, "Mine Warfare and Globalization: Low-Tech Warfare in a High-Tech World," in Sam J. Tangredi, ed. *Globalization and Maritime Power,* (Washington, D.C.: National Defense Univ. Press, 2002), p. 395. The authors do not recognize that China has this weaponry.

81. See Bernard D. Cole, *The Great Wall at Sea: China's Navy Enters the Twenty-first Century* (Annapolis, Md.: Naval Institute Press, 2001), p. 103, for the high estimate and "Naval Mine-Hunting Unit Featured," *Lien-Ho Pao,* 20 April 1997, OSC FTS19970716000491, for the low. Both these guesses are now roughly a decade old.

82. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 16. For PRC research on remote-control sea mines, see 龙兴祖 [Long Xingzu], "遥控水雷及其在未来海战中的特殊作用" [Remote-Control Sea Mines and Their Use in Future Special Sea Warfare], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2000); 陈川 [Chen Chuan], "激光致声在水雷遥控中的应用研究" [The Sound-Sending Laser in Remote-Control Sea

Mine Applied Research], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (1999).

83. 茹呈瑶 [Ru Chengyao], "水雷" [Sea Mine], in 陈德第, 李轴, 库桂生 主编 [Chen Dedi, Li Zhou, and Ku Guisheng, chief eds.] 国防经济大辞典 [National Defense Economy Dictionary], (Beijing: 军事科学出版社 [Military Science], 2001), p. 906.

84. The depth limitations of Chinese mines are not known but are probably quite similar to those of Russian mines. The deepest waters in which most Russian bottom mines can be effectively laid range from fifty to two hundred meters. See Anthony Watts, "Russian Federation Underwater Weapons," *Jane's Underwater Warfare Systems,* 21 January 2005, www.janes.com.

85. Minesweepers can tow submerged cables with cutting devices attached. This apparatus, dragged through a suspected minefield, snags and severs the cables that attach the mines to their anchors. The Russian mine-manufacturing firm Gidropribor offers such sweeping mechanisms for sale; see its website, www.gidropribor.ru/eng/products/91/index.php4.

86. Chinese sources, including Lin Changsheng, "Hidden Dragon in the Deep," also refer to a "701 Research Institute" (中国舰船研究院701研究所), likewise located in Yichang. Confusing the matter further, the most detailed article available on the Institute's location calls it the "701 Research Institute" in English and the "710 Research Institute" in Chinese. See 刘见, 张玮, 齐小丹 [Liu Jian, Zhang Wei, and Qi Xiaodan], "中国船舶重工集团公司七一〇研究所" [Plan and Building Design of CSIC-No.701] (original English title), 华中建筑 [Huazhong Architecture], no. 4 (2006). For an earlier reference to a "701 Institute," see "七〇一研究所引进计算机辅助设计系统" [701 Research Institute Introduces Computer-Aided Design System], 船海工程 [Ship and Ocean Engineering], no. 4 (1985). For purposes of clarity, this study uses the term "710 Research Institute" throughout.

87. The paragraphs on Piao-1 and -2 are derived primarily from Lin Changsheng, "Hidden Dragon in the Deep," p. 24; and Wayne Mason, "Naval Mine Technologies," (briefing, Mine Warfare Association Spring 2009 Regional Conference, Panama City, Fla., 19 May 2009).

88. Ibid.

89. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* pp. 137–42.

90. The video clip, originally at web.search.cctv.com, has been removed from the CCTV website. An image from the television footage has been posted on *China Defense Forum* at www.china-defense.com/forum/index.php?showtopic=160&st=75.

91. See Lin Changsheng, "Hidden Dragon in the Deep," pp. 24–25.

92. The authors thank Professor Peter Dutton for these legal insights.

93. The following text is excerpted from 赵培英 [Zhao Peiying, ed.], 当代军人国际法基础 [Basis of International Law for Modern Soldiers], "全军军事科研工作 '八五' 计划列项课题" [Armywide Military Affairs Research Work Eighth Five-Year Plan Study Subject] (Beijing: 解放军出版社 [PLA Press], 1996), pp. 258–59.

"(2) Rules Regarding the Usage of Sea Mines and Torpedoes

"At the beginning of the 20th century sea mines were widely used in naval warfare, posing an enormous threat to international shipping and the interests of neutral nations. Consequently, their use had come under the regulation of international law. According to the 1907 *Hague Convention (VIII) relative to the Laying of Automatic Submarine Contact Mines,* although it is impossible to forbid the employment of sea mines, it is nevertheless desirable to restrict and regulate their employment in order to mitigate the severity of war and to ensure the security of peaceful navigation in times of war. The Convention prohibited the laying of unanchored automatic contact mines, except when they were so constructed as to become harmless one hour at most after the person who laid them ceases to control them. It prohibited the laying of anchored automatic contact mines which did not become harmless as soon as they have broken loose from their moorings; or the use of torpedoes which did not become harmless when they have missed their mark. Likewise it was forbidden to lay automatic contact mines off the coast and ports of the enemy, with the sole object of intercepting commercial shipping. When anchored automatic contact mines were employed, every possible precaution must be taken for the security of peaceful shipping. Neutral Powers which laid automatic contact mines off their coasts must observe the same rules as were imposed on belligerents, and they must inform ship owners and the Governments where mines have been laid through the diplomatic channel. The belligerents were likewise obliged to notify ship owners of the danger zones should their mines cease to be under surveillance, as soon as military exigencies permitted. At the close of the war, the Contracting Powers were obliged to remove the mines which they have laid, each Power removing its own mines. At the time a total of 44 nations became signatories to the Convention, although during the two World Wars both sides employed sea mines on a massive scale, declaring danger zones all around the world, thereby seriously undermining the rules of the Convention."

94. See ibid. See also 刘进 [Liu Jin], "水雷使用中涉及的国际法" [The Involvement of International Law in Sea Mine Use], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2000); 夏立新 [Xia Lixin], "水雷和军备控制" [Sea Mines and Arms Control], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2000).

95. Lin Changsheng, "Hidden Dragon in the Deep," pp. 22–23.

96. Rob Hewson, "Type 500 and 1000 Mines, Underwater Weapons," *Jane's Air-Launched Weapons,* www.janes.com. According to this source, these mines also have "eight operating modes, which are believed to be mixtures of fuze and logic settings to meet different operational or environmental conditions."

97. Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," pp. 154–55.

98. This has not always been the case. The first U.S. Destructor mines laid in Haiphong Harbor (simply converted gravity bombs detonated by magnetic signature change) were so sensitive, having been adjusted to destroy passing trucks when used against land targets, that a solar magnetic storm detonated the entire field prematurely. Hartmann with Truver, *Weapons That Wait,* pp. 72–80, 244.

99. Ibid., pp. 72–80, 129.

100. Lin Changsheng, "Hidden Dragon in the Deep," p. 24.

101. As implied in note 84 above, the very deepest that any of the very large Russian bottom influence mines can be laid is two hundred meters. Seventy meters is the maximum depth for the smaller Russian bottom mines. See Watts, "Russian Federation Underwater Weapons."

102. See, for example, 王伟, 郭大江 [Wang Wei and Guo Dajiang], "甚底频遥控 水雷全向数字接收机的研究" [Research on All-Around Digital Receiver for Very Low Frequency Remote-Controlled Naval Mines], 现代电子技术 [Modern Electronics Technology] (December 2007), pp. 1–3.

103. See U.S. Defense Dept., *Future Military Capabilities and Strategy of the People's Republic of China* (Washington, D.C.: November 1998), p. 14, available at www.fas.org/news/china/.

104. U.S. Defense Dept., *Annual Report on the Military Power of the People's Republic of China* (Washington, D.C.: June 2000), p. 16, available at www.defenselink.mil/.

105. 肖敏 [Xiao Min], 西北工业大学, 交通运输规划与管理 [Northwest Polytechnic University, Communications and Transportation Planning and Management], "主动攻击水雷鲁棒控制和仿真研究" [Research on Robust Control for Initiative Attack Mine and Simulation] (master's thesis, 9 June 2006); 肖敏, 史忠科 [Xiao Min and Shi Zhongke], 三峡大学, 西北工业大学 [Three Gorges University, Northwest Polytechnic University], "主动攻击水雷鲁棒跟踪控制研究" [Research on the Tracking and Robust Control of Initiative Attack Sea Mines], in 中国航空学会控制与应用第十二届学术年会论文集, 2006 年 [The Collected Works of the China Aviation Institute's Twelfth Annual Academic Meeting on Control and Applications, 2006].

106. Lin Changsheng, "Hidden Dragon in the Deep," p. 27.

107. Watts, "Russian Federation Underwater Weapons." Gidropribor more modestly claims a maximum depth of one thousand meters for its PMR-2 rising torpedo mine and for its PMR-2E rising rocket mine. See www.gidropribor.ru/eng/products.php4.

108. See Richard Fisher, "Chinese Notes from Aero-India and IDEX," *International Assessment and Strategy Center,* 28 February 2005, www.strategycenter.net/.

109. Samuel Morison, *Guide to Naval Mine Warfare* (Arlington, Va.: Pasha, 1995), pp. 88–89.

110. Rob Hewson, "EM 52 Mine, Underwater Weapons," *Jane's Air-Launched Weapons,* 14 April 2005, www.janes.com. This depth is probably a significant understatement of the true maximum operating depth, since a two-hundred-meter depth would severely limit its versatility and usefulness.

111. Lin Changsheng, "Hidden Dragon in the Deep," p. 26.

112. Ibid.

113. Ibid., p. 28.

114. U.S. Navy Dept., *U.S. Naval Mine Warfare Plan,* 4th ed. (Washington, D.C.: 2000). See also 李宝祥 [Li Baoxiang], "俄罗斯水雷武器的现状和未来" [The Present Situation and Future of Russian Sea Mine Weapons], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (1999).

115. "俄罗斯: 世界上的'水雷王国'" [Russia: The World's Sea Mine Kingdom], "外国海军纵横" [Foreign Navy Crisscross], 当代海军 [Modern Navy], no. 6 (2003).

116. 傅金祝 [Fu Jinzhu], "俄罗斯的火箭上浮水雷" [Russia's Rocket Rising Sea Mines], 舰载武器 [Shipborne Weapons] (April 2004), p. 65.

117. 焦方金 [Jiao Fangjin], "双头鹰的水中伏兵" [The Double-Headed Eagle's Ambush at Sea], 国防科技 [Defense Science] (July 2003), p. 90.

118. Ibid.

119. See, for example, ibid.

120. 邹字 [Zou Zi], "芬兰潜艇: 装备与作战历史" [Finnish Submarines: Equipment and Fighting History], 国际展望 [World Outlook], no. 490 (May 2004), p. 56.

121. Jiao Fangjin, "Double-Headed Eagle's Ambush at Sea," p. 91.

122. This quote and the remainder of this paragraph are drawn from 李克峰 [Li Kefeng], "俄罗斯火箭上浮水雷" [Russian Rocket Rising Sea Mines], 舰船知识 [Naval and Merchant Ships] (October 2002), pp. 34–36.

123. 刘新民, 徐红明 [Liu Xinmin and Xu Hongming], "亲历潜艇布战雷" [Firsthand Experience with Submarine Minelaying], 舰船知识 [Naval and Merchant Ships] 285, no. 6 (June 2003), pp. 6–7; "EM-52 Fast Rising Rocket Mine," Sinodefence.com. For details on a commanding officer of a Ming submarine practicing how to evade ASW defenses to "mine an 'enemy' harbor" (likely a Taiwan port), see 李振林, 张圣江 [Li Zhenlin and Zhang Shengjiang], "隐踪洋底练绝杀—312艇艇长胡文明; 蔡一清式一线指挥员风采录27" [Hiding the Trail at the Bottom of the Ocean to Practice Unique Kill: Submarine 312 Captain Hu Wenming; Series on Gallantry of Frontline Commanders in the Style of Cai Yiqing, Part 27], 人民海军 [People's Navy], 22 July 2008, p. 2.

124. Lin Changsheng, "Hidden Dragon in the Deep," p. 28.

125. See 茹呈瑶 [Ru Chengyao], "现代鱼雷, 水雷技术发展研究" [Modern Torpedo and Mine Technology Research], 舰船科学技术 [Ship Science and Technology] 25, no. 4 (August 2002), p. 42; 任德奎 [Ren Dekui], "水雷技术保障系统发展研究" [Sea Mine Technology Safeguard System Development and Research], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (1999); and 傅金祝 [Fu Jinzhu], "21世纪水雷发展预测" [Developments in Mines Expected for the 21st Century], 现代舰船 [Modern Ships], no. 140 (July 1997), p. 26.

126. 刘检, 黄文斌 [Liu Jian and Huang Wenbin], "一种自航水雷布概率的计算方法" [A Method of Calculating the Dispersion Probability of Self-Propelled Mines], 鱼雷技术 [Torpedo Technology] 13, no. 3 (September 2005), pp. 43–45.

127. See, for example, 倪永杰, 王建国 [Ni Yongjie and Wang Jianguo], 大连舰艇学院装备系统与自动化系 [Dalian Naval Vessel Academy, Equipment and Automation Systems Department], "潜布自航水雷障碍的效力计算方法" [Effectiveness Calculation Method for Submarine-Laid Self-Propelled Sea Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2007); and 许三祥 [Xu Sanxiang], 710 Research Institute, CSIC, "自导水雷及其自导装置发展初探" [The Development of Self-Guided Sea Mines and their Guidance Devices], 舰船科学技术 [Ship Science and Technology] (February 2008).

128. See 卢楠, 张旭 [Lu Nan and Zhang Xu], "自航水雷雷位误差对障碍伤概率影响分析" [Analysis on the Influence of an SLMM Position Deviation as It Relates to the Destruction Probability of a Mine Barrier], 指挥控制与仿真 [Command Control and Simulation] (May 2008); and 朱红波, 宋保维, 赵娥 [Zhu Hong, Song Baowei, and Zhao E], "一种自航水雷障碍效力的计算方法" [A Calculation Method of the Effectiveness of the SLMM Barrier], 弹箭与制导学报 [Journal of Projectiles, Rockets, Missiles and Guidance] (April 2007).

129. Ni Yongjie, Wang Jianguo, "Effectiveness Calculation Method for Submarine-Laid Self-Propelled Sea Mines," *Sea Mine Warfare and Ship Self-Defense,* no. 1 (2007); 洪星, 洪志平, 马爱民 [Hong Xing, Hong Zhiping, and Ma Aimin], "定向攻击水雷打击概率模型研究" [Striking Probability of Directional Attack Sea Mines], 情报指挥控制系统与仿真技术 [Information Command Control System and Simulation Technology] 26, no. 5 (October 2004), pp. 50–52, 60; 孙明太 [Sun Mingtai et al.], "应用统计法计算主动攻击水雷命中概率的仿真研究" [Application of Calculation of the Hitting Probability of Floating Rocket Mines by Simulation Methods], 弹箭与制导学报 [Journal of Projectiles, Rockets, Missiles and Guidance] 22, no. 2 (2001), pp. 48–51; 孙明太 [Sun Mingtai et al.], "应用统计法计算主动攻击水雷命中概率的仿真研究" [Simulation Study of the Active Attack Mine's Hitting Probability Using Statistical Methods], 系统仿真学报 [Journal of System Simulation] 12, no. 6 (November 2000), pp. 678–84.

130. 张宇文, 谢建辉 [Zhang Yuwen and Xie Jianhui], "自航水雷沉底稳定性与自航性能的兼容性问题" [The Problem of Compatibility between Stability of Self-Propelled Mines on the Ocean Floor and Their Moving Performance], 舰船工程 [Ship Engineering] 5, 1997, pp. 46–49.

131. 陈雄洲, 舒旭光, 廉斌 [Chen Xiongzhou, Shu Xuguang, and Lian Bin], "水下火箭发动机喷管出口压强研究" [Study on the Pressure Strength of Nozzle Exit for Underwater Rocket Motor], 舰

船科学技术 [Ship Science and Technology] 26, no. 6 (December 2004), pp. 38–40; 刘乐华 [Liu Lehua et al.], "自主攻击水雷发射流场分析与数值仿真" [Analysis and Numerical Simulation of Automatic Attacking Mines' Jet Flow Field], 实验力学 [Journal of Experimental Mechanics] 17, no. 4 (December 2002), pp. 488–91.

132. 刘乐华, 张宇文 [Liu Lehua and Zhang Yuwen], "深海垂直发射内弹道研究" [Study on the Interior Trajectory for Vertical Launch under Deep Sea], 舰船科学技术 [Ship Science and Technology] 26, no. 1 (February 2004), pp. 24–26; 李体方, 张志峰 [Li Tifang and Zhang Zhifeng], "海浪作用下的水下弹道数学模型" [Mathematical Modeling of the Effect of Sea Waves on an Underwater Missile Trajectory], 弹道学报 [Journal of Ballistics] 11, no. 3 (September 1999), pp. 47–51; 袁绪龙, 张宇文, 查展鹏, 刘乐华 [Yuan Xulong, Zhang Yuwen, Zha Zhanpeng, and Liu Lehua], "基于高端平台的水雷弹道视景仿真研究" [Torpedo Sea Mine Trajectory Visual Simulation Based on High-End Platforms], 舰船科学技术 [Ship Science and Technology] 26, no. 1 (February 2004), pp. 35–38.

133. 张旭, 滕兆新 [Zhang Xu, Dalian Naval Vessel Academy; and Teng Zhaoxin, Northwestern Polytechnical University], "水雷封锁作战决策科学化的思考" [Thoughts on Scientific Decision Making in Mine Blockade Warfare], 军事运筹与系统工程 [Military Operations Research and Systems Engineering] (June 2008), pp. 59–62.

134. 王容, 李庆民, 李华 [Wang Rui, Li Qingmin, and Li Hua], Department of Weaponry Engineering, Naval University of Engineering, Wuhan, supported by the National Defense Preliminary Research Fund, "马尔科夫链扫雷效果评估模型可信度验证" [Validation of Credibility of Markov Chain Mine Sweeping Effectiveness Evaluation Model], 海军工程大学学报 [Journal of Naval University of Engineering] 19, no. 6 (December 2007), pp. 108–12.

135. 胡红波, 马爱民 [Hu Hongbo and Ma Aimin], Dalian Naval Vessel Academy, "MATLAB 神经网络的舰船磁场强度估算" [Estimation on Intensity of Magnetic Field around Warship Based on NN in MATLAB], 火力与指挥控制 [Fire Control and Command Control] 32, no. 2 (February 2007), pp. 77–79.

136. See 赵晓哲, 沈治河主编 [Zhao Xiaozhe and Shen Zhehe, chief eds.], 海军作战数学模型 [Mathematical Models for Naval Warfare] (Beijing: National Defense Industry, 2004), foreword, pp. 25–37, 44–45.

137. 陈孟君, 赵治平, 谭华 [Chen Mengjun, Zhao Zhiping, and Tan Hua], 710 Research Institute, CSIC, "通电二电极对水雷的干扰性研究" [Research on Two Electrodes' Interference on Sea Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2007).

138. 吴中平, 韩召, 赖建云 [Wu Zhongping, Han Zhao, and Lai Jianyun], 中国船舶重工集团公司第七一〇研究所 [710 Research Institute, CSIC], "高速摄影的照明测试与分析" [Illumination Testing and Analysis of High-Speed Photographs], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2006).

139. 胡敏 [Hu Min], 中国船舶重工集团公司第七一〇研究所 [710 Research Institute, CSIC], "一种新型大容量水雷内记仪" [A New Large Capacity Mine Internal Recorder], 舰船科学技术 [Ship Science and Technology], no. 2 (2007).

140. 杨翠云, 李永红, 闫建生, 张玉东, 熊志红 [Yang Cuiyun, Li Yonghong, Yan Jiansheng, Zhang Yudong, and Xiong Zhihong], 中北大学电子工程系; 科泰微技术有限公司技术中心; 中国船舶重工集团公司第710研究所 [Zhongbei University Electronic Engineering Department; Elcoteq Micro Technology Co., Ltd. Technology Center; and 710 Research Institute, CSIC], "水雷用定深测控系统的设计和实现" [Design and Implementation of a Sea Mine Depth Measurement and Control System], 微计算机信 [Microcomputer Information], no. 28 (2007).

141. 彭荆明, 李兴生; 中国船舶重工集团公司第七一〇研究所 [Peng Jingming and Li Xingsheng, Yichang Testing Technique Research Institute/710 Research Institute, CSIC] and 帅高山, 海军驻宜昌地区军事代表室, 湖北宜昌 [Shuai Gaoshan, Military Representives Office of the Chinese Navy in Yichang], "国军标在水雷软件工程化中的应用" [National Military Standard and Its Application in Mine Software Engineering], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2007).

142. The system should be based on "analog circuit fault diagnosis techniques." 赵延安 [Zhao Yanan], 西北工业大学, 检测技术及自动化装置 [Northwest Polytechnic University, Detection Technology and Automation Devices], "某型水雷引信故障诊断技术研究及测试系统设计" [Research on Fault Diagnosis Techniques for Certain Mine Fuses and Design of a Testing System] (master's thesis, 23 May 2007). For similar research, see 寇琼月, 艾华, 宋磊 [Kou Qiongyue, Ai Hua, and Song Lei; Mailbox 1014 18, Beijing 102249] and 黄天琰, 95202部队计量站 [Huang Tianyan, PLA Unit 95202, Guangdong 528227], "水雷专用测试设备计量校准系统的设计与实现" [Design and Realization of the Metrological Calibration System for Special Sea Mine Test Equipment], 电子测量技术 [Electronic Measurement Technology], no. 11 (2008).

143. 周丰 [Zhou Feng et al.], "卡尔曼滤波在水雷引信目标定位中的应用" [Application of Kalman

Filter to Target Location of the Mine Fuse], 海军工程学院学报 [Journal of Naval University of Engineering] 89, no. 4 (1999), pp. 21–25.

144. 刘军, 王树宗 [Liu Jun and Wang Shuzong], "两种水雷破坏半径计算方法比较与实例分析" [Two Methods of Calculating a Mine's Blast Radius: A Comparison and Sample Analysis], 舰船科学技术 [Ship Science and Technology] 27, no. 4 (August 2005), pp. 59–61.

145. 刘进 [Liu Jin], "水雷壳体厚度对水雷性能的影响" [The Influence of Sea Mine Shell Thickness on Sea Mine Function], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2000).

146. 腾兆新, 张旭 [Teng Zhaoxin and Zhang Xu], Dalian Naval Vessel Academy, "水雷对舰船的毁伤概率计算模型及仿真" [Model for Calculating the Damage Probability of Sea Mines against Warships], 系统仿真学报 [Journal of System Simulation] 20, no. 16 (August 2008), pp. 4241–43; 描锦, 帅高山 [Miao Jin and Shuai Gaoshan], "水面爆炸损失模型的探讨" [Evaluation of a Surface Explosion Model], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2008); 张志宏 [Zhang Zhihong], "预测航线上的水压水雷对舰船损伤的新方法" [A New Way to Calculate Damage to Shipping by Hydraulic (Water Pressure) Sea Mines in Shipping Lanes], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000).

147. 方毓景, 冯陵波, 刘维基, 李青梅 [Fang Yujing, Feng Linbo, Liu Weiji, and Li Qinmei], "火箭上浮水雷噪声特性测量分析" [The Measurement and Analysis of the Noise Characteristics of Rocket-Propelled Rising Mines], 现代引信 [Modern Fuses], no. 1 (1998), pp. 58–62.

148. 王海燕 [Wang Haiyan], "利用目标噪声频域信息的定位方法研究" [Research on Localization Method Using the Information of Frequency Domain of a Target-Radiated Noise], 现代引信 [Modern Fuses], no. 2 (1998), pp. 46–49.

149. 张旭, 冷相文 [Zhang Xu and Leng Xiangwen], "自航水雷雷位次序坐标散布特性" [The Distributed Characteristics of Ordering Coordinates of a Submarine-Launched Mobile Mine's Position], 火力与指挥控制 [Fire Control and Command Control] 29, supplement (June 2004), pp. 47–48, 51; 张云海 [Zhang Yunhai], "水雷潜布弹道研究" [Submarine-Laid Sea Mine Trajectory Research], 舰船科学技术 [Ship Science and Technology], no. 1 (1995), pp. 26–31.

150. 刘旭晖 [Liu Xuhui], "水鱼雷发展趋势深讨" [Mine Torpedo Development Trends], 鱼雷技术 [Torpedo Technology] 11, no. 2 (June 2003), pp. 4–7.

151. Shao Delun, Gao Chunzhan, and Xu Feng, "Underwater Firing Range." For similar effort expended in perfecting "safety support and underwater tracking and positioning" for "a high precision and long-range mine test," see Mao Jinxiong, Xiao Delun, and Chen Wanjun, "Miraculous Sword Holding Up Sea and Sky," *Liaowang,* no. 41, 13 October 2008, pp. 52–53, OSC CPP20081023710017.

152. This process is conceptually similar to the addition of a JDAM (Joint Direct Attack Munition) tail kit or the U.S. upgrading of "dumb" bombs into Destructor mines through use of film transistors as magnetic fuses for employment in North Vietnam's Haiphong Harbor.

153. See, for example, 詹广平, 倪华, 张光法 [Zhan Guangping, Ni Hua, and Zhang Guangfa], "专家系统在智能水雷引信中的应用研究" [Applications Research Concerning Expert Systems on Intelligent Mine Fuse Systems], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2007).

154. 谢磊, 上海船舶电子设备研究所 [Xie Lei, Shanghai Marine Electronic Equipment Institute] and 李秀坤, 哈尔滨工程大学 [Li Xiukun, Harbin Engineering University], "水雷目标的亮点信息提取及融合研究" [Research on the Extraction and Fusion of Sea Mine Highlight Information], 声学技术 [Technical Acoustics] 27, no. 5, part 2 (October 2008), pp. 508–509.

155. 周穗华 [Zhou Suihua et al.], "智能化水雷引信及其评估方法" [The Intelligized Sea Mine Fuse and its Fuzzy Evaluation Method], 海军工程大学学报 [Journal of Naval University of Engineering] 16, no. 1 (February 2004), pp. 48–53, 82; 李艳丽, 程塞先 [Li Yanli and Cheng Saixian], "人工神经网络技术在目标识别中的应用" [Application of Artificial Neural Network Based on Target Recognition], 舰船电子工程 [Ship Electronic Engineering] 24, no. 5 (2004), pp. 92–95; 韩鹏 [Han Peng et al.], "适于水雷工作的软件引信研究" [Study on Software Fuses for Mines], 探测与控制学报 [Journal of Detection and Control] 25, no. 1 (March 2003), pp. 44–47; 周穗华 [Zhou Suihua], "现代水雷控制电路中开关器件可靠性分析及其应用" [Reliability of Switching Components in the Mine Control Circuit], 海军工程大学学报 [Journal of Naval University of Engineering] 15, no. 1 (February 2003), pp. 38–41; 傅金祝 [Fu Jinzhu], "水雷的非触发引信" [Influence Fuses of Mines], 现代舰船 [Modern Ships], no. 137 (May 1997), p. 30.

156. 郑新明, 郝力勤, 陈刚 [Zheng Xinming, Hao Liqin, and Chen Gang], 中国船舶重工集团公司第710研究所 [710 Research Institute, CSIC], "基于功率谱的舰船水压信号检测方法研究" [A Method of Ship Hydraulic Pressure Signal Detection Based on Power Spectrum], 指挥控

制与仿真 [Command Control and Simulation], no. 1 (2008); 张晓兵, 玄兆林 [Zhang Xiaobing and Xuan Zhaolin], "使用双水压传感器抗风浪干扰原理" [Principles of Counteracting Wave Disturbance by Two Pressure Sensors], 海军工程大学学报 [Journal of Naval University of Engineering] 15, no. 5 (October 2003), pp. 65–67, 74. See also 傅金祝 [Fu Jinzhu], "非触发引信用的流体动力换能器原理样机的结构与实验" [Construction and Testing of Prototype Hydrodynamic Transducers for Influence Sea Mine Fuses], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2008).

157. 王闵, 董大群, 孙玉兰, 刘叶红 [Wang Min, Dong Daqun, Sun Yulan, and Liu Yehong], "弱信号自适应检测技术研究" [Research on the Adaptive Weight Vector Technique of Detecting Weak Signals], 探测与控制学报 [Journal of Detection and Control] 27, no. 2 (June 2005), pp. 45–47, 54.

158. Naval University of Engineering researchers, for example, are studying how to make mines more resistant to sweeping by altering their shapes. 谭昕, 玄兆林, 张小兵 [Tan Xin, Xuan Zhaolin, and Zhang Xiaobing], "水雷不同外形目标强度的计算与测量" [Calculating and Measuring the Target Strength of Different Shapes of Mines], 海军工程大学学报 [Journal of Naval University of Engineering] 16, no. 2 (April 2004), pp. 69–73; 程锦房, 何希盈, 王文水 [Cheng Jinfang, He Xiying, and Wang Wenshui], "基于舰船声磁相关的水雷抗扫性能研究" [Sea Mine Antisweeping Performance Research Based on the Correlation of Ship Magnetic Fields and Acoustic Fields], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2008); 玄兆林, 谭昕, 张小兵 [Xuan Zhaolin, Tan Xin, and Zhang Xiaobing], "水雷总体的声学问题" [The Acoustical Problem of Sea Mine Collectivity], 海军工程大学学报 [Journal of Naval University of Engineering] 14, no. 6 (December 2002), pp. 10–12, 18. For research concerning sweeping resistance, see 傅金祝 [Fu Jinzhu], "水雷发火判据的数学理论" [Mathematical Theory for Sea Mine Detonation Criteria], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2000); and 傅金祝 [Fu Jinzhu], "海中类似水雷目标引起的声散射自回归分析" [An Autoregressive Analysis of Acoustic Scattering Caused by Minelike Targets in the Ocean], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (1999).

159. Shao Delun, Gao Chunzhan, and Xu Feng, "Underwater Firing Range."

160. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry.*

161. 何洁莹 [He Jieying], "水雷伞的飞行轨迹研究" [Study on the Flight Path of Mine Parachutes], 南京航空航天大学学报 [Journal of Nanjing University of Aeronautics and Astronautics] 26, no. 4 (August 1994), pp. 545–50.

162. 高大全 [Gao Daquan], "'航天器回收技术' 在兵器上的应用" [The Application of "Space Recovery Technology" in Armaments], 航天返回与遥感 [Spacecraft Recovery and Remote Sensing] 19, no. 3 (August 1998), pp. 16–20.

163. 韩光智 [Han Guangzhi], 中北大学, 测试计量技术及仪器 [Zhongbei University, Testing Measurement Technology and Instrumentation], 空投水雷冲击过载测试技术研究 [Research on the Impingement Acceleration Test of the Air-Drop Mine] (master's thesis, 14 October 2008); 宋保维, 杜晓旭, 孟锐, 李家旺, 绍成 [Song Baowei, Du Xiaoxu, Li Jiawang, and Shao Cheng], "空投水雷入水冲击力仿真" [Numerical Simulation of Water-Entry Impact Force for Air-Launched Mines], 鱼雷技术 [Torpedo Technology] (March 2008); 潘光, 伟刚, 杜晓旭 [Pan Guang, Wei Gang, and Du Xiaoxu], "空投水雷入水及水下弹道的设计与仿真" [The Design and Simulation of Water Entry and Underwater Trajectory for an Air-Dropped Sea Mine], 火力与指挥控制 [Fire Control and Command Control] (March 2007), pp. 85–93.

164. 于汉玉 [Yu Hanyu], "飞机布雷效能评估—数模建立和指数分析" [An Evaluation of Minelaying by Aircraft: An Analysis That Establishes a Mathematical Model and Index], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (1998).

165. Shao Delun, Gao Chunzhan, and Xu Feng, "Underwater Firing Range."

166. See, for example, 徐阳 [Xu Yang], "国外反水雷技术装备的发展" [Foreign Development of MCM Technology and Equipment], 舰载武器 [Shipborne Weapons], no. 1 (2002), pp. 39–42.

167. See, for example, 邹洋 [Zou Yang], 哈尔滨工程大学, 信号与信息处理 [Harbin Engineering University, Signals and Information Processing], "水雷目标识别信息融合方法研究" [Research on Methods of Information Fusing for Mine Recognition] (master's thesis, 21 August 2007); 陈萍 [Chen Ping], 哈尔滨工程大学, 信号与信息处理 [Harbin Engineering University, Signals and Information Processing], "分数阶Fourier变换在水雷目标特征提取中的应用" [The Application of the Fractional Fourier Transform in the Extraction of Mine Characteristics] (master's thesis, 21 August 2007); 迟慧广 [Chi Huiguang], 哈尔滨工程大学, 水声工程 [Harbin Engineering University, Acoustical Engineering], "希尔伯特—黄变换在水雷目标特征提取中的应用" [The Application of the Hilbert-Huang Transform in the Extraction of Mine Characteristics] (master's thesis, 21 August 2007); 于妮娜

[Yu Ninuo], 哈尔滨工程大学, 通信与信息系统 [Harbin Engineering University, Communication and Information Systems], "基于支持向量机的水雷目标识别研究" [Research on the Mine Target Recognition Based on Support Vector Machines] (master's thesis, 2007); 郭丽华, 王大成, 丁士圻 [Guo Lihua, Wang Dacheng, and Ding Shiqi], "水下目标特征提取方法研究" [Research Concerning the Extraction of Underwater Targets' Features], 声学技术 [Technical Acoustics] 24, no. 3 (September 2005), pp. 148–51, 156; 郭丽华, 王大成,丁士圻 [Guo Lihua, Wang Dacheng, and Ding Shiqi], "水雷目标识别中的数据融合技术" [Data Fusion Technology for Recognition of Mine Characteristics], 海洋技术 [Ocean Technology] 24, no. 2 (June 2005), pp. 36–38, 45.

168. 赵祚德 [Zhao Zuode], "甚于概率推断网的水雷战专家系统" [An Expert System for Mine Warfare Based on a Probabilistic Inference Network], 情报指挥控制系统与仿真技术 [Information Command Control Systems and Simulation Technology] 27, no. 2 (April 2005), pp. 52–56.

169. 缪涛, 张志宏, 顾建农 [Miao Tao, Zhang Zhihong, and Gu Jiannong], 海军工程大学理学院 [College of Science, Naval University of Engineering, Wuhan], "浅水低速舰船通过雷区危险航速的预报模型" [Forecast Model of Dangerous Speed When Ships Pass a Mine Area in Shallow Water at Low Speed], 舰船科学技术 [Ship Science and Technology], no. 5 (2008).

170. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 4.

171. Jiao Fangjin, "Double-Headed Eagle's Ambush at Sea," p. 91.

172. Wang Wei, "Enduring and Yet Fully Relevant," p. 58.

173. Chen Dongyuan, "The Mysterious Underwater Sentry," p. 45.

174. 刘衍中, 李祥 [Liu Yanzhong and Li Xiang], "实施智能攻击的现代水雷" [Carrying Out Intelligent Attacks with Modern Mines], 当代海军 [Modern Navy] (July 2006), p. 29.

175. 沈国光, 李德筠, 李润珊, 王继红 [Shen Guoguang, Li Deyun, and Wang Jihong], "大当量爆炸兴波的数值模拟" [A Mathematical Simulation of a Wave from a Large Explosion], 海洋学报 [Acta Oceanologica Sinica] (September 1996), pp. 128–33.

176. Some European countries have reportedly fielded sea mines with antiaircraft capabilities, and the United States has apparently conducted research in this area as well.

177. Wang Wei, "Enduring and Yet Fully Relevant," p. 59. This capability is also hinted at in the introduction of Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 1.

178. Wang Wei, "Enduring and Yet Fully Relevant," p. 59.

179. Lin Changsheng, "Hidden Dragon in the Deep," p. 28.

180. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* p. 155.

181. Ibid., p. 29.

182. 李宝祥, 董大群 [Li Baoxiang and Dong Daqun], "导弹水雷" [Guided Missile Sea Mines], in 栾恩杰 [Luan Enjie, chief ed.], 国防科技名词词典: 船舶 [National Defense Science & Technology Phrase Dictionary: Shipping] (Beijing: 航空工业出版社/兵器工业出版社/原子能出版社 [Aviation Industry Press/Weapons Industry/Atomic Energy], 2002), p. 78.

183. One article states that the system would use a thousand bottom mines—with sonar, magnetic, or pressure fuses—in six salvoes from twenty-eight launchers to blockade a port in three hours. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 18. China has over three decades of experience with relatively simple, shorter-range rocket deployment of the smaller types of land mines and has developed advanced multiple-launch rocket systems (MLRSs). 沙兆军 [Sha Zhaojun], 炮兵学院南京分院 [Nanjing Artillery Academy], "火箭布雷弹抛撒均匀性评定模型及仿真研究" [Rocket Minelaying Bomb Distribution Assessment Model and Simulation Study], in ed. 陈宗海 [Chen Zonghai], 2007系统仿真技术及其应用学术会议论文集 [The Collected Works of the 2007 Systems Emulation Technology and Applications Science Conference], 高云飞, 李晓燕, 王宁 [Gao Yunfei, Li Xiaoyan, and Wang Ning], 解放军理工大学工程兵工程学院 [Engineering Corps Institute, PLA University of Science and Technology, Nanjing], "蒙特卡罗法在火箭布雷中的应用" [The Application of the Monte Carlo Method in Rocket Minelaying], in 陈光亚 [Chen Guangya, ed.], 科学发展观与系统工程—中国系统工程学会第十四届学术年会论文集, 2006 年 [Scientific Outlook on Development and Systems Engineering: Proceedings of the 14th Annual Conference of Systems Engineering Society of China, 2006], 兰宁远 [Lan Ningyuan], "'现代雷神' 李钊" [Li Zhao, "The Modern Mine God"], 海内与海外 [At Home and Overseas], no. 11 (2004); "中国74式布雷火箭系统" [China's Type 74 Minelaying Rocket System], 现代兵器 [Modern Weapons], no. 11 (1998); 田思明, 申小健, 陈振有 [Tian Siming, Shen Xiaojian, and Chen Zhenyou; Resident Military Representative Roon in 743 Factory, Taiyuan], "122 mm 火箭布雷系统训练模拟弹结构设计" [Structure Design of 122 mm

Rocket Minelaying System Practice Simulation Projectile], 弹箭技术 [Rocket Technology], no. 2 (1997); "火箭布雷车" [Rocket Minelaying Truck], "火箭布雷" [Rocket Minelaying], in *Modern Soldier Dictionary,* chief ed. Xiong Wuyi, pp. 379, 383–84. Chinese MLRSs include the China Academy of Launch Vehicle Technology's A-100 300 mm, ten-tube variant, which is similar to Russia's Smerch 9K58 300 mm rocket system. For recent research, see 王锋 [Wang Feng], 南京理工大学, 兵器发射理论与技术 [Nanjing University of Technology and Engineering, Weapons Launch Theory and Technology], "舰载多功能火箭炮系统分析与研究" [Systems Analysis and Research on Shipborne Multifunction Rocket Launchers] (PhD dissertation, 21 November 2007). A student at Nanjing University of Science and Technology, who has received guidance from a PLA unit and an expert on missiles and submunitions, has conducted research and testing of a rudimentary canister holding two mine-sized objects, which are released one at a time so their trajectories can be observed. 江宏寿 [Jiang Hongshou], 南京理工大学 [Nanjing University of Science and Technology], 兵器发射理论与技术 [Weapons Launch Theory and Technology Discipline], "空投水雷抛撒过程数值仿真与实验研究" [Numerical Simulation and Experiment Study of Mine Throwing] (master's thesis, 6 December 2006). For an article that "puts forward two rocket launchers, a firing switch implementation mechanism, and technical means" (提出了两座火箭发射装置, 实现调转发射的机理与技术途径), see 燕飞, 周晓明 [Yan Fei and Zhou Xiaoming], 中船重工集团公司第七一〇所 [710 Research Institute, CSIC], "火箭炮交替调转发射的机理与实现" [Alternating Reverse Rocket-Launch Mechanism and Implementation], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2006).

184. A major flaw in Michael Glosny's analysis is his dismissal of the use of all but East Sea Fleet submarines in a Taiwan-blockade MIW scenario. Why would China invest time and resources in practicing with platforms that it did not intend to use?

185. Lin Changsheng, "Hidden Dragon in the Deep," p. 32.

186. As a textbook elaborates, "When employing surface vessels to lay mines, they maneuver slowly, passage requires a long time, and they tend to expose the goal of the operations. . . . Only beyond the range of the opponent's main coastal firepower and with cover from strong naval and airborne forces is it possible to fully utilize [their] advantages . . . such as the ability to carry large quantities of mines, the ability to lay out a long string of mines, accurate positioning of mines, the ability to deploy a tight, large area of mines and obstructions, and the ability to deploy multiple types of mines." "174. How Does One Determine the Main Attack Targets in a Naval Base Defense Campaign?" in Bi Xinglin, ed., *Campaign Theory Study Guide.*

187. Ren Daonan, "Submarine Minelaying," p. 26. See also 刘定平 [Liu Dingping], "水雷在战场上的运用" [The Use of Sea Mines in Battle], 现代兵器 [Modern Weapons], no. 3 (2002).

188. Ren Daonan, "Submarine Minelaying," p. 26. Ren adds that submarine-laid mines can "baffle the enemy, and thus achieve exceptional combat results."

189. Unless otherwise specified, information in this paragraph is from Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," pp. 17, 18.

190. Ibid., p. 16.

191. Lin Changsheng, "Hidden Dragon in the Deep," p. 33. Another source notes, however, that "submarines built after World War II rarely carry mines externally." See "潜艇布雷" [Submarine Minelaying], 现代舰船 [Modern Ships] (July 2002), p. 44.

192. Ying Nan, "Goals of Offensive Minelaying Discussed," *Jianchuan Zhishi* [Naval Merchant Ships], no. 241 (September 1999), pp. 10–11, OSC FTS19991022001765.

193. Lin Changsheng, "Hidden Dragon in the Deep," p. 33.

194. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 16.

195. "32. How to Conduct Barrier Blockade Combat?" in "II. Blockade Campaign," in Bi Xinglin, ed., *Campaign Theory Study Guide.*

196. Ibid., p. 16; Lin Changsheng, "Hidden Dragon in the Deep," p. 33.

197. This estimate is based on the nine-thousand-kilogram internal payload capacity of the H-6 as reported in "H-6 Bomber," Sinodefence.com. The estimate of one hundred H-6 aircraft is from "China, Armed Forces," *Jane's Sentinel Security Assessment: China and Northeast Asia,* 12 July 2005, www.janes.com.

198. "Military Report," CCTV-7, 12 January 2009, OSC CPM20090304013025.

199. The payload capacity is based on study of Internet photos.

200. 计生文, 姜毅, 王松涛 [Ji Shengwen, Jiang Yi, and Wang Songtao], "金戈铁甲啸海疆--回眸改革开放以来海军装备建设成就" [Steel Weapons, Armor Roar through the Coastal Areas and Territorial Seas: Looking Back at the Achievements in the PLA Navy's Equipment Effort since

the Beginning of Reforms and Opening Up], 人民海军 [People's Navy], 6 October 2008, p. 1.

201. China's seventy-six SU-30MKK fighters could conceivably carry several mines, since they are designed to carry Russian free-fall bombs. However, it is unlikely that such a high-value platform (e.g., fourth-generation aircraft) would be used in this role when less sophisticated aircraft would suffice. PLA Navy aviation force J-8s (numbering approximately fifty) and Q-5s (approximately thirty) could also conceivably perform the MIW mission, as could the two hundred obsolete, and even expendable, PLA Navy aviation force J-6s. If the PLA Air Force (PLAAF) assumes the MIW mission, it will have many more candidate platforms, including J-7s (620), J-8s (184), Q-5s (300), and J-6s (350). But if the objective of aerial mining is the quick placement of large numbers of weapons, platforms that carry significant numbers of mines make much more sense than larger numbers of planes that carry only one or two each.

202. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 17.

203. Yao Jun, ed., 中国航空史 [A History of China's Aviation] (Zhengzhou: Dajia, September 1998), pp. 183–89.

204. See Ying Nan, "Goals of Offensive Minelaying Discussed."

205. Min Zengfu, "A Glimpse at 21st-Century Air Combat," *Zhongguo Junshi Kexue* [China Military Science], 20 February 1995, OSC FTS19950220000008.

206. See, for example, the detailed operational parameters suggested in Yu Hanyu, "An Evaluation of Minelaying by Aircraft." See also the analysis of the effects of parachute drag on the trajectory of a mine dropped from a plane in He Jieying, "Study on the Flight Path of Mine Parachutes," pp. 545–50, and Gao Daquan, "The Application of 'Space Recovery Technology' in Armaments," pp. 16–20.

207. "Report on Role of China's Naval Air Force," "China Today" program, CCTV-9, 2300 GMT, 22 April 2009, OSC CPM20090423017042.

208. 刘文平, 孙樱, 李斌富 [Liu Wenping, Sun Ying, and Li Binfu], "叱咤海天30载与满清武报国志; 填补空白18项痴心反潜为打赢; 北航某舰载机团反潜战术主任赵树民—堪称 '航空反潜先锋'" [Thirty Years of Commanding the Sea and the Sky Filled with a Determination of Serving the Country with Superb Military Skills; Filling in Eighteen Voids by Focusing Whole-Heartedly on Winning in Antisubmarine Warfare; Zhao Shumin, Antisubmarine Tactical Director of an Unidentified Ship-Board Aircraft Regiment of North Sea Fleet Aviation Force: Worthy of Being Called an "Aviation Antisubmarine Pioneer"], 人民海军 [People's Navy], 16 December 2008, p. 1.

209. The Russian series of AMD bottom mines, in production since the late 1950s, is designed to be delivered by air and is believed to have been exported to, and copied by, China. See Watts, "Russian Federation Underwater Weapons," and Hewson, "Type 500 and 1000 Mines." Gidropribor's MDM-2 bottom influence mine and PMR-2 rising influence mine are both designed to be delivered by aircraft. See www.gidropribor.ru/eng/products.php4.

210. Lin Changsheng, "Hidden Dragon in the Deep," p. 32.

211. "32. How to Conduct Barrier Blockade Combat?"

212. "182. What Force Groups are Usually Assembled in a Naval Blockade Campaign?" in "XI. Naval Blockade Campaign," in Bi Xinglin, ed., *Campaign Theory Study Guide.*

213. 荣森芝, 烟台警备区副司令员 [Rong Senzhi, Deputy Commander, Yantai Garrison District], "构筑海上民兵民船, 建用分级保障体系" [Construct a Civilian-Ship-Based Sea Militia, Build and Employ Support System with Different Levels]," 国防 [National Defense], 15 September 2003, p. 42.

214. Information Office of the State Council, People's Republic of China, "China's National Defense in 2008," pp. 50–51. This is introduced by Chen Zhou, one of the drafters, as new information. Bai Ruixue, Wang Jingguo, and Xiong Zhengyan, "(Interpreting White Paper on National Defense) Focus the First Time in the New White Paper on National Defense," *Xinhua,* 20 January 2009, OSC CPP20090120172004.

215. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 18.

216. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 13. More forceful advocacy appears in "148. During a Sea Transportation Defense Campaign, How Does One Rely on Island Shores and Comprehensively Employ Various Forces to Ensure the Safety of Transportation Lines on Nearby Shores?" "VI. Naval Shipping Protection Campaigns," in Bi Xinglin, ed., *Campaign Theory Study Guide.*

217. "Military Report," CCTV-7, 1130 GMT, 19 October 2008, OSC CPP20081019091002.

218. 查春明, 王秋阳 [Zha Chunming and Wang Qiuyang], "海军某基地 民兵海上训练纪实" [An On-the-Spot Report of a People's Militia Sea Drill at a Certain Navy Base], 舰船知识 [Naval and Merchant Ships], no. 3 (5 February 2005), p. 4.

219. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11.

220. Ibid.

221. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 18.

222. 李杰 [Li Jie], "新秀闪亮水下战场" [A New Harvest of Weapons for the Undersea Battlefield], 中国民兵 [China Militia] (May 2008).

223. Jia Yeliang and Guo Yike, "A Para-Naval Force from among the People: Civilian Ships," *Dangdai Haijun* [Modern Navy] (February 2004), pp. 46–47, OSC CPP20041102000199.

224. The concept of "People's War at Sea" has been endorsed by recently retired Major General Peng Guangqian—who has served as a research fellow at China's Academy of Military Sciences and who, as an adviser to China's powerful Central Military Commission (CMC) and Politburo Standing Committee, has enjoyed significant influence in the shaping of PLA strategy. See Peng Guangqian and Yao Youzhi, eds., *The Science of Military Strategy* (Beijing: Military Science, 2005), p. 456.

225. Indeed, the PLA has outfitted sea mines for use in sub-laying and air-dropping training. These include the Xun-1 submarine-laid deep-bottom sea mine and the Model 500 air-laid deep-bottom sea mine. Xun-1's distinguishing feature is its ability to utilize a fuse from either C-1, C-2, or C-3 to mimic those mines in exercises. Ling Xiang, "Raise Mighty Chinese Sea Mine Warfare Ships on the Sea," p. 156.

226. Cole, *Great Wall at Sea,* p. 156.

227. See, for example, 李建生 [Li Jiansheng], "考核内容, 海域, 程序不, 予提前通报: 某扫雷舰大队训练考核从严从难" [The Content, Sea Area, and Procedures of the Proficiency Assessment Will Not Be Revealed in Advance: A Certain Minesweeper Squadron's Exercises Assesses Training in a Strict and Difficult Manner], 人民海军 [People's Navy], 10 November 2006, p. 1; 张建, 李德, 张军红 [Zhang Jian, Li De, and Zhang Hongjun], "突围, 不按 '规则' 出牌—北海舰队某型潜艇布雷演练目击记" [To Break Out of Encirclement, Don't Play Cards according to the "Rules": An Eyewitness Report of a Minelaying Drill by a Certain Type of North Sea Fleet Submarine], 人民海军 [People's Navy], 18 October 2006, p. 1; and 曹明, 陈建族 [Cao Ming and Chen Jianzu], "某扫雷舰大队: 战场逼真火药味浓," [A Certain Minesweeping Unit: A Realistic Battlefield with a Strong Smell of Gunpowder], 人民海军 [People's Navy], 18 February 2003, p. 2.

228. 奏泅敬, 徐红明, 余子富 [Zou Qinjing, Xu Hongming, and Yu Zifu], "马立新: 大洋深处走蛟龙" [Ma Lixin: The Dragon Cruises the Ocean Depths], 人民海军 [People's Navy], 5 February 2005, pp. 1, 3.

229. Kondapalli, *China's Naval Power,* p. 142; 张罗灿, 向延波, 彭赳 [Zhang Luocan, Xiang Yanbo, and Peng Jiu], "某支队新艇首射水雷3发3中" [A Certain Flotilla's New (Submarine) Boat Launched Sea Mines for the First Time: Three Shots, Three Bullseyes], 人民海军 [People's Navy], 17 April 2006, p. 1.

230. 徐红明, 刘新民, 邱智勇 [Xu Hongming, Liu Xinmin, and Qiu Zhiyong], "既练 '攻击术' 又训 '隐身法': 东海舰队某潜艇支队能打能藏没有 '软肋'" [Train in Both "Attack Techniques" and "Concealment Methods": A Certain East Fleet Submarine Detachment Can Attack and Hide without "Weak Spots"], 人民海军 [People's Navy], 9 November 2002, p. 3; 李兵, 向延波 [Li Bing, Xiang Yanbo], "3月下旬, 南海舰队某潜艇支队军港保障大队利用潜艇训练时机 . . ." [During the Last 10 Days of March, A Certain South Sea Fleet Submarine Flotilla Port Support Squadron Seized an Opportune Moment to Carry Out Exercises . . .], 人民海军 [People's Navy], 21 April 2006, p. 1.

231. 刘荣华, 龙运河, 钟魁润 [Liu Ronghua, Long Yunhe, and Zhong Kuirun], "中华第一士官方阵" [China's First Petty Officers Take Position], 人民海军 [People's Navy], 9 April 2002, p. 2.

232. 特约通讯员 闾勇政 [Lu Yongzheng], "某潜艇支队 临战处置能力大幅跃升" [A Certain Submarine Detachment Makes a Great Leap in Battle Management Capability], 人民海军 [People's Navy], 31 October 2002, p. 2.

233. 张罗灿 [Zhang Luocan], "岸港教练室攻难关: 某潜艇支队长魏学义" [Littoral Port Training Room Attacks Difficulty: A Certain Submarine Detachment Exercises], 人民海军 [People's Navy], 23 March 2002, p. 1.

234. 桂平电, 吴中秋, 唐幸芳, 贺跃民 [Gui Pingdian, Wu Zhongqiu, Tang Xingfang, and He Yuemin], "海军航空兵: 高难科目砺新招" [Navy Airmen: High, Difficult Subjects Sharpen New Recruits], 人民海军 [People's Navy], 8 August 2002, p. 2.

235. 孙施伟, 金伟, 张罗灿 [Sun Shiwei, Jin Wei, and Zhang Luocan], "既能 '一剑封喉' 又能 '金蝉脱壳,' 某潜艇支队 训练讲求攻防兼备" [Can Already Both "Seal the Throat with One Sword" and "Escape by Cunning Maneuvering": A Certain Submarine Unit's Training Stressing Both Attack and Defense], 人民海军 [People's Navy], 20 July 2002, p. 1. Col. Lo Ch'eng-lieh, Air Force Academy, "The Chinese Communist Military Revolution and Inherent Threat," *Kuo Hun,* 1 April 1999, pp. 42–45, OSC FTS19990627000936.

236. 虞章才 [Yu Zhangcai et al.], "怒海练剑—探寻某潜艇支队315艇艇长蔡一清谋打赢之路"

[Forge Swordsmanship in the Raging Sea: A Look at How Captain Cai Yiqing of Submarine 315, Subordinate to a Certain Submarine Flotilla of the North Sea Fleet, Sought the Path to Winning Victory], 人民海军 [People's Navy], 22 February 2008, p. 1; 魏垂高, 李德, 闾勇政 [Wei Chuigao, Li De, and Lu Yongzheng], "358艇艇长代胜杰--胸怀韬略, 驾艇趟过封锁线" [Dai Shengjie, Captain of Submarine 358: A Strategy That Is Hidden Within; Driving a Submarine through a Blockade], 人民海军 [People's Navy], 24 August 2007, p. 2; 江山, 闾勇政 [Jiang Shan and Lu Yongzheng], "走出浅滩潜入远海练蛟龙--某潜艇支队坚持训战一致苦练真打本领" [Away from Shallow Waters and into the Distant Sea to Train the Dragon: A Certain Submarine Flotilla Persists in Training-Operation Integration to Practice and Cast Real Capabilities Painstakingly], 人民海军 [People's Navy], 1 May 2006, p. 1.

237. 徐红明, 刘新民 [Xu Hongming and Liu Xinmin], "'敌后'布雷—中国海军某潜艇突破反潜编队训练目击记" [Lay Mines "in the Enemy's Rear Area": An Eyewitness Account of a Certain PLAN Submarine Exercise involving Breaking Through Antisubmarine Formations], 当代海军 [Modern Navy], no. 4 (2003), p. 38; Liu Xinmin and Xu Hongming, "Firsthand Experience with Submarine Minelaying," pp. 6–7.

238. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11.

239. 刘剑 [Liu Jian], "潜艇学院突出复杂和应急条件下的教学训练—课堂向训练场靠拢, 教员向战斗员转换" [Submarine Academy Emphasizes Teaching and Training under Complex and Emergency Conditions: Classroom Moves to the Training Ground; Instructors Switch with Warriors], 人民海军 [People's Navy], 15 December 2006, p. 1.

240. Ch'i Le-yi, "Chinese Communists Conspicuously Increase Military Intelligence Gathering on Taiwan," *Chung-Kuo Shih-Pao,* 28 May 2002, OSC CPP20030528000033; Zhang Luocan, "Littoral Port Training Room Attacks Difficulty," p. 1.

241. Lu Yongzheng and Zhang Qingzhou, "A Certain North Sea Fleet Submarine Flotilla Discards 12 Impractical Combat Methods," p. 3.

242. Kondapalli, *China's Naval Power,* p. 143.

243. "PLA Navy Captain Ma Lixin Leads Drill Using New-Type Submarine," CCTV-1, 27 February 2005, OSC CPP20050302000014.

244. Zou Qinjing, Xu Hongming, and Yu Zifu, "Ma Lixin," pp. 1, 3.

245. See, for example, 李伟, 钱学东, 王桂芹[Li Wei, Qian Xuedong, and Wang Guiqin], "面向多对象的水雷保险器综合参数测试议研究与设计" [Study and Design on Multi-Objective-Oriented Mine Safety Device Comprehensive Parameter Testing Instrument], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2008); and 秦锋, 逄洪照 [Qin Feng and Pang Hongzhao], "基于第二类拉格朗日方程的水雷内未弹道仿真" [Simulation of Interior Trajectory Termina for Sea Mines Based on the Second Lagrange Formulation], 鱼雷技术 [Torpedo Technology] (May 2008).

246. "Submarine Minelaying" (July 2002), p. 44. A translation of this article has been produced by Gabriel Collins.

247. Zhang Luocan, Xiang Yanbo, and Peng Jiu, "A Certain Flotilla's New (Submarine) Boat Launched Sea Mines for the First Time: Three Shots, Three Bullseyes," p. 1. Three mines reached the "furthest distance" (最远航行距离) and their "dispersion error" (散布误差) was "completely within the pre-determined scope" (预设范围之内). Because this type of mine was "very technical" (科技含量高), because the mines were to be "fired a long distance" (射程远), and because it was the new type of submarine's first time carrying out the "furthest distance test launch" (最远距离试射), the crew members had to meet very high requirements. Also on submarine mine testing, see 高春占, 肖德伦 [Gao Chunzhan and Xiao Delun], "试验场腾起烽火硝烟--海军某试验区瞄准未来战场鉴定某新型装备纪实; 科学发展观在海疆: 使命, 责任" [Flames of War and Smoke of Gunpowder Erupt on Testing Ground: A Certain Navy Test Base Evaluates New Armaments with View to Future Battlefield; Scientific Development Concept on the Coastal Seas and Territorial Waters: Mission and Duty], 人民海军 [People's Navy], 30 January 2008, p. 1.

248. Regarding sea mines, the 1997 report states, "China conducts training exercises using surface ships, submarines, and aircraft in coastal areas and is well-prepared to conduct both mine laying and mine sweeping operations in these areas." U.S. Defense Dept., *Report to Congress Pursuant to Section 1305 of the FY 97 National Defense Authorization Act* (Washington, D.C.: 8 April 1997), p. 5, available at www.fas.org/. The 1998 report states, in part, "The [Chinese] Navy has made some improvements in its sea denial military capabilities, particularly with respect to sea mines and submarines." U.S. Defense Dept., *Future Military Capabilities and Strategy of the People's Republic of China* (Washington, D.C.: 1998), p. 13, available at www.fas.org/.

249. See, for example, 高宏伟, 寇永强 [Gao Hongwei and Kou Yongqiang], "战场环境不再似曾相识: 南航部队苦练远海陌生战场破敌硬功" [Battlefield Environments Will No Longer Be Familiar Ones: South Sea Fleet Aviation Troops

Train Hard to Develop Superb Enemy-Defeating Skills to Be Used on Unfamiliar Battlefields in Distant Seas], 人民海军 [People's Navy], 8 April 2008, p. 1; 张秀锦 [Zhang Xiujin], "超额完成年度训练任务: 东航某飞行团十六大精神指引下" [Accomplish Annual Training Assignment above Quota: A Certain East Sea Fleet Aviation Regiment Vigorously Leads the Way after the 16th Party Congress], 人民海军 [People's Navy], 19 December 2002, p. 2.

250. Kou Yongqiang, "The Building of Fighting Capacity Begins with an Emphasis on Details," *Liberation Army Daily,* 14 February 2008, OSC CPP20080225088001; Qian Xiaohu, Liang Qingcai, and Kou Yongqiang, "Forging a 'Naval Aviation Iron Fist': Naval Bomber Regiment Seeks Truth from Facts in Training," *Liberation Army Daily,* 12 February 2006, p. 1, OSC CPP20060216502001.

251. 张秀锦, 方立华 [Zhang Xiujin and Fang Lihua], "空中鹰长途袭击深海鱼鲨—东航某飞行团大机群陌生海域成功布雷" [Eagles in the Sky Launch Long-Range Attacks on Deep-Sea Sharks: The Air Fleet of a Flight Regiment of the East Sea Fleet of the Chinese Navy Successfully Lays Mines in Unfamiliar Waters], 人民海军 [People's Navy], 27 June 2007, p. 1.

252. Gui Pingdian, Wu Zhongqiu, Tang Xingfang, and He Yuemin, "Navy Airmen," p. 2.

253. He Yuemin and Xie Xi, "A Unit Organizes Sea-Air 3D Confrontational Exercise to Improve Its Emergency Maneuvering Capability," *Jiefangjun Bao* [Liberation Army Daily], 30 August 2002, p. 1, OSC CPP20020830000027. For a similar exercise, see Wang Shijun and Tang Zhongping, "Our Reporter Experiences Actual Combat Confrontation Integrated Training Carried Out by a Certain Regiment of the South Sea Fleet: 'Flames of War' Spread over the Ground, Sea and the Sky," *Liberation Army Daily,* 12 September 2008, p. 3, OSC CPP20080912710003.

254. 余五海, 章光辉 [Yu Wuhai and Zhang Guanghui], "战鹰, 子夜起飞—南航某轰炸机团下半夜飞行训练目击" [Fighting Eagles Take Off at Midnight: Witnessing a Certain South Sea Fleet Naval Aviation Bomber Regiment Conduct Flight Exercises after Midnight], 人民海军 [People's Navy], 24 April 2006, p. 1; Zhang Guanghui, "'Fighting Eagles' Take to the Sky on Rainy Night: An Eye-Witness Account of Nighttime Long-Range Precision Bombing Flight Exercises Conducted by a South China Sea Fleet Bomber Regiment," *Liberation Army Daily,* 15 August 2006, p. 2, OSC CPP20060815710006.

255. 佘贺, 王世均 [She He and Wang Shijun], "空投64枚炸弹全部命中--南航某团复杂气象展现训练高水平" [64 Air-Dropped Bombs All Hit Their Targets: A South Sea Fleet Naval Aviation Air Regiment Trains at a High Level under Complex Meteorological Conditions], 人民海军 [People's Navy], 21 June 2006, p. 1.

256. Zhang Jian, Li De, and Zhang Hongjun, "To Break Out of Encirclement, Don't Play Cards according to the 'Rules': An Eyewitness Report of a Minelaying Drill by a Certain Type of North Sea Fleet Submarine," p. 1.

257. 胡朋, 陈勇 [Hu Peng and Chen Yong], "攻势布雷课题演练取得突破--南航某师提高复杂电磁环境下遂行作战能力" [Breakthroughs Are Made in Offensive Mine-Laying Drills: An Aviation Division of the South Sea Fleet Raises the Ability to Fulfill Operational Tasks under a Complex Electromagnetic Environment], 人民海军 [People's Navy], 17 September 2008, p. 2.

258. "Military Report," CCTV-7, 12 January 2009.

259. "Military Report," CCTV-7, 1130 GMT, 15 April 2009, OSC CPP20090416091001.

260. Information Office of the State Council, *China's National Defense in 2008,* p. 51.

261. Wang Guangxin and Chen Yijing, "On the Scene in the East China Sea," pp. 5–6.

262. As identified in Du Wenlong, "Look for Militia around You," *Bingqi Zhishi* [Weapons Knowledge] (April 2008), pp. 26–27, OSC CPP20080728436001.

263. Unless otherwise specified, information for this paragraph derives from Zha Chunming and Wang Qiuyang, "An On-the-Spot Report of a People's Militia Sea Drill at a Certain Navy Base," p. 4.

264. "Military Report," CCTV-7, 1130 GMT, 26 July 2008, OSC CPP20080727091001.

265. 汪鲁迅, 李建生 [Wang Luxun and Li Jiansheng], "海军预备役部队首次成建制海上训练" [The Navy Prepares the First Reserve Unit to Conduct At-Sea Training as an Organization], 人民海军 [People's Navy], 17 July 2006, p. 1. According to the reserve minesweeper squadron's Political Commisar, Dong Huasen (董华森), more than 95 percent of the reserve officers participating in the training "came from Party and government organizations" (来自党政机关), 30 percent were former "military members converted to cadre status" (军转干部), and 80 percent were party members. The East Sea Fleet party committee assigned a full quota of "active duty cadres/officers" (现役干部). Responsible organizations, including the "city Party Committee Organization Department and the transportation and fisheries departments in the city where [the unit] was stationed" (驻地市委组织, 交通, 渔业部门), along with the "Military Sub-District" (军分区)

and a "ship squadron(s)" (舰艇大队), adopted the "area of jurisdiction authorization and allocation method" (属地编配方法) to requisition ships in advance. Funding came from the public finance budgets of the city and the "county" (县) and "district" (区). To create at-sea operational capability as quickly as possible and manage the contradiction between production and training, in early 2006, the reserve squadron's party committee decided to conduct training at the same time as fishing. It developed a full understanding of fishing status before the reserve unit was formed. It paid attention to each boat's fishing goals and set training activities rationally. It used the time when the fishing boats were going out to sea and returning as opportunities to conduct training in driving the vessel and in mechanical and electrical maintenance. It used times when fishing boats were assembling and putting to sea as opportunities to conduct training in assembling, forming up for a voyage, and changing formation. In 2006, the squadron arranged for more than two hundred reserve officers and enlisted personnel to go aboard a minesweeper in groups for training. Standardized training corrected the reservists' peacetime tendency to rely on their senses and experience and got them in the habit of plotting courses as required, keeping a voyage log, and plotting course-change points.

266. 郑广科, 何名享 [Zheng Guangke and He Mingxiang], "遂行任务由陆地向海空拓展—山东省蓬莱市民兵组织结构发生新变化" [Fulfilling the Expansion of Missions from Land to Sea and Air—The Structure of the Militia Organizations in Shandong Province's Penglai City Undergoes a New Transformation], 解放军报 [Liberation Army Daily], 31 March 2007, http://www.chinamil.com.cn/.

267. 代宗锋, 郑光辉, 武新广, 谭依娜 [Dai Zongfeng, Zheng Guanghui, Wu Xinguang, and Tan Yina], "扫雷舰与渔船联合扫雷" [Minesweepers and Civilian Fishing Boats Work Together to Sweep Mines Jointly], 人民海军 [People's Navy], 1 March 2007, pp. 30–31.

268. 李高健, 孙樱 [Li Gaojian and Sun Ying], "预备役船队成为海上训练新锐—海军某预备役大队主动为破解训练难题" [Reserve Ship Unit Becomes New Force for Training At Sea—Naval Reserve Squadron Takes the Initiative toward Resolving Difficult Problems], 人民海军 [People's Navy], 15 December 2008, p. 2.

269. 牛彤, 孙飞 [Niu Rong and Sun Fei], "中国海军918型布雷舰" [The Chinese Navy's Type 918 Minelaying Ship], 舰船知识 [Naval and Merchant Ships] 7, no. 310 (2005), p. 11. See also 石景山 [Shi Jingshan], "10月11日, 北海舰队某水警区进行防空袭条件下舰艇紧急吊装水雷演练 . . ." [On 11 October, a Certain North Sea Fleet Water Garrison District, under Air-Raid Defense Conditions, Urgently Carried Out a Sea-Mine Hoisting Exercise . . .], 人民海军 [People's Navy], 3 November 2006, p. 1.

270. 孙铁富 [Sun Tiefu], "某支队研制成功新型装雷专用车" [A Certain Flotilla Has Successfully Developed a Special-Purpose Mine-Loading Vehicle], 人民海军 [People's Navy], 30 August 2006, p. 2.

271. 王松岐, 章汉亭 [Wang Songqi and Zhang Hanting], "在转变中求发展" [Strive for Development in the Course of Transformation], 人民海军 [People's Navy], 1 May 2006, p. 2.

272. 汪祖峰, 盛长峰, 李文喜 [Wang Zufeng, Sheng Changfeng, and Li Wenxi], "南海舰队某鱼水雷仓库引导官兵: 接新使命任务要求主动作为" [A Certain South Sea Fleet Torpedo and Sea Mine Depot Guides Officers: Receive New Mission Assignment Requiring Independent Initiative], 人民海军 [People's Navy], 8 October 2005, p. 1.

273. 高尔健, 宋雪云, 李建生 [Gao Erjian, Song Xueyun, and Li Jiansheng], "东海舰队某水雷库立足实战: 练就全天候野外无依托保障" [A Certain East Sea Fleet Sea Mine Depot Has a Foothold in Actual Combat: Training in All-Weather Field [with] Independent Safeguards], 人民海军 [People's Navy], 8 October 2005, p. 1.

274. 张建, 李文杰, 李德 [Zhang Jian, Li Wenjie, and Li De], "现代海战催生保障新模式" [Modern Naval Warfare Hastens Development of a New Mode of Logistics Support], 解放军报 [Liberation Army Daily], 26 February 2007, p. 3.

275. 周亚文 [Zhou Yawen], "千里之外崛起临时保障阵地—南海舰队某保障基地成功完成新型导弹水雷应急补给" [A Temporary Support Base Arises from Far Away—A Certain South Sea Fleet Support Base Successfully Accomplishes Emergency Supply for New Types of Missiles and Sea Mines], 人民海军 [People's Navy], 5 December 2006, p. 2. For a similar exercise, see Shi Yuanming, "Ordnance Technical Support Team Uplifts Mobile Support Capacity," *Liberation Army Daily*, 24 March 2008, OSC CPP20080325702016.

276. 高庆, 谭依娜 [Gao Qing and Tan Yina], "军民一体, 精确高校--海军新型鱼水雷保障能力大幅提升" [The Military and the Civilian Work Together to Ensure Precise and Highly Efficient Support Work—The Chinese Navy Significantly Improves Its Support Capability for New-Type Torpedoes and Sea Mines], 人民海军 [People's Navy], 2 December 2008, p. 2.

277. 林在连, 王亚军, 张文西, 章汉亭 [Lin Zailian, Wang Yajun, Zhang Wenxi, and Zhang Hanting], "时不我待砺硬功—北海舰队某扫雷舰大队抓紧点滴时间训练" [Time and Tide Await No

Man Sharpening Good Achievements: A Certain North Sea Fleet Minesweeper Squadron Pays Close Attention to Training Times], 人民海军 [People's Navy], 5 June 2006, p. 2.

278. Kondapalli, *China's Naval Power,* p. 141.

279. 张军红 [Zhang Junhong], "冰海之中破雷阵: 北海舰队某水警区在-16C进行扫雷训练实录 [Destroying a Mine Array in Icy Water: A Certain North Sea Fleet Water Garrison District Sets a Record by Conducting Minesweeping Exercises in -16C]," 人民海军 [People's Navy], 18 April 2006, p. 1.

280. "突出副长训练提高复训质量: 北海舰队某卫舰让副长挑训练 '大梁'" [Outstanding XO Exercise Improves Complex Training Quality: Some North Sea Fleet Frigates Let XOs Lead Training "Big Bridge"], 人民海军 [People's Navy], 23 February 2002, p. 2.

281. Chen Wanjun and Zhang Wenxi, "The Chinese Navy Established the First Ship Captain Training Center at Lushun Naval Base," Xinhua, 24 October 2006, OSC CPP20061024442016.

282. 杜喜尔, 宋晓彪 [Du Xier and Song Xiaobiao], "穿过 '死亡海'" [Passing Through "Deadly Seas"], 人民海军 [People's Navy], 25 January 2005, p. 2; 成斌 [Cheng Bin], 谋打赢风采录—有奖摄影比赛: 新职手砺兵忙 [A Splendid Record of Strategizing to Fight and Win—Photography Contest: Rookies Busy Honing Their Crafts], 人民海军 [People's Navy], 22 January 2005, p. 1. For additional evidence of the PLAN MCM force's embracing of revolution of military affairs, see 程建华, 刘健忠, 陈泽锦 [Cheng Jianhua, Liu Jianzhong, and Chen Zejin], "明确新要求—接受新挑战: 某扫雷舰大队紧贴军事改革实际锤炼党员先进性" [Understand Well the New Requirements and Accept the New Challenges: A Certain Minesweeper Squadron Forges the Vanguard Character of Party Members in Strict Adherence to Military Reforms], 人民海军 [People's Navy], 29 July 2004, p. 1. On "intelligization," see also 高春占, 肖德伦 [Gao Chunzhan and Xiao Delun], "让鱼水雷越打越 '聪明'—某实验区瞄准未来战场提高水下靶场实验效能纪实" [Making Torpedoes and Sea Mines More and More "Intelligent"—An On-the-Spot Report of a Certain Test Area Taking Aim at the Future Battlefield and Raising the Experimental Efficacy of an Underwater Shooting Range], 人民海军 [People's Navy], 24 November 2006, p. 2.

283. 孙涛, 乔燕飞, 吴超 [Sun Tao, Qiao Yanfei, and Wu Chao], "帆正自可行千里—某扫雷舰大队推进信息化建设的一段经历/谜提一串: 扫雷舰咋拿了那么多第一?/谜底揭开: 原来他们有信息化帮忙/谜的背后: 信息化老装备上'着陆'" [Set the Sail Right and You Can Travel for a Thousand Leagues: A Certain Minesweeper Unit's Experience in Carrying Out Informationalization Construction/A String of Puzzles: How Did the Minesweeper Capture So Many First Places?/Unraveling the Puzzles: They Had the Help of Informationalization/Behind the Puzzles: Informationalization Makes Its Landing on Old Equipment], 人民海军 [People's Navy], 1 November 2003, p. 2.

284. Ibid.

285. 张守军, 王松岐, 王尤起 [Zhang Shoujun, Wang Songqi, and Wang Youqi], "大洋深处砺精兵" [Ocean Depths Sharpen Crack Troops], 人民海军 [People's Navy], 27 December 2005, p. 3.

286. See photograph of AD-2 Skyraider at Pawtuxet River, Maryland, in 1949, at www.navweapons.com/.

287. Liu Ronghua, Long Yunhe, and Zhong Kuirun, "China's First Petty Officers Take Position," p. 2.

288. 范保锋, 张庆洲 [Fan Baofeng and Zhang Qingzhou], "具有多种弹型技术保障能力—某导弹技术队教导员耿焱" [Possessing the Ability to Support Many Types of Missile Technology—Geng Yan, [Battalion Level] Political Instructor of a Certain Missile Technology Group], 人民海军 [People's Navy], 25 October 2006, p. 2.

289. 范保峰, 廖天保, 孙政 [Fan Baofeng, Liao Tianbao, and Sun Zheng], "知权利义务, 明肩上责任—某鱼水雷仓库采取多种形式组织党员学习党章" [Knowledge Is a Right and a Duty, Brilliantly Shoulder the Responsibility: A Certain Torpedo and Sea Mine Depot Adopts Multiform Formation of Party Members Studying the Party Constitution], 人民海军 [People's Navy], 18 February 2006, p. 3.

290. 陈启正, 罗明新, 周拥军, 张剑 [Chen Qizheng, Luo Mingxin, Zhou Yongjun, and Zhang Jian], "目标锁定未来战场—九一七O八部队某扫雷舰大队勇闯雷阵练硬功纪事" [The Goal is to Lock in on the Battlefield of the Future: Recording a Certain Minesweeper Brigade from Unit 91708's Heroic Efforts at Difficult Minesweeping Exercises], 人民海军 [People's Navy], 21 March 2002, pp. 1–2.

291. 代宗锋, 余子富 [Dai Zongfeng and Yu Zifu], "守着水库洗澡难, 驻在山上上山难—某扫雷舰大队10万元营造仨战士舒心环境" [Have a Reservoir but Can't Take a Bath, Being Stationed on a Hill That is Difficult to Climb: A Minesweeping Squadron Invests 100,000 Yuan So That Three Enlisted Soldiers Will Have a Comfortable Environment], 人民海军 [People's Navy], 12 May 2006, p. 2.

292. See, for example, 李根苗, 代宗锋 [Li Genmiao and Dai Zongfeng], "多个训练弱项岁尾 '回炉': 东海舰队某扫雷舰大队组织1个月补差训练" ["Return to the Furnace" [to Be Recast

after] Many Deficiencies in Training at the End of the Year: An East Sea Fleet Mining Squadron Organizes a Month of Remedial Training], 人民海军 [People's Navy], 29 November 2006, p. 2; 桂喜尔, 周拥军 [Gui Xier and Zhou Yongjun], "把军事比武融入训练全过程—某扫雷舰大队立足现有装备和未来实战" [Integrate the Military Contest into the Whole Process of the Training—A Certain Minesweeper Squadron Has a Foothold in Both Existing Equipment and Future Combat], 人民海军 [People's Navy], 9 February 2006, p. 2; and 李大军 [Li Dajun], "水雷战舰的总指挥" [Commander of Mine Warfare Vessels], 现代舰船 [Modern Ships], no. 129 (September 1996), p. 18.

293. 刘备战, 林在连, 刘文平 [Liu Beizhan, Lin Zailian, and Liu Wenping], "剑胆琴心—记某护卫舰大队大队长王滨" [Brave Sword: Recording a Certain Frigate Unit's Commander Wang Bin], 人民海军 [People's Navy], 28 March 2002, p. 1; 刘备战, 北海站记者林在连 [Liu Beizhan and Lin Zailian] "一部新大纲几多新景观: 值更官走上操舰台" [A New Set of Guidelines and Many New Outlooks: Watch Officers on Duty Engage in New Ship Exercises], 人民海军 [People's Navy], 7 March 2002, p. 1.

294. 林在连, 孙飞, 崔军 [Lin Zailian, Sun Fei, and Cui Jun], "实践先进性 高扬先锋旗—某扫雷舰大队八一四舰党支部发挥战斗堡垒作用纪实" [Put the Vanguard Status into Practice and Raise High the Banner of the Pioneer: A Firsthand Report on How the Boat 814 Party Branch Fulfilled Its Duty as a Combat Stronghold], 人民海军 [People's Navy], 30 March 2002, p. 3.

295. 蒋敏军, 梁庆才 [Jiang Minjun and Liang Qingcai], "借得东风好行船—南海舰队某驱逐舰支队新大纲试训改革实录" [Take Advantage of the East Wind to Navigate Well: A Firsthand Record of New Outline Test Exercises by a Destroyer Detachment from the South Sea Fleet], 人民海军 [People's Navy], 5 March 2002, pp. 1–2.

296. Lin Zailian, Sun Fei and Cui Jun, "Put the Vanguard Status into Practice and Raise High the Banner of the Pioneer," p. 3.

297. 温上京, 王志海, 陈建族 [Wen Shangjing, Wang Zhihai, and Chen Jianzu], "852舰创新训发取得实效" [Warship 852 Obtains Substantial Results in Innovating Training Methods], 人民海军 [People's Navy], 11 May 2002, p. 2.

298. 张佐委, 储建国, 崔晓龙 [Zhang Zuowei, Chu Jianguo, and Cui Xiaolong] "'海上工兵'磨砺硬功" ["Sea Engineers" Temper Themselves through Meritorious Service], 舰船知识 [Naval and Merchant Ships], no. 310 (July 2005), p. 3.

299. Information in this paragraph is derived from 曹明, 梁庆才 [Cao Ming and Liang Qingcai], "随南海舰队'809'舰海上扫雷" [Following South China Sea Fleet Unit "809" Ship Sweeping Mines at Sea], 当代海军 [Modern Navy], no. 4 (2003), pp. 18–19; Chen Qizheng, Luo Mingxin, Zhou Yongjun, and Zhang Jian, "The Goal is to Lock in on the Battlefield of the Future," pp. 1–2.

300. For an identical paragraph describing Unit 91708's achievements, see 罗明新, 周拥军, 张剑 [Luo Mingxin, Zhou Yongjun, and Zhang Jian], "和平时期, 他们在海上趟雷" [In Times of Peace, They Are at Sea Measuring Mines], 当代海军 [Modern Navy] (April 2002), pp. 2–3.

301. Research along these lines includes 李志远, 赵治平 [Li Zhiyuan and Zhao Zhiping], "水雷相关引信技术及其干扰研究" [Research Related to Fuse Technology and Jamming], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2007).

302. The last three sentences are derived from 曹明, 梁庆才 [Cao Ming and Liang Qingcai], "809舰: 为战场开道" [Ship 809: Clearing the Way for the Battlefield], 人民海军 [People's Navy], 22 February 2003, pp. 1–2.

303. Qian Xiaohu, Wang Luxun, and Mao Zhaosheng, "Boom! With a Noise as Loud as Thunder, the Channel Was Open—Officers and Men of a Certain East Sea Fleet Squadron Set Off Urgently on a New Type of Minesweepers," *Jiefangjun Bao* [Liberation Army Daily], 30 January 2007, p. 11, CPP20070130710007; Qian Xiaohu, Wang Luxun, and Mao Zhaosheng, "Experiencing the Chinese Navy's New Type of Minesweeper," *Zhongguo Guofang Bao* [China Defense News], 30 January 2007, p. 5, OSC CPP20070205721039.

304. 傅金祝 [Fu Jinzhu], "MINEA—先进的非触发教练水雷系统" [MINEA: The Advanced Multi-Influence Exercise Mine System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2008).

305. 代宗锋, 余子富 [Dai Zongfeng and Yu Zifu], "重奖之下为何难觅勇夫?—某扫雷舰大队鼓励官兵岗位成才的一段经历" [Why Is It Difficult to Seek Courageous Workers When Emphasizing Awards?—The Experience of a Certain Minesweeping Group Encouraging Officers and Enlisted to Grow into Accomplished Talents at the Post], 人民海军 [People's Navy], 25 March 2006, p. 3.

306. Mao Zhaosheng, Yu Zifu, and Wang Luxun, "A Point Man in Mine Clearance and Obstacle Elimination—Record of Zhang Jianming, the Commander of a Certain Mine Sweeper Squadron, East Sea Fleet, Chinese Navy," *Dangdai Haijun* [Modern Navy], April 2007, pp. 46–49, OSC CPP20070620325003.

307. 尤晓航, 中国船舶重工集团公司 江苏 自动化研究所, 江苏 连云港 [You Xiaohang,

Jiangsu Automation Research Institute of CSIC, Lianyungang], "舰载深弹武器系统发展思路探讨" [Discussion on Development of Ship-borne Depth Charge Weapon System], 指挥控制与仿真 [Command Control & Simulation] 28, no. 3, June 2006, pp. 1–5.

308. 毛敬雄 [Mao Jingxiong], "目击舰艇抗大当量战雷实爆冲击试验" [Bearing Witness to Live Tests of Mine Countermeasures Equipment], 现代舰船 [Modern Ships] (January 2008), pp. 4–5.

309. One officer, for example, was twice profiled in *People's Navy* in 2006. See 汪鲁迅, 毛昭胜 [Wang Luxun and Mao Zhaosheng], "'雷海先锋' 有新作为—记 '海军十杰青年,' 某扫雷舰大队大队张张建明" [The Sea Mine Vanguard Has a New Accomplishment: Recording One of Navy's Most Outstanding Youth, Zhang Jianming, Commander of a Certain Minesweeper Squadron], 人民海军 [People's Navy], 8 September 2006, p. 8.

310. 贾峰华, 闾勇政 [Jia Fenghua and Lu Yongzheng], "以优异成绩迎接党的十六大召开: 北海舰队某潜艇支队 自设困境苦练自救能力" [Greeting the 16th Party Congress with Excellent Performance Records: A Certain Submarine Detachment from the North Sea Fleet Trains Hard to Improve Survivability through Self-Designed Contingencies], 人民海军 [People's Navy], 31 August 2002, p. 2.

311. 桂喜尔, 周拥军 [Gui Xier and Zhou Yongjun], "某扫雷舰大队立足现有装备和未来实战—把军事比武融入训练全过程" [A Certain Minesweeper Group Has a Foothold in Both Existing Equipment and Actual Future Combat—To Integrate the Military Contest into the Entire Process of Training], 人民海军 [People's Navy], 9 February 2006, p. 2.

312. "Military Report," CCTV-7, 30 April 2005, OSC FBS20050430359682.

313. 毛昭胜, 蔡善明, 吴罗春 [Mao Zhaosheng, Cai Shanming, and Wu Luoqun], "扫雷舰部队: 走向深海 '敢死队'" [Minesweeper Unit: The "Dare-to-Die Corps" Heads for the Deep Sea], 当代海军 [Modern Navy], no. 143 (August 2005), pp. 14–15.

314. 刘相林, 虞章才, 许森, 米晋国, 李德 [Liu Xianglin, Xu Sen, Mi Jinguo, and Li De], "骑鲸蹈海竞风流—记北海部队某潜艇基地 '水下先锋艇' (下)" [Reporting on a Certain North Sea Fleet Submarine Base's "Underwater Vanguard Boat" (Part 2)], 人民海军 [People's Navy], 14 October 2004, p. 2.

315. 李义保, 张善标, 代宗锋 [Li Yibao, Zhang Shanbiao, and Dai Zongfeng], "点击834扫雷舰舰长朱德保 我海军深海扫雷能力迅速提升" [A Brief Introduction to 834 Minesweeper Captain Zhu Debao: China's Deep-Sea Minesweeping Capability Rapidly Elevates], 当代海军 [Modern Navy] (January 2005), pp. 16–18; 郭江山, 李义保 [Guo Jiangshan and Li Yibao], "攻潜计划临时更改之后" [The Plan to Attack Submarines after Temporary Changes], 人民海军 [People's Navy], 30 March 2002, p. 3; "PLA Maritime Engineering Unit Conducts Rapid Minesweeping Exercises," *Jiefangjun Bao* [Liberation Army Daily], 10 July 2003, OSC CPP20030712000062.

316. "一次布扫水雷 '大战'—东海舰队某扫雷舰大队训练素描" [A "Big War" of Laying and Sweeping Sea Mines: A Sketch of a Certain East Sea Fleet Minesweeper Exercise], 当代海军 [Modern Navy] (September 2000), pp. 38–39.

317. 周亚文, 陈建族 [Zhou Yawen and Chen Jianzu], "心系 '数字战场'" [Core System "Digital Battlefield"], 人民海军 [People's Navy], 13 July 2002, p. 1.

318. This quarterly publication was established in early 1993. It is published by CSIC's 710 Research Institute, a major center of Chinese sea-mine development. Information derived from journal abstracts and www.chinamag.com.cn/, gotoread.com/, slzyjcfh.periodicals.net.cn/, and www.zazhicom.com/. For this study, this journal's abstracts were consulted, as full-length articles were unavailable.

319. Phrases in quotation marks represent specific Chinese-character phrases; phrases without quotation marks represent ideas that are conveyed through various sets of characters.

320. See 肖占中 [Xiao Zhanzhong], "对抗猎雷技术的机器人水雷" [Anti–Mine Hunting Technology Robotic Sea Mines], 机器人技术与应用 [Robotic Technology and Application], no. 3 (2001).

321. Lin Changsheng, "Hidden Dragon in the Deep," p. 22.

322. See, for example, Shen You, "Ten Reflections on Naval Equipment Deployed in the Gulf War," p. 10.

323. 赵太勇, 冯顺山, 董永香 [Zhao Taiyong, Feng Shunshan, and Dong Yongxiang], "水雷武器的现状及发展趋势" [Summary of Modern Development Trends for Sea Mines], 中北大学学报 [Journal of the Northern University of China] (December 2007), pp. 27–30.

324. 徐阳 [Xu Yang], "水雷武器过时了吗?" [Is Sea Mine Weaponry Obsolete?], 国际展望 [World Outlook], no. 10 (1996), p. 27.

325. "Mine Warfare: Understanding the Basics," USS *Pioneer (MCM 9),* www.pioneer.navy.mil/.

326. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 12.

327. 刘一建 [Liu Yijian], "控制权理论及发展趋势" [Theory of the Command of the Sea and Its Trends of Development], 中国军事科学 [China Military Science] 18, no. 1 (2005), p. 43.

328. Fu Jinzhu, "Mine Warfare in the Gulf War," pp. 30–33.

329. Shen You, "Ten Reflections on Naval Equipment Deployed in the Gulf War," p. 10.

330. Lin Changsheng, "Hidden Dragon in the Deep," p. 33.

331. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11.

332. Chen Fu-cheng, "Mine and Anti-Blockade Operations," book excerpt, *Fang-wei Ta Tai-wan,* 1 November 1995, pp. 226–35, OSC FTS19990317001886.

333. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 12.

334. Wang Guangxin and Chen Yijing, "On the Scene in the East China Sea," pp. 5–6.

335. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11 [emphasis added].

336. Fu Jinzhu, "Taiwan's Problematic Mine Warfare Capability," *Jianchuan Zhishi* [Naval and Merchant Ships], 4 October 1999, pp. 33–34, OSC FTS19991108001755.

337. Niu Rong and Sun Fei, "Chinese Navy's Type 918 Minelaying Ship," p. 11.

338. Fu Jinzhu, "What Explains the Failure of Iraq's Mines?" p. 45.

339. Liu Xiasen, "If a Taiwan Strait War Erupted," p. 3.

340. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 12.

341. Fu Jinzhu, "Mine Warfare in the Gulf War," p. 32.

342. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11.

343. "Submarine Minelaying" (July 2002), p. 44.

344. Ying Nan, "Goals of Offensive Minelaying Discussed," pp. 10–11.

345. 陈建华 [Chen Jianhua, ed.], 舰艇作战模拟理论与实践 [Naval War Gaming Theory and Practice] (Beijing: National Defense Industry, 2002), pp. 150, 196.

346. 胡红波, 邱继进, 马爱民 [Hu Hongbo, Qiu Jijin, and Ma Aimin], "基于德尔菲法的未知水雷性能分析" [Performance Analysis of an Unknown Mine Based on the Delphi Method], 情报指挥控制系统与仿真技术 [Information Command Control System and Simulation Technology] 27, no. 2 (April 2005), pp. 12–14. *Campaign Theory Study Guide* alludes to some of these factors, adding enemy navigation routes, the influence of enemy bases and harbors on PLAN surface ships, and the enemy's schedule and defenses, which determine opportunities for attack. "205. What Major Situations Shall Be Ascertained and What Main Issues Shall Be Verified by Campaign Commanders in the Preparation Stage of a Maritime Shore-Raiding Campaign?" in "XIII. Maritime Shore-Raiding Campaign," in Bi Xinglin, ed., *Campaign Theory Study Guide.*

347. Wang Guangxin and Chen Yijing, "On the Scene in the East China Sea," pp. 5–6.

348. Jia Yeliang and Guo Yike, "A Para-Naval Force from among the People: Civilian Ships," pp. 46–47.

349. Notions concerning the comingling of the Chinese military and society can be traced to Mao Zedong's writings from the 1930s.

350. 田国垒, 乔玉明 [Tian Guolei and Qiao Yuming], "现代航母的六大'克星'" [The Modern Aircraft Carrier's Six Great "Nemeses"], 人民海军 [People's Navy], 6 November 2006, p. 4.

351. Lin Changsheng, "Hidden Dragon in the Deep," p. 31. For further details, see Andrew Erickson, Lyle Goldstein, and William Murray, "China's 'Undersea Sentries': Sea Mines Constitute Lead Element of PLA Navy's ASW," *Undersea Warfare* 9 (Winter 2007), pp. 10–15; and Gabriel Collins, Erickson, Goldstein, and Murray, "Chinese Evaluations of the U.S. Navy Submarine Force," *Naval War College Review* 61, no. 1 (Winter 2008), pp. 68–86.

352. Of flagship minesweeper 809's fifteen major training missions over the past few years, for instance, four involved responsibility for "submarine escort" [护潜任务]. Cao Ming and Liang Qingcai, "Ship 809," p. 1.

353. 唐水福, 张彦中 [Tang Shuifu and Zhang Yanzhong], "从保障单一陆军向保障三军转变 从保障陆战场向保障立体作战转变我国民兵队伍中有了'海空军'" [Transformation from Exclusively Supporting Ground Forces into Supporting the Three Armed Branches, from Supporting Land Battlefields into Supporting Multi-Dimensional Operations; Our Militia Forces Now Have Their 'Naval Forces, Air Forces, and Ground Forces'"], 解放军报 [Liberation Army Daily], 30 September 2006, p. 1.

354. See also 袁茂钱 [Yuan Maoqian], 西南交通大学, 光学工程 [Xinan Communications University, Optical Engineering], "水雷反潜中探测技术的研究与分析" [Study and Analysis of Detection Technology on Antisubmarine Mines] (master's thesis, 13 November 2008).

355. Li Kefeng, "Russian Rocket Rising Sea Mines," pp. 34–36.

356. Chen Dongyuan, "The Mysterious Underwater Sentry," pp. 42–43.

357. Ibid.

358. Han Peng and Li Yucai, eds., *Outline of Undersea Weaponry,* pp. 2, 4, 27.

359. 张剑, 袁珍军 [Zhang Jian and Yuan Zhenjun], "'海战实验室' 打响现代海战—东海舰队某驱逐舰支队网上战术对抗演习目击记" ["Sea Warfare Laboratory" Wins Initial Success in Modern Warfare: An Eyewitness Account of a Certain East Sea Fleet Submarine Chaser Flotilla Network Tactics Confrontation Exercise], 人民海军 [People's Navy], 28 June 2006, p. 1.

360. "168. How Is the Defense System Structure Established in a Naval Base Defense Campaign?" in Bi Xinglin, ed., *Campaign Theory Study Guide.*

361. As a recent article notes, "submarine[s] . . . cannot use all the mine-clearing tools available to surface ships. . . . [P]re-cursor sweeping before transiting a minefield is generally not an option." John Holmes, "Underwater Stealth: Mine Countermeasures' Ace in the Hole," *Undersea Warfare* (Spring 2006), available at www.chinfo.navy.mil/.

362. See, for example, 薛大伟, 周开华, 徐先勇 [Xue Dawei, Zhou Kaihua, and Xu Xianyong], "水雷战信息化建设初步探讨" [Primary Discussion of Mine Warfare Informationization Construction], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2007); and 郑锴, 陆文骏, 童利标 [Zheng Kai, Lu Wenjun, and Tong Libiao], "联网水雷陈及其关键技术研究" [Study on Key Techniques Related to Mine Networks], 兵工自动化 [Ordinance Industry Automation] (January 2008).

363. Niu Rong and Sun Fei, "Chinese Navy's Type 918 Minelaying Ship," p. 11.

364. 汪祖峰, 盛长峰, 李文喜 [Wang Zufeng, Sheng Changfeng, and Li Wenxi], "一年打了翻身仗—某鱼水雷仓库分库教导员徐和平带领'一班人' 改变后进面貌纪事" [Turning Around Weaponry in One Year: A Record of a Certain Torpedo and Sea Mine Depot Instructor Xu Heping Leading "Squad Members" to Transform Backwardness], 人民海军 [People's Navy], 22 October 2005, p. 2.

365. 黄艳儒, 曾志鹏, 卢杏忠 [Huang Yanru, Zeng Zhipeng, and Lu Xingzhong], "广州军区航务军代处积极探索一体化联合作战保障新模式—为保障打赢当好 '代表'" [Guangzhou Military Region Military Traffic Representative Office Actively Explores New Patterns of Integrated Joint Operations Support: Being Good "Representatives" in Support of Fighting and Winning], 解放军报 [Liberation Army Daily], 3 January 2007, p. 3.

366. 周拥军, 成斌, 桂喜尔 [Zhou Yongjun, Cheng Bin, and Gui Xier], "为了雷场奏凯歌—某扫雷舰大队党委求真务实抓装备管理纪实" [A Victorious Song for the Minefield: An On-the-Spot Report of a Certain Minesweeping Squadron's Party Committee Demanding Concrete Work in Equipment Management], 人民海军 [People's Navy], 9 February 2006, p. 1.

367. 张存先 [Zhang Cunxian], "浅谈水雷仓库技术兵的培训" [A Discussion of the Training of Sea Mine Depot Technology Soldiers], 海军院校教育 [Education of Naval Academies], no. 1 (1995), pp. 68–70.

368. "南海舰队某基地—'高级蓝领' 成为练兵 '磨刀石'" [A South Sea Fleet Base's "Senior Blue Collar" Personnel Become "Whetstones" for Sailor Training], in Qian Xiaohu and Zhou Yawe, "三军开训 亮点频现" [Three Services Start Training, Bright Spots Seen Everywhere], 解放军报 [Liberation Army Daily], 8 January 2007, p. 2.

369. Zhang Cunxian, "Discussion of the Training of Sea Mine Depot Technology Soldiers," pp. 68–70.

370. Wu Dengfeng and Guan Jingchong, "Chinese Naval Ordnance Support Forces Possess All-Weather Support Capabilities," Xinhua, 27 October 2006, OSC CPP20061027329006.

371. Li Gencheng, "Naval Vessel Ordnance Depot Enhances Support Capability," *Liberation Army Daily,* 1 July 2008, OSC CPP20080702702004.

372. 李文杰, 李德, 范保峰 [Li Wenjie, Li De, and Fan Baofeng], "让战斗力成为撬动革新的支点—青岛保障基地探索科研与战斗力接轨的一段经历" [Make Combat Strength the Lever for Shifting Renovation's Center of Balance: A Qingdao Logistics Base's Experience in Exploring Ways to Link Scientific Research and Combat Strength], 人民海军 [People's Navy], 16 May 2007, p. 3.

373. Mao Zhaosheng, Yu Zifu, and Wang Luxun, "A Point Man in Mine Clearance and Obstacle Elimination," pp. 46–49.

374. 周开华, 徐先勇, 李鸿雁 [Zhou Kaihua, Xu Xianyong, and Li Hongyan], "影响水雷操作可靠性常见问题及解决对策" [Common Problems Influencing Mine Operation Reliability and Solutions], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2008); 左传友, 刘海波 [Zuo Zhuanyou and Liu Haibo], "浅析水雷备件储备量" [Analysis of the Storage Quantity of Mine Spare Parts], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2008); 徐森丰, 任德奎 [Xu Senfeng and Ren Dekui], "基于层次分析法的水雷效能灰色评估" [Gray Evaluation of Mine Efficiency Based on AHP], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (2008); 尹美方, 李鸿雁, 郭东, 白正勤 [Yin Meifang, Li Hongyan,

Guo Dong, and Bai Zhengqin], "水雷武器设计中的人性化问题思考" [Humanization in Mine Weapon Design], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2007); 马莉, 刘成, 程志 [Ma Li, Liu Cheng, and Cheng Zhi], "基于虚拟仪器技术的水雷引信测试系统" [Mine Fuse Test System Based on Virtual Instrument Technique], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2007); 于文峰 [Yu Wenfeng], "水雷用一次锂池组的安全保护" [Protection of Primary Lithium Battery Packs for Sea Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2007).

375. Wang Guangxin and Chen Yijing, "On the Scene in the East China Sea," pp. 5–6.

376. The different Chinese MCM approach is likely the result of lower force capitalization, higher tolerance for casualties, different operational goals, and, most fundamentally, the primary anticipated conflict scenarios.

377. China is also conducting significant MCM research. The synergies with MIW research are readily apparent. See, for example, 徐维川, 马爱民 [Xu Weiquan and Ma Aimin], "概率条件下雷区范围估计研究" [Study on the Evaluation of the Scope of a Minefield Using Probability], 指挥控制与仿真 [Command Control and Simulation] (May 2008); 薛山花, 田杰, 李宇, 黄海宁, 张春华 [Xue Shanhua, Tian Jie, Li Yu, Huang Haining, and Zhang Chunhua], "基于时变AR预白滤波处理的水雷非水雷识别算法" [Classification Algorithm for Sea Mines Based on an Autoregressive Model], 微计算机应用 [Microcomputer Applications] (February 2008); 徐维川, 马爱民 [Xu Weiquan and Ma Aimin], "虚假雷区判别研究" [Research on Discrimination of False Minefields], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2008); 倪永杰, 徐晓刚 [Ni Yongjie and Xu Xiaogang], "基于粒子系统的水雷冲刷掩埋过程三维仿真方法" [3D Simulation Method of Mine Burial Process by Scouring Based on Particle System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2008); 倪永杰, 徐晓刚 [Ni Yongjie and Xu Shaogang], "水雷掩埋研究" [Research on Mine Burial], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2007); 马爱民, 郭伟民, 洪星 [Ma Aimin, Guo Weimin, and Hong Xing], "高频声纳回波影像仿真技术" [Sound Reflection and Sound Shadow Simulation Technology of High-Frequency Sonar], 系统仿真学报 [Journal of System Simulation] (December 2006), pp. 3342–45; 佳水 [Jia Shui], "以光子系统排除水雷" [Using a Photon System to Remove Sea Mines], 激光与光电子学进展 [Laser and Photoelectron Research Progress], no. 11 (2001); 夏立新 [Xia Lixin], "掩埋水雷电磁探测的可行性分析" [Feasibility Study of Buried Sea Mine Electromagnetic Probes], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2001); 刘进 [Liu Jin], "使用极低频电磁场探测浅水水雷的可行性研究" [Feasibility Study: Using an Ultra-Low-Frequency Electromagnetic Field to Survey Shallow-Water Sea Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000); 王金根, 李林 [Wang Jingen and Li Lin], "手持式水雷穿透系统" [Handheld-Style Sea Mine Penetration Systems], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000); 傅金祝 [Fu Jinzhu], "对水雷和未爆武器进行磁探和磁性识别的进展" [Progress Concerning the Carrying Out of Magnetic Surveying and Recognition on Sea Mines and Unexploded Weapons], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (1999); 是海梅 [Shi Haimei], "水雷通用自检仪中舰船模拟信号设计探讨" [A Discussion on the Design of Simulated Vessel Signals in General Self-Testing Devices for Sea Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (1999); 张智 [Zhang Zhi], "舰船的电磁特征及其减少措施" [Electromagnetic Signatures of Ships and How to Effect Their Depression], 现代舰船 [Modern Ships], no. 142 (September 1997), p. 29; 刁海龙 [Diao Hailong], "反水雷新途径: 快速探测航道" [Rapid Channel Detection: A New Approach to Mine Countermeasures], 现代舰船 [Modern Ships], no. 129 (September 1996), p. 27.

378. 李凝 [Li Ning], "利用护卫舰上的直升机搜索水雷" [Organic Mine Searching with Helicopters from Frigates], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2007).

379. 崔荣鑫, 徐德民, 严卫生 [Cui Rongxin, Xu Demin, and Yan Weisheng], "一种自主水下航行器路径规划算法" [Path Planning Algorithm for Autonomous Underwater Vehicle], 系统仿真学报 [Journal of System Simulation], (December 2006), pp. 3373–76.

380. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 26.

381. 王冰川, 王亚军 [Wang Bingchuan and Wang Yajun], "贴近实战演练, 盯着问题完善—北海舰队某保障基地30余种新战法推向演兵场" [Conducting Exercises That Closely Approximate to Actual Combat, Perfecting Combat Methods by Focusing on Problems—A North Sea Fleet Support Base Puts Some 30 New Combat Methods to Use on the Exercise Field], 人民海军 [People's Navy], 3 June 2008, p. 2.

382. "Chronicle of Events of Military Training," *Guangzhou Zhanshi Bao,* 27 December 2005, pp. 1, 3, OSC CPP20060224318002.

383. Wang Guangxin and Chen Yijing, "On the Scene in the East China Sea," pp. 5–6.

384. See, for example, Arnold S. Lott, *Most Dangerous Sea* (Annapolis, Md.: Naval Institute Press, 1959), p. 77. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 12, demonstrate an understanding of this crucial problem, noting that "one must conduct close monitoring of our own mine obstacles that have been dispositioned."

385. See, for example, 陈可志 [Chen Kezhi], "GPS在水道扫雷中的应用" [Application of GPS Techniques to Hydrographic Minesweeping], 地矿测绘 [Surveying & Mapping of Geology & Mineral Resources] 17, no. 3, pp. 43–45.

386. Cao Ming and Liang Qingcai, "Following South China Sea Fleet Unit '809' Ship Sweeping Mines at Sea," pp. 18–19; Chen Qizheng et al., "The Goal is to Lock in on the Battlefield of the Future," pp. 1–2.

387. 孙涛 [Sun Tao], "某大队研制水雷内部记录仪" [A Certain Unit Develops a Sea Mine Interior Recording Instrument], 人民海军 [People's Navy], 4 December 2004, p. 1.

388. See Fifi Kieschnick, Naval Station Ingleside Public Affairs, "Mine Warfare 'Shifts Colors' to Southern California," *Pentagon Brief,* pentagonbrief.wordpress.com/2008/12/28/mine-warfare-shifts-colors-to-southern-california/. Four U.S. mine countermeasure ships are now based in Bahrain. See MCM and MSC links at the new Naval Mine and Anti-Submarine Warfare Command, http://www.nmawc.navy.mil.

389. These two mine countermeasures helicopter squadrons, located in Virginia Beach, Virginia, and in Ingleside, Texas, each have ten aircraft.

390. The textbook adds: "When the enemy unfolds minesweeping and barrier clearing forces, campaign commanders shall organize mobile forces from the Navy and Air Force operating groups, coastal missile and coastal artillery forces, and far-range artillery troops to seize the favorable opportunity to resolutely launch attack when the enemy ships towing minesweeping tools are blocked by barriers and are not easy to maneuver. The best time to attack the enemy minesweeping helicopter carrier and minesweeping hovercraft carrier is when the enemy enters our inshore sea and when the minesweeping helicopters and minesweeping hovercraft have not yet left the carrier." Bi Xinglin, ed., *Campaign Theory Study Guide,* pp. 448–49.

391. See *U.S. Navy Mine Warfare Plan,* 4th ed., www.exwar.org/Htm/ConceptDocs/Navy_USMC/MWP4thEd/contents.htm. For a cogent description of the future of U.S. mine countermeasures, see Paul Ryan, RADM, U.S. Navy (Ret.), "LCS Will Transform Mine Warfare," *U.S. Naval Institute Proceedings* (December 2004), pp. 37–39.

392. The requirement to map or survey an area suspected of containing mines suggests that the vehicle performing the mapping must itself have sufficiently small signatures that it can operate in the presence of sensitive mines without causing their detonation. Furthermore, the vehicle must know its location precisely, so that if it detects a minelike object, the suspected object can be accurately located to later be identified and reported. The mapping vehicle must also have sufficient endurance and speed to map the desired waters in an operationally useful length of time. These requirements tend to increase the size, complexity, and costs of candidate systems, making them difficult to develop.

393. Ron O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Oversight Issues, and Options for Congress," CRS Report for Congress, Order Code RL3741, updated 17 November 2008, p. 1.

394. Bettina H. Chavanne, "DDG-51 and LCS Winners in Gates Budget," *Aviation Week and Space Technology,* 7 April 2009, http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=defense&id=news/PROG04079.xml.

395. According to the consultant described in an earlier footnote, the initial LCS ships will both cost between $700 and $900 million each. As the program enters serial production, the unit cost is expected to become as low as $350 million.

396. Fu Jinzhu, "Taiwan's Problematic Mine Warfare Capability," pp. 33–34.

397. Taiwan purchased the *Yung Fung* vessels from Germany in the early 1990s as "offshore oil support vessels." Taipei subsequently converted the ships into mine hunters by installing remotely operated underwater vehicles and advanced high-frequency sonar systems. See Commodore Stephen Saunders, RN (Ret.), "Yung Feng (MWV 50) Class Minehunters-Coastal (MHC)," *Jane's Fighting Ships,* 17 February 2005, www.janes.com.

398. Fu Jinzhu, "Taiwan's Problematic Mine Warfare Capability," pp. 33–34. See also 岩文 [Yan Wen], "台湾水中兵器研制揭秘" [Taiwan's Undersea Weapons Development Revealed], 舰船知识 [Naval and Merchant Ships] 295, no. 4 (April 2004), p. 9.

399. Raymond Cheung, "Fleet Review, Standing Guard across the Taiwan Strait," *Jane's Navy International* 101, no. 8 (October 1996), p. 48.

The intervening decade has not improved these vessels' condition or Western appraisals of them. "All are in very poor condition," states Stephen Saunders, Commodore, RN (Ret.), in "Adjutant and MSC 268 Classes," *Jane's Fighting Ships,* 17 February 2005, www.janes.com.

400. Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," pp. 19–21.

401. This inventory includes twelve of the *Sugashima*-class coastal minesweepers, three of the *Yaeyama*-class ocean mine hunter/sweepers, and eleven *Hatsushima/Uwajima*-class mine hunter/sweepers. *Jane's Fighting Ships,* 28 February 2008, www.janes.com.

402. See U.S. Department of State, "Joint Statement of U.S.-Japan Security Consultative Committee," 19 February 2005, www.mofa.go.jp/region/n-america/us/security/scc/joint0502.html.

403. See, for example, 陶爱月 [Tao Aiyue], "日本水雷战舰艇纵览" [A Survey of Japanese Mine Warfare Ships], 舰船知识 [Naval and Merchant Ships], no. 312 (September 2005), pp. 44–47; 傅金祝 [Fu Jinzhu], "数量最多, 更新最快: 日本海上自卫队的反水雷实力" [Greatest Quantity, Fastest Renewal: The JMSDF's MCM Strength], 舰船知识 [Naval and Merchant Ships], no. 312 (September 2005), pp. 48–49; 侯建军 [Hou Jianjun], "挑战智能水雷的570吨级新型猎扫雷艇" [A New Type of 570 Ton Mine Hunter/Sweeper to Challenge Intelligent Sea Mines], 舰船知识 [Naval and Merchant Ships], no. 312 (September 2005), pp. 50–51; 傅金祝 [Fu Jinzhu], "体现反水雷装备发展方向的日本新型S-10猎雷具" [Japan's New Type of S-10 Mine Hunting Tool Reflects the Development Direction of MCM Equipment], 舰船知识 [Naval and Merchant Ships], no. 312 (September 2005), pp. 52–53.

404. See, for example, 候建军 [Hou Jianjun], "美国海军水雷战装备" [United States Navy Mine Warfare Equipment], 当代海军 [Modern Navy], no. 6 (2003); 张云庆 [Zhang Yunqing], "航空激光水雷监测系统的进展" [The Development of an Aviation Laser Sea Mine Monitoring System], 光电子技术与信息 [Optoelectronic Technology & Information], no. 4 (2002); 夏立新 [Xia Lixin], "掩埋水雷探测研究" [Buried Sea Mine Detection Research], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2001); 傅金祝 [Fu Jinzhu], "美海军的中等深度滨海水雷开发" [U.S. Navy Medium-Depth Surf-Zone (Shallow Water) Mine Development], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (1999); 夏立新 [Xia Lixin], "美国的反水雷, 水雷和特种战计划" [American Mine Countermeasures, Sea Mines and Special Operations Plans], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (1999); 刘平, 杨洋, 王青 [Liu Ping, Yang Yang, and Wang Qing], "国外反水雷舰艇装备现状及发展趋势" [The State-of-the Art and Development Trends of Equipment of Foreign Mine Countermeasures Ships], 舰船工程 [Ship Engineering] 26, no. 6 (2004), pp. 1–3; and 张豪娟 [Zhang Haojuan], "美国海军对电池的需要及研制" [U.S. Navy Battery Requirement and Development Efforts], 电池工业 [Battery Industry] 4, no. 2, April 1999, pp. 71–74.

405. For analyses of other Western MCM developments, see 王晓娟 [Wang Xiaojuan], "最新水雷对抗系统" [The Latest Counter–Sea Mine Systems], 情报指挥控制系统与仿真技术 [Information Command Control System and Simulation Technology], no. 10 (2001); 张保山 [Zhang Baoshan], "多国部队未来水雷对抗作战研究" [The Future Sea Mine Opposition Warfare Research of Various Countries' Militaries], 情报指挥控制系统与仿真技术 [Information Command Control System and Simulation Technology], no. 7 (2001); 夏立新 [Xia Lixin], "英国的水雷全仿真系统" [England's Complete Sea Mine Simulation System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2001); 赵祚德 [Zhao Zuode], "澳大利亚的三维声水雷成像声纳" [Australia's Three-Dimensional Acoustic Sea Mine AMI Sonar], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000); 赵祚德 [Zhao Zuode], "英国的 '铺路者' 综合水雷战武器系统" [British Comprehensive Mine Warfare Weapon System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2000); 傅金祝 [Fu Jinzhu], "探测浑水中水雷的声成像系统" [The Turbid Water Sea Mine Sound Imaging System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 1 (1999); 付伟 [Fu Wei], "国外激光水下侦察设备发展综述" [A Survey of the Development of Foreign Underwater Laser Surveillance Equipment], 舰船电子对抗 [Ship Electronic Resistance], no. 6 (2001), pp. 21–23; 周智超 [Zhou Zhichao et al.], "水面舰艇对水雷防御训练评估的 AHP-Fuzzy 方法" [The AHP-Fuzzy Evaluation Method of Training on Surface Ship Anti-mine Defense], 系统工程与电子技术 [Systems Engineering & Electronics] 23, no. 9 (September 2001), pp. 56–59; 范军, 万琳, 汤渭霖 [Fan Jun, Wan Lin, and Tang Weilin], "沉底水雷目强度预报" [Predicting Target Strength of Mines Lying on the Seabed], 声学技术 [Technical Acoustics] 20, no. 4 (2001), pp. 145–48; and 张小兵, 周穗华 [Zhang Xiaobing and Zhou Suihua], "一种基于模糊理论和神经网络的水雷状态识别方法" [A Method of Mine State Classification Based on Fuzzy Sets and Artificial Neural Networks], 海军工程大学学报 [Journal of Naval University of Engineering] 92, no. 3 (2000), pp. 77–80.

406. 钱东 [Qian Dong], "美国海军水下战中心 NUWC" [The U.S. Naval Undersea Warfare Center], 鱼雷技术 [Torpedo Technology] 11, no. 2 (June 2003), pp. 50–51; 钱东 [Qian Dong], "美国未来的大型 UUV—MANTA" [The Future U.S. Large-Scale Unmanned Undersea Vehicle—MANTA], 鱼雷技术 [Torpedo Technology] 11, no. 1 (March 2003), pp. 47–50; 傅金祝 [Fu Jinzhu], "利用敌方水雷开发有效的反水雷方法" [Using an Effective Anti-mine Method from Enemy Sea Mine Development], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (1999).

407. 周丽萍 [Zhou Liping], "水下 '猎雷者'—美国 AN/WLD-1型遥控猎雷系统" [Underwater 'Mine Hunter'—The U.S. AN/WLD-1 Remote Control Mine Hunting System], 环球军事 [Global Military], pp. 26–27; 黄江飞 [Huang Jiangfei], "AN/WLD-1型遥控猎雷系统" [The AN/WLD-1 Remote Control Mine Hunting System], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2000).

408. 乔昶超, 张旭; 海军大连舰艇学院研究生队, 海军大连舰艇学院水武与防化系 [Qiao Changchao, Graduate Student Team; Zhang Xu, Department of Underwater Weapons and Chemical Defense Systems; Dalian Naval Vessel Academy], "AUV探查水雷搜索模式仿真比较研究" [Research on Comparison and Simulation of Mine Detection Search Mode by AUVs], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2008); 傅金祝 [Fu Jinzhu], "反水雷自主式水下航行器" [Anti-mine Independent AUVs], 舰船知识 [Naval and Merchant Ships] 292, no. 2 (2004), p. 39.

409. 李杰 [Li Jie], "新型无人潜艇的战力" [The Battle Power of a New Type of Unmanned Submarine], 当代海军 [Modern Navy], no. 10 (2004), pp. 48–50; 孙云利 [Sun Yunli], "美国海军的水下无人潜水器展望" [The Prospects for Future U.S. Navy Submarine UUVs], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2003).

410. See 杨毅 [Yang Yi], "美国海军航空反水雷的发展趋势" [The Development Trend of U.S. Navy Aviation MCM], 航海 [Navigation], no. 2 (2003), pp. 41–42; 夏立新 [Xia Lixin], "美国直升机反水雷的研究和开发" [The Research & Development of U.S. Helicopter MCM], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (1999).

411. He Shan, "Can the *Virginia* Class Become the New Century's Maritime Hegemon?" pp. 18–21.

412. At the moment, Beijing is playing a relatively positive role in the Six-Party Talks. However, a future return to a more belligerent posture that involves siding explicitly with Pyongyang cannot be ruled out at this time.

413. This would be consistent with the PLA's Cold War effort to defend the Bohai Sea by fortifying the Miaodao and Changdao islands between the Shandong and Liaodong peninsulas. Interview, Beijing, 2007.

414. For a Chinese analysis of Southeast Asia's vulnerability to sea mines, see 夏立新 [Xia Lixin], "水雷对东南亚地区的潜在威胁" [The Potential Sea Mine Threat to Southeast Asia], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2001).

415. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 14.

416. This is determined by the shallow littoral waters, for example, in the Gulf of Tonkin, and also, of course, by Vietnam's proximity to Chinese bases, particularly on Hainan Island. Japan might also become a target of a limited Chinese MIW campaign under worst-case circumstances. Clearly, submarines (and perhaps civilian vessels) would have to lead such operations given the potentially high-intensity battle environment and the distances involved. However, one-third of the Chinese submarine force (approximately twenty vessels) fully loaded could deliver almost 500 sophisticated mines, enough to close several ports or sea lines of communication for at least a week or two, causing substantial damage, possibly in the form of psychological-strategic effects.

417. The bathymetry of the waters proximate to Taiwan immediately reveals that the Taiwan Strait itself, as well as waters to the immediate north and south (adjacent to the island's largest ports), are shallow enough to create a wholly appropriate environment for the use of all types of mines. Although Taiwan's eastern coast has deeper waters, the authors nevertheless believe that by relying on a combination method of deployment (air, surface, submarine, and civilian) a major Chinese MIW campaign could efficiently blockade Taiwan, especially if working in concert with the PLA Navy's submarine force. Chinese analysts, moreover, assess that Taiwan's MCM are inadequate to this challenge and that efforts by Taiwan to deploy its own mines could be dealt with by the PLA.

418. "16. How Is Sea Mine Warfare and Anti-blockade Combat Carried Out?" in "One. The Basic Combat Theory of the Taiwanese Army," in Bi Xinglin, ed., *Campaign Theory Study Guide*. Another source states that "the PLA can execute offensive mining against any of Taiwan's ports [naval, commercial, oil off-loading areas], sea channels or adjoining sea areas, cutting off Taiwan's sea lines of communication, destroying its economy

and energy lifeblood." Hai Lin, "In 2010 Taiwan Will Be Surrounded with a Sea Mine Battle Array," p. 16.

419. A discussion of how Taiwan's air force could be rendered ineffective by current Chinese weapons is included in William S. Murray, "Revisiting Taiwan's Defense Strategy," *Naval War College Review* 61, no. 3 (Summer 2008), pp. 13–38.

420. Mei Lin, "Analysis of the CPC Armed Forces' Development of New Methods of Operations," *Taipei Chung Kung Yen Chiu,* 15 November 1997, pp. 50–60, OSC FTIS19980310000807.

421. Technology does not appear to ameliorate this enduring reality, according to one practitioner. See Lt. Cdr. Patrick Molenda, U.S. Navy, "Don't Forget Dedicated Mine Countermeasures," U.S. Navy Institute *Proceedings* (October 2001), p. 41.

422. 丁信成 [Ding Xincheng], "高技术战争中的反潜战" [Anti-submarine Warfare under Circumstances of High-Tech War], 中国民兵 [China Militia], (December 1996), p. 37.

423. In WWII, Germany successfully mined several U.S. ports via submarine, and closed the ports to traffic for periods of roughly two weeks. See Hartmann with Truver, *Weapons That Wait,* pp. 69–70. Special MIW operations of this nature—limited, but high-profile strikes—could have important psychological effects early in a Sino-American military crisis, for example dramatically shifting U.S. Navy resources toward protecting sea areas closer to home, and thus enabling China's swift conquest of Taiwan. As the recent 2003 Iraq War (not to mention Hurricane Katrina) so powerfully demonstrates, strategists and military planners must work with worst-case, not best-case, assumptions for planning purposes.

424. Lin Changsheng, "Hidden Dragon in the Deep," p. 32.

425. Ibid., p. 30.

426. 周洪光, 徐维川, 曾松林 [Zhou Hongguang, Xu Weichuan, and Zeng Songlin], "浅析登陆作战中水雷武器的使用" [Simple Study on the Use of Sea Mine Weapons in Landing Operations], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 2 (2007).

427. 杨琼 [Yang Qiong], "抗登陆水雷" [Anti-landing Mines], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 3 (2007). A detailed survey of Taiwan's sea-mine capabilities is reviewed in the PRC article 邓又辉 [Deng Youhui], "水雷—'台独' 幻想的救命稻草," [Sea Mines—The Illusory Lifesaving Sustenance of "Taiwan Independence"], 环球军事 [Global Military] (2005), pp. 22–23.

428. Zhang Yuliang, Yu Shusheng, and Zhou Xiaopeng, *Science of Campaigns,* chap. 13.

429. The continental shelf extends from China about 250 miles out into the East China Sea (more than halfway to Japan) enabling the use of relatively primitive (shallow water) minefields.

430. Lin Changsheng, "Hidden Dragon in the Deep," p. 31. For PLAN Submarine Academy research on this topic, see 赵祚德 [Zhao Zuode], "水雷障碍封潜作战的效率评定模型" [An Assessment Model for the Effectiveness of Sea Mine Barriers in Antisubmarine Warfare], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2002).

431. Quotations in this paragraph from Glosny, "Strangulation from the Sea?" pp. 133, 140, 143.

432. See figures in "Total Mines Laid" in Table 4, "Results of Mine-Laying Analysis (after 6 months)," p. 144. These figures are for "scenarios one and two." In footnote 81, Glosny rejects the maximum finding of 10,166 mines for scenario 3, "[a] situation that looks worse for Taiwan," because this scenario involves "heroic assumptions." Glosny, "Strangulation from the Sea?" p. 145.

433. Murray, "Revisiting Taiwan's Defense Strategy," pp. 13–38.

434. USAF doctrine has long promulgated the notion that all missions are secondary to achieving "air dominance." This was not the case in World War II (before 1944) when massive raids were undertaken under dangerous circumstances. If the ROCAF survives the initial attack, moreover, its aircraft will be preoccupied with defending high-priority targets (leadership, air bases, missile defense sites, population centers) rather than chasing Chinese aircraft sowing mines at sea.

435. Glosny, "Strangulation from the Sea?" p. 148.

436. Sailors of the U.S. merchant marine had a higher proportion of deaths in combat than any other service in the Second World War. See www.usmm.org/men_ships.html.

437. See, for example, Glosny, "Strangulation from the Sea?" p. 145.

438. Glosny, "Strangulation from the Sea?" p. 150.

439. On the imperative of accelerating PLAN MIW development, see 张光法, 黄江华 [Zhang Guangfa and Huang Jianghua], "充分利用研制资源 促进在研水雷尽快形成战斗力" [Make Full Use of Development Resources, Accelerate Existing Sea Mine Research to Form Fighting Capacity as Quickly as Possible], 水雷战与舰船防护 [Sea Mine Warfare and Ship Self-Defense], no. 4 (2001).

440. "Blockade," defined narrowly, simply means a very significant reduction in sea borne trade, because of the closing of ports by adversary forces.

Abbreviations and Definitions

A	**ASW**	antisubmarine warfare
	ASUW	antisurface warfare
C	**CSIC**	China Shipbuilding Industry Corporation
G	**GPS**	Global Positioning System
I	**IS**	*International Security*
J	**JDAM**	Joint Direct Attack Munition
L	**LCS**	Littoral Combat Ship
M	**MCM**	mine countermeasures
	MIW	mine warfare
	MLRS	multiple-launch rocket system
P	**PLA**	People's Liberation Army
	PLAAF	People's Liberation Army Air Force
	PLAN	People's Liberation Army Navy
	PRC	People's Republic of China
R	**RBU**	underwater rocket bomb
	ROCAF	Republic of China Air Force
	ROV	remotely operated vehicle
S	**SLMM**	submarine-launched mobile mine
	SSN	nuclear-powered attack submarine
U	**UUV**	unmanned underwater vehicle
X	**XO**	executive officer

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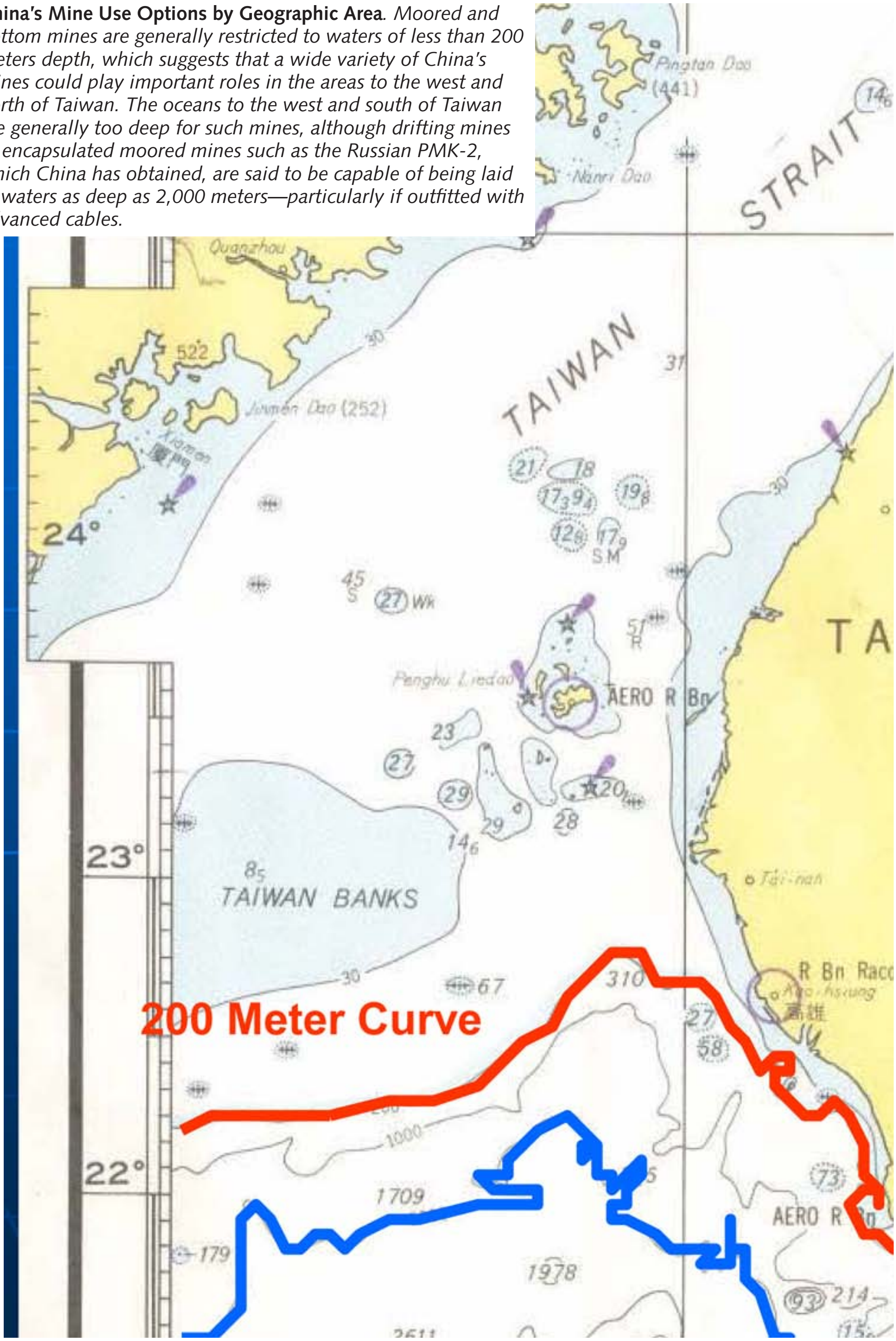
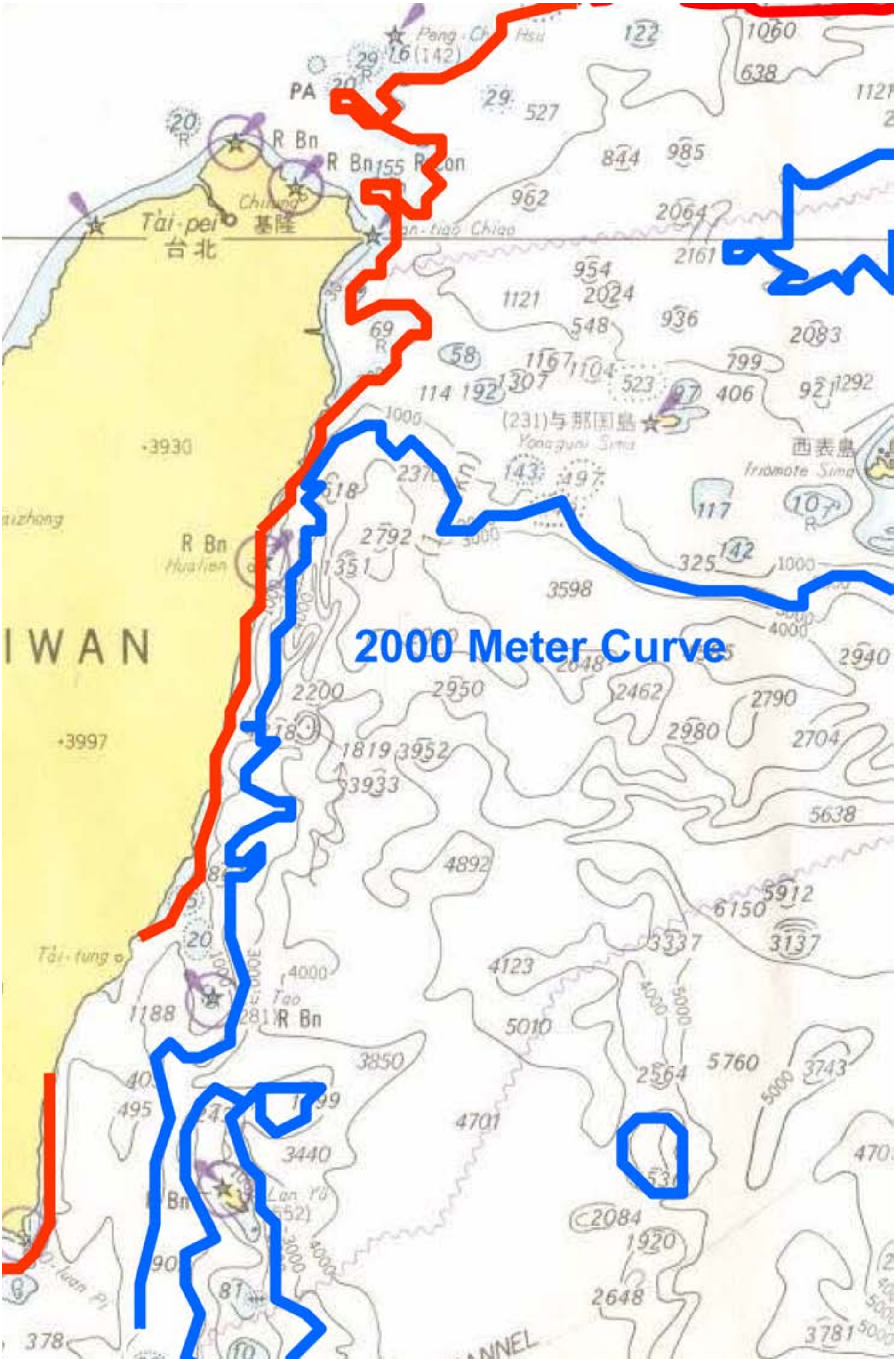
China's Mine Use Options by Geographic Area. *Moored and bottom mines are generally restricted to waters of less than 200 meters depth, which suggests that a wide variety of China's mines could play important roles in the areas to the west and north of Taiwan. The oceans to the west and south of Taiwan are generally too deep for such mines, although drifting mines or encapsulated moored mines such as the Russian PMK-2, which China has obtained, are said to be capable of being laid in waters as deep as 2,000 meters—particularly if outfitted with advanced cables.*

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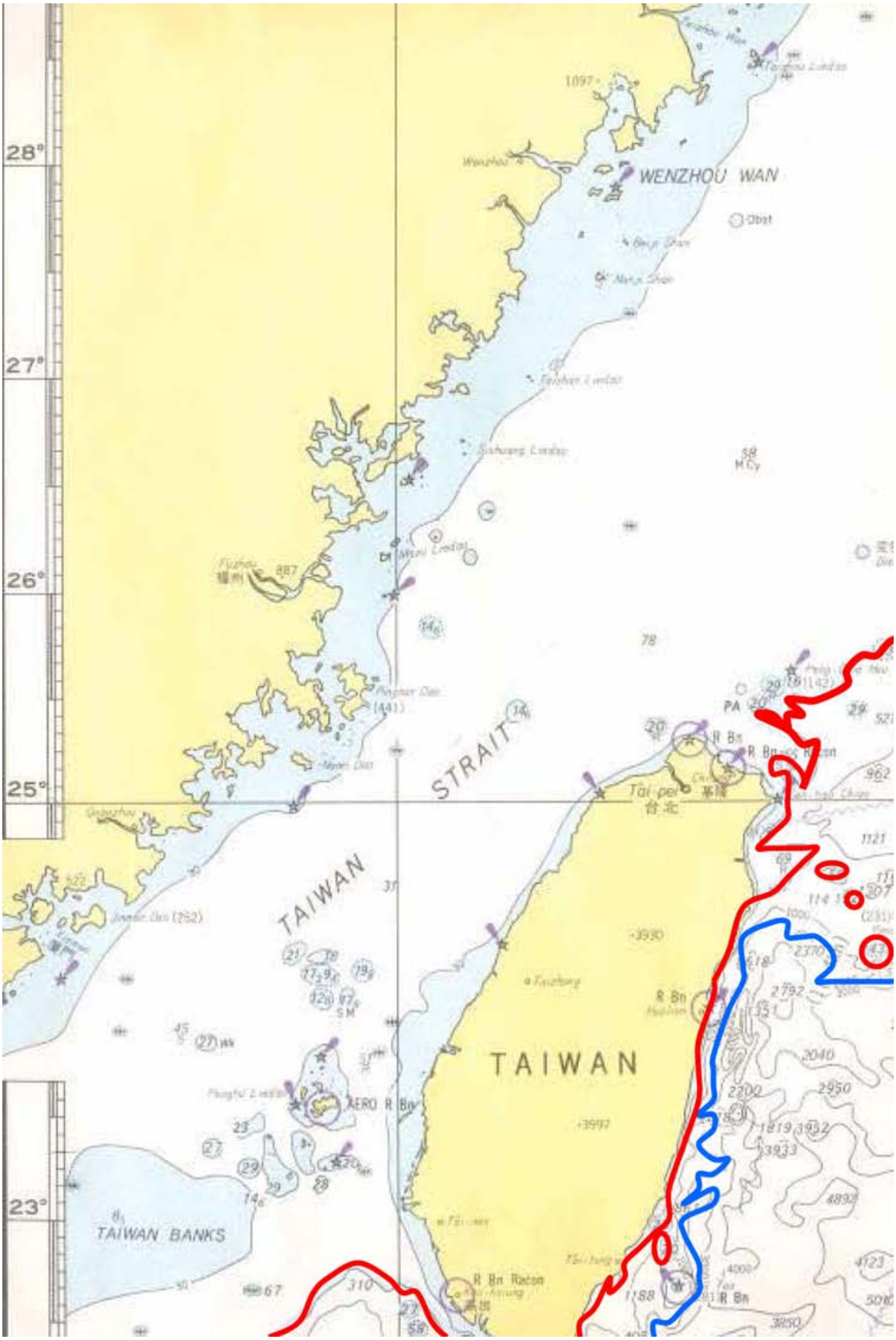
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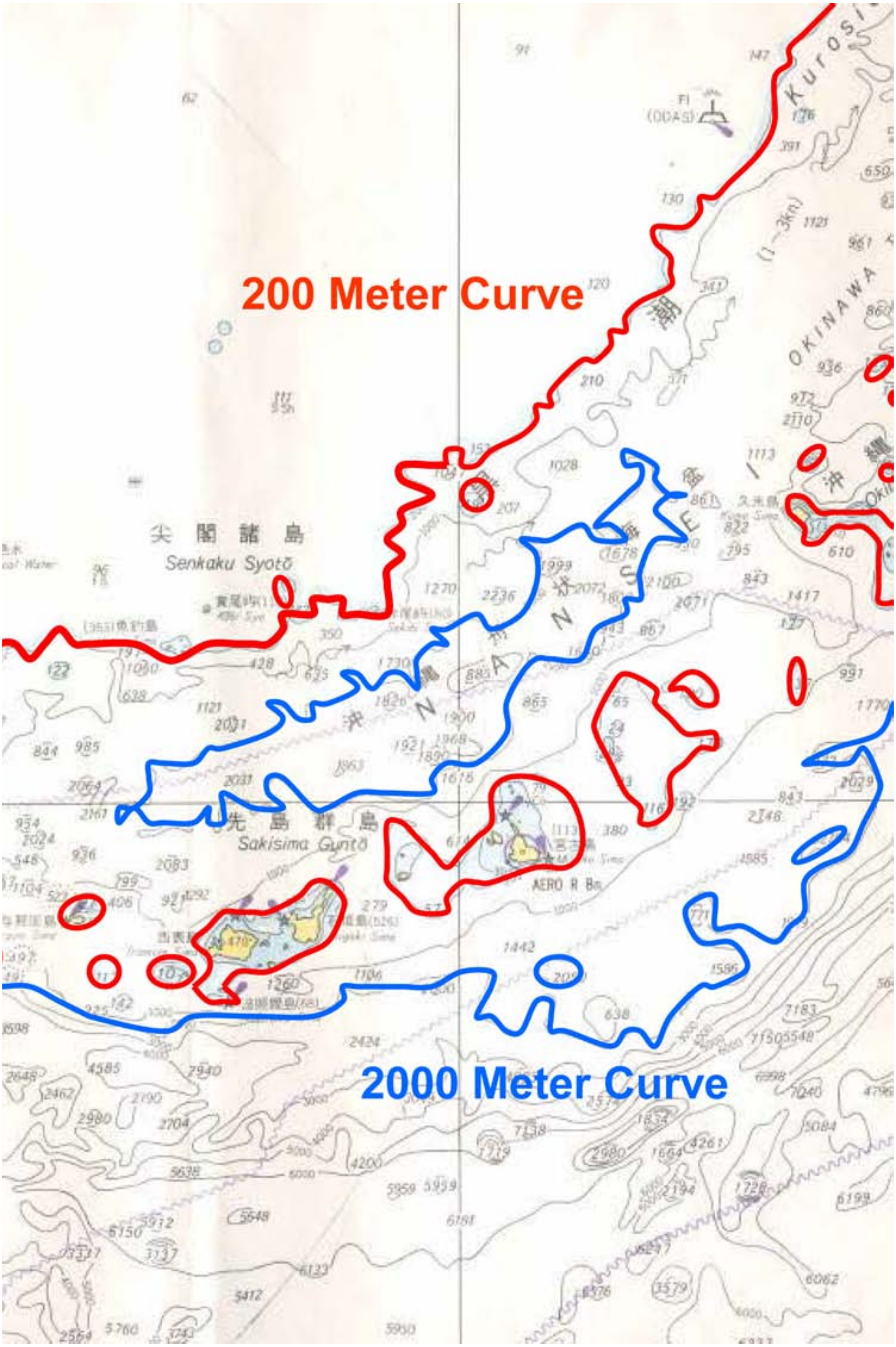
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