

ROYAL AUSTRALIAN NAVY

SEA POWER

SOUNDINGS



Issue 18, 2020

BREACHING THE SURFACE:

THE FUTURE OF SEA MINES IN THE INDO-PACIFIC

Alia Huberman,

The Australian National Internships Program



EXECUTIVE SUMMARY

This report argues that several dynamics of the coming few decades in the Indo-Pacific will see naval mines used once again in the region. It suggests they will form the basis of anti-access strategies for some Indo-Pacific states in a way that will be deeply transformative for the region's strategic balance and for which Australia is thoroughly unprepared. It seeks to draw attention to the often-underappreciated nature of sea mines as a uniquely powerful strategic tool, offering the user an unparalleled asymmetric ability to engage high-value enemy targets while posing a minimal-risk, low-expense, and continuous threat. In the increasingly contested strategic environment of the contemporary Indo-Pacific - a region in which the threats to free navigation and the maritime economy are existential ones - there is considerable appetite for anti-access and sea denial weapons as defensive, offensive, and coercive tools. Naval strategists must, prepare for the resurgence of mine warfare in the Indo-Pacific, and for the grand-scale and rapid timeline in which it can transform an operational environment.

This report first seeks to collate and outline those characteristics of sea mines and of their interaction with an operational environment that make them attractive for use. It then discusses the states most likely to employ mine warfare and the different scenarios in which they might do so, presenting five individual contingencies: China, Taiwan, North Korea, non-state actors, and Southeast Asian states. Finally, it presents three key recommendations for Australian defence policymakers in responding to the likely future proliferation of sea mines in the Indo-Pacific.



ACKNOWLEDGMENTS

I would like to thank several people who've helped me in the process of writing this report. Firstly, thanks to all the incredible staff at the Sea Power Centre-Australia who have provided me with excellent advice and resources and indulged my curiosity – in particular, Commander Andrew Schroder RAN, Commander Alastair Cooper RAN, and Lieutenant Mitchell Vines RAN. I have had a fascinating experience at SPC-A and the opportunities generously provided to me by its personnel.

I would also like to thank Dr Laurence Brown and all the staff at the Australian National Internships Program for coordinating and facilitating this unique and extraordinary experience.



TABLE OF CONTENTS

Introduction and Approach.....	4
Section I: The Mine Warfare Appeal.....	5
Section II: Scenarios.....	10
China.....	10
Taiwan.....	12
North Korea.....	13
Non-State Actors.....	14
Southeast Asia.....	15
Section III: Conclusion and Recommendations	16
Bibliography	18

ACRONYMS

A2/AD	Anti-Access/Area Denial
GNP	Gross National Product
KPN	Korean People’s Navy
LCS	Littoral Combat Ship
PLAN	People’s Liberation Army Navy
SLOC	Sea Line of Communication



INTRODUCTION

The naval mine is considered to be one of the most cost-effective and powerful weapons in the maritime domain, and yet receives comparatively little attention or concern, particularly in Western security establishments. Mine warfare has shaped a remarkable number of conflicts throughout the twentieth century but does not occupy a commensurate place in the global collective security consciousness. It has been decisive in the outcome of wars in Korea, Vietnam, the Pacific, and the Persian Gulf, and has incapacitated or sunk almost four times more US ships than any other means of attack combined.¹ Despite this, the memory of defence policymakers seems short: after each use, sea mines quickly fall behind 'flashier' weapons in attention received, due in large part to their perception as an unglamorous weapon of the 'poor man's navy'.² Mine warfare has therefore been called the 'lesson that never stays learned,'³ and doctrine concerning it often is trapped in a reactive cycle that leaves navies unprepared to cope with the newest incarnation (see figure 1). Given several dynamics of the coming decades in the Indo-Pacific, Australia will likely be caught vulnerable and unawares by this cycle yet again: as a result of several structural factors, sea mines will likely return as the basis of anti-access strategies for many different states. This begs the questions: what are those structural factors, how might those scenarios look, and what ought Australia to do about it?

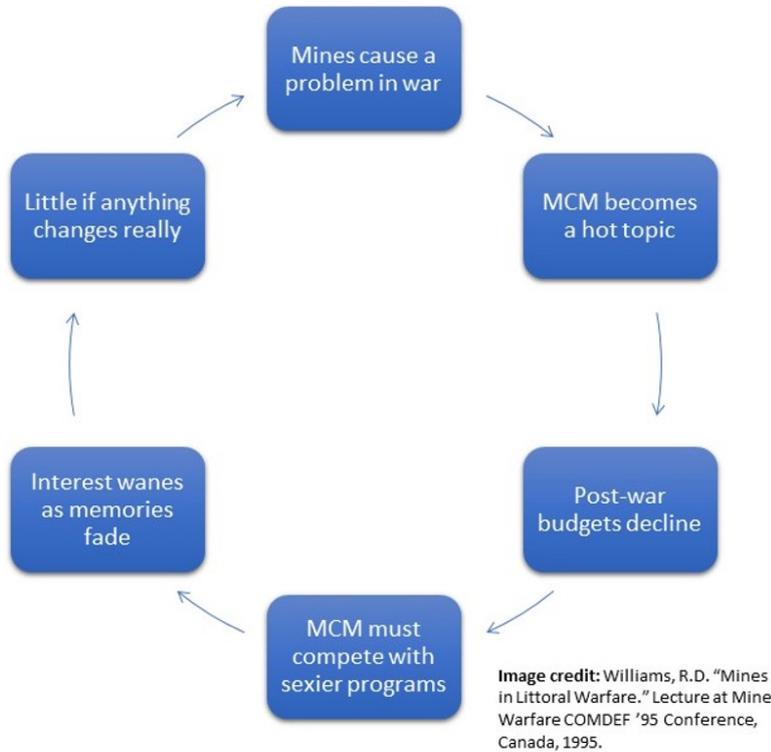


Figure 1: the MINE WARFARE cycle¹

This report has sought to answer those questions by researching a desk-based literature review using published and grey literature on different aspects of sea mines and specific scenarios. There is considerable and highly reputable literature outlining the ‘overlooked’ benefits of naval minefields, and considerable literature discussing rising tensions in the Indo-Pacific and scenarios in which they might play out, but little writing linking these two concepts in causality and implications. This report has therefore sought to fill this gap by synthesising these two types of sources to produce a holistic assessment of the future role of sea mines in the shifting regional threat landscape.

Section I: The Mine Warfare Appeal

Sea mines are fundamentally unique tools that influence the operational environment differently from most conventional weapons. They offer their user a distinct set of advantages that make them highly appealing to several actors in the Indo-Pacific, becoming the ‘weapon of choice’ for many smaller states,⁴ but equally attractive for the region’s great powers.⁵ Firstly, they are undoubtedly the most affordable and efficient anti-access weapon available and are therefore a perfect asymmetric tool for



a navy of any size to impact a conflict on a strategic scale. This cost-effectiveness is a function of a number of their unique characteristics. As an unmanned platform, they act as a powerful force multiplier, freeing up manned platforms that would usually be engaged in active Anti-Access /Area Denial (A2/AD) measures to manoeuvre or undertake duties elsewhere.⁶ They are compact, easy to stockpile,⁷ highly durable and have low maintenance requirements.⁸ Mines are set-and-forget weapons, requiring no continued manpower hours for monitoring and targeting – the cost of a man-out-of-the-loop mine is therefore significantly lower compared with the cost of a manned platform actively performing the same task, such as a blockade or interdiction.⁹

Importantly, as a cheap and inherently disposable tool capable of incapacitating a navy's highest-value assets, they are extremely cost-effective in terms of dollars invested per dollars of damage to the enemy platform.¹⁰ This principle is best exemplified by the case of the frigate *USS Samuel B Roberts*, which was hit on 14 April 1988 by what is presumed to have been an M08/39 moored contact mine laid by Iranian forces. The explosion tore a 6.5-metre hole in *Roberts*' hull and broke her keel, nearly sinking the ship.¹¹ Repairs cost some \$135 million (USD) and the ship was out of action for 18 months, while the Iranian mine that caused such damage cost only an estimated USD \$1,500 to lay.¹² With this drastically low price, states with small navies and limited resources can afford to build large stockpiles that can shape the course of an entire conflict, as with the 250-ship UN amphibious task force landing that was prevented in October 1950 by 3,000 mines laid off North Korea's east coast. The incident prompted the task force's US commander, Rear Admiral Allen E. Smith to lament that 'we have lost control of the seas to a nation without a navy.'¹³

Moreover, the cost of mine hunting and clearance is totally out of proportion with the cost of placement, and the process is extremely slow, providing yet another asymmetrical advantage to the user.¹⁴ Mine countermeasures (MCM) operations are laborious and often high-casualty; they require extremely expensive specialised equipment, meaning that most states' MCM force is fractional and would require weeks to clear a given field. Another factor complicating MCM operations is the proliferation and exponential increase of 'mine-like' human artefacts and man-made debris on the sea



bed, hindering a force's ability to positively identify and dispose of mines. During the 1984 international effort to clear the mined Red Sea approaches to the Suez Canal, British minehunters encountered and were forced to investigate 15 mine-like objects per four square miles of the seabed – even with advances in technology, the steady increase in seabed debris makes the task slower and more difficult with each passing year.¹⁵ The ease and speed with which mines can be laid compared with the difficulty and time it takes to sweep them are therefore highly appealing, as it allows a user to stall an adversary's military and civilian shipping for a strategically significant amount of time while the defendant state is forced to undertake MCM operations.¹⁶

Mine warfare also poses a dramatic and distinctive psychological threat, introducing an incapacitating element of uncertainty to an operating environment and polarising decision-making towards pessimism and stoppage.¹⁷ As mines generally cannot be detected by anything other than slow and expensive dedicated MCM forces, the mere suggestion that an area has been mined, or the presence of even a small and unsophisticated minefield, will delay the deployment of any manned vessels while search and clearing being conducted.¹⁸ This inherent ambiguity means also that a defendant state has no way to determine the veracity of an adversary's claim about a minefield – once a state has demonstrated a capacity to lay one field, any field it declares after that point must also be treated as mined.¹⁹ Therefore, up to and during the process of clearing, both the sailor and the decision-maker face an unnerving lack of knowledge about the size and extent of the minefield and their proximity to it – functionally, a paralysing sense of 'suspense' and blindness to the threat they're facing.²⁰ In this respect, mines bear more similarity to the unknowable terror of chemical and biological weapons than other conventional weapons. As a result, the powerful psychological impact of mines affords them a unique coercive power by forcing decision-makers into prioritising MCM and confirmation of clearance above their operational objectives.

Mines also provide several broader strategic uses for decisively shaping the outcome of a conflict. They can serve as a useful tool for tactical de-escalation, both because they physically separate forces to slow down the outbreak of active conflict,²¹ and because of their passive, impersonal nature: as



they are less visible or confrontational than human-directed systems, there is less shame and political cost to a refusal to challenge them. They can, therefore 'provide the basis of a politically invaluable 'golden bridge', by allowing the opponent a legitimate excuse to tone down his efforts, and supply a foundation for truce and negotiation.'²² As a result, they can also be used as a flexible instrument for a graduated response to aggression or incursion without sparking more intensive conflict.²³

The capacity of mine warfare to disrupt an opponent's maritime operations is one of its most powerful functions, as demonstrated by the minefields that frustrated US plans for amphibious assaults at Wonsan Harbour during the Korean War and at Ash-Shuaybah during Operation DESERT STORM.²⁴ Even when mines don't detonate or fail to fully incapacitate a platform, the damage they cause or its potential is often enough to induce mission abort.²⁵ They also allow their users to subvert an adversary's battle plans and manipulate the movement of their forces to its benefit, as they can be used strategically to force shipping into narrow sea lines of communication (SLOCs) that are more vulnerable to attack.²⁶

It's also particularly important to highlight the impact of mine warfare as an anti-commerce operation, particularly in the economic context of the contemporary Indo-Pacific. By disrupting or halting an opponent's seaborne logistics and trade, a state using sea mines against civilian merchant shipping can effectively strangle its adversary's economy.²⁷ Indo-Pacific states are more reliant than ever before on SLOCs that supply their domestic needs, and 60% of global maritime trade passes through Asia.²⁸ In an increasingly globalised world, even limited mine warfare operations can have a drastic impact on the health of individual economies, raise prices globally by spiking shipping insurance costs and slowing or halting trade, and undermine confidence in the world's biggest markets.²⁹ Moreover, a significant portion of global daily oil supply passes through the Indo-Pacific's maritime geographic bottlenecks, such as the Strait of Malacca, through which a quarter of all sea-transported oil is shipped.³⁰ The deployment of mines around such chokepoints could destabilise the global economy and potentially threaten lives around the world.³¹ Mine warfare for anti-commerce interdiction has been proven to have a decisive impact in weakening states in wartime and coercing them to surrender:



both the 1975 fall of the Cambodian regime and the end of the Second World War in the Pacific theatre have been attributed in large part to mine blockades in the Mekong River³² and around Japanese home waters³³ respectively.

Together, these factors make mine warfare a highly attractive option for several diverse players in the Indo-Pacific. They are highly affordable, strategically significant and disruptive, both tactically and on a macro scale to the entire state. In short, they constitute the ultimate maritime asymmetric weapon, allowing both the region's great powers and its smaller and less wealthy states to deliver effective defensive or offensive area denial against any adversary. This report will now discuss the states most likely to employ mine warfare and the different scenarios in which they might do so.

Section II: Scenarios

CHINA

The People's Republic of China (PRC) is estimated to possess a stockpile of between 50,000-80,000 sea mines,³⁴ conducts extensive, realistic and frequent minelaying exercises, and is working hard to improve the quality and training of the People's Liberation Army Navy (PLAN) mine warfare officers and sailors.³⁵ China is considered to be fully capable of using its mine stockpiles as the basis of an anti-access strategy for the forced reunification of Taiwan, the seizure of disputed islands and features in the South or East China Seas,³⁶ or the interdiction of SLOCs in the broader Western Pacific area for other strategic purposes.³⁷ The PLAN considers sea mines to be the 'main threat to any navy'³⁸ in future maritime warfare, has assessed that the United States Navy's relative mine warfare capabilities are 'extremely weak'³⁹ and a 'critical vulnerability'⁴⁰, and has accordingly focussed on developing its capability for asymmetric leverage. The scenario long postulated by US wargamers involves a sudden



Chinese announcement of a ‘total exclusion zone’ covering Taiwan or an islet such as the Spratlys.⁴¹ In this scenario, the Chinese would use its A2/AD capabilities – including missiles and submarines, but relying heavily on offensive mining – to blockade the target territory and prevent the US or other third-party intervention for long enough to establish a fait-accompli presence there.⁴² A 2004 piece in China’s official Navy newspaper affirms this model, writing of the possible utility of offensive mine warfare in a possible US-China conflict: ‘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.’⁴³

In many scenarios for a cross-strait conflict, China is likely to seek to pursue a lower-intensity ‘grey zone’ campaign that limits casualties and infrastructure damage to soften the islanders’ resistance and complicate a US or Japanese decision to intervene. Under these conditions, it would likely target Taiwanese ports with mine warfare rather than a more destructive heavy missile barrage using its considerable coastal capabilities.⁴⁴ Current Chinese naval concepts envision a blockade of 5,000-7,000 mines laid in a first 4 to 6-day phase, with the most strategically important ports cut off within two days. It would simultaneously mine or claim to mine Taiwan’s eastern waters with its more technologically advanced platforms, deterring the natural arrangement of US or allied forces.⁴⁵

US or allied forces would face extreme difficulty in responding to such a scenario. Even at the most generous projections of US MCM forces following a total success of its program to revitalise its MCM capability with their Littoral Combat Ships (LCS), US capability would be inadequate to combat the massive volume of PLAN mine stockpiles and delivery platforms.⁴⁶ In light of the program’s failures,⁴⁷ the outlook is even worse. The nearest MCM assets are homeported in Sasebo, Japan, only a day and a half from Taiwan,⁴⁸ but are preparing for decommissioning to be replaced by modules with only limited sweeping and neutralisation capability.⁴⁹ Some scholars argue that it is overly reductive to assume the success of such a Chinese blockade, given the difficulty of laying a contiguous field around Taiwan’s almost 1,000 miles of coastline,⁵⁰ the possibility of rerouting trade shipping around any



blockaded chokepoints like the Straits of Malacca,⁵¹ and the detectability and disruptability of any such large-scale effort.⁵²

However, it has been demonstrated throughout history that even a limited minefield can prevent the US military from manoeuvring and implementing its battle plans – as few as 1,300 Iraqi mines had a significant impact on US operational planning in 1991,⁵³ and China could deploy as many mines using only half its submarine fleet and no surface vessels.⁵⁴ Moreover, considering Taiwan’s heavy dependence on trade – constituting more than half its GNP⁵⁵ – and the psychological effects of mine warfare previously described- it appears that a mine-based blockade could be a highly effective strategy for China and one which it could seriously contemplate employing.

TAIWAN

Taiwan faces an ongoing and serious threat of invasion and forced ‘reunification’ by the PRC. The most affordable and effective option for Taiwan in deterring this outcome is the sea mine.⁵⁶ In late May 2019, in apparent recognition of this fact, Taiwan announced the construction of four dedicated minelayers and three stealthy missile corvettes that appear to be fitted with stern-mounted racks for naval mine deployment. This announcement has been taken as a shift in priority towards mine warfare, in an acknowledgement of the critical role defensive mining would play in challenging China’s cross-strait capability.⁵⁷

When laid in the Taiwan Strait, a minefield can incur high costs on an invading PLAN, both by directly inflicting damage and by forcing Chinese MCM vessels to expose themselves to other types of attack by manoeuvring slowly and predictably to clear the field.⁵⁸ The coercive power of a well-laid field could narrow Chinese channels of attack, allowing Taiwan to better focus its limited defensive resources.⁵⁹ It can also provide an early-warning system; the deployment of Chinese MCM operations can alert Taiwan both to an imminent attack and its location. Most importantly, the minefield and the time



needed to clear it will slow down or stall a Chinese seaborne invasion, extending Taiwan's reaction window, increasing its force survivability, and providing an opportunity for third-party intervention.⁶⁰ Such a defensive minefield would aim to suggest to China that any cross-strait victory would be a pyrrhic one, and therefore indefinitely deter an attack.

This sentiment is echoed clearly in Taiwan's new Overall Defence Concept, developed in 2017 by Admiral Lee Hsi-Ming. The strategy envisions sea mines laid in the Taiwanese littoral zone, up to 100km from the island, relying in part on the extreme difficulty of sweeping mines in shallow waters.⁶¹ Fast, automated minelaying vessels would lay mines in the waters off beaches at expected Chinese landing sites, aiming to slow invading forces and make them more vulnerable to Taiwan's defensive strengths: swarms of small fast attack boats and truck-launched anti-ship cruise missiles, targeting key ships.⁶² Together, Taiwan's recent mine-focussed acquisitions and strategic concept suggest a high likelihood of Taiwan using mine warfare in anticipation of, or reaction to a cross-strait invasion.

[NORTH KOREA](#)

The Democratic People's Republic of Korea (DPRK – North Korea) made heavy use of mine warfare during the Korean War, with considerable success, and retains a credible mine warfare capability that it would likely use defensively against any oncoming amphibious invasive force.⁶³ Amphibious assaults devastated North Korean offensive operations during the Korean War,⁶⁴ while 70% of the casualties the Korean People's Navy (KPN) successfully inflicted on US Navy vessels were caused by its defensive mines.⁶⁵ It can, therefore, be assumed that in compiling lessons learned from that defining war, North Korea has prepared extensively to combat a potential future amphibious invasion with its mine warfare capability. Indeed, the US Marine Corps' North Korea Country Handbook instructs its officers to expect 'extensive use of naval mining' by the KPN in any Korean peninsula contingency. The naval balance between North Korea and the Republic of Korea (ROK – South Korea) also favours the KPN in terms of the sorts of small surface vehicles that would be used as minelayers, suggesting that an agile



force of North Korean boats would lay mines close to shore and outside the range of the large US surface vessels likely stationed nearby in any such scenario.⁶⁶

While not necessarily ultimately decisive in a conventional Korean Peninsula conflict, North Korea's mining capability would certainly complicate a US or ROK invasion, particularly as MCM vessels would be vulnerable to coastal artillery and anti-ship missile batteries.⁶⁷ Mining would also hinder or imperil US and ROK forces as they attempted to combat North Korea's submarine force during an invasion.⁶⁸ The DPRK's large inventory of crude ex-Soviet mines and conviction in their historical effectiveness means that any US or ROK force would need to expect and prepare for a challenging mine warfare defence.⁶⁹

NON-STATE ACTORS

The asymmetric characteristics inherent to sea mines make them attractive to non-state and terrorist actors, and particularly devastating in their hands. As a weapon, the mine is particularly well-suited to the clandestine, low-infrastructure needs of a terrorist cell: it's anonymous and difficult to conclusively attribute,⁷⁰ easy to manufacture secretly and store covertly,⁷¹ and is ubiquitously available on the global market as more navies around the globe upgrade their stockpiles and sell off their crude but operable surplus stocks.⁷² Terrorists and non-state actors seek above all to create chaos, psychological pressure, and disruption, and for the reasons outlined in Section I of this report, sea mines are highly capable of achieving each of those outcomes. Terrorist use of sea mines is not yet common, though not unseen: non-state forces, suspected to be under unofficial Libyan command, emplaced mines in the Red Sea in mid-1984 and damaged 19 ships under 15 different flags.⁷³ This incident underscored the ease with which unsophisticated, low-cost mines could be easily dropped off inconspicuous boats by untrained personnel, single-handedly halting freedom of navigation and obstructing maritime trade.⁷⁴



It is reasonable to assume that non-state actors and transnational terrorists will soon realise the flexible, cost-effective potency of mine warfare to paralyse harbours and undermine the global commercial system.⁷⁵ Some commentators consider maritime terrorism to be the ‘greatest threat to daily maritime security’⁷⁶ in the coming years – others consider terrorist sea mining to be the ‘Achilles’ heel of US homeland defence’.⁷⁷ The capability to halt shipping and movement for weeks in major economic hubs, population centres and geographic bottlenecks while MCM is conducted is a particularly dangerous one, for which the world must actively prepare.

SOUTHEAST ASIA

Mine warfare is a likely tool for use by powers across Southeast Asia, particularly in reaction to growing Chinese assertiveness.⁷⁸ A number of states are likely to seek an asymmetric capability that would protect them against sudden land grabs or other actions of Chinese belligerence and might look to mine warfare to delay an approaching Chinese force until support from allies arrives. Sea mines allow a militarily weaker state to end gradual Chinese territorial incursions or ‘salami-slicing’⁷⁹ tactics by shifting the onus of escalation to its adversary and forcing a choice between a cessation or full conflict. Such states could also use mine warfare more as non-state actors, relying on the anonymity and plausible deniability of ubiquitous models of mines to damage Chinese commercial ventures in disputed territories and deter further incursion into the South China Sea or elsewhere.⁸⁰ Mine warfare can also be used in this context in its de-escalator capacity, emplaced protectively in a state’s territorial waters as a relatively low-risk but flexible tool to establish boundaries and demonstrate resolve at the lower rungs of threat development.⁸¹

The extent of mine stockpiles possessed by Southeast Asian states is difficult to pinpoint. However, as previously established, a minimum mine warfare capability is easily acquired, and mines can be deployed off any number of small coastguard or civilian fishing vessels. As a result, mine warfare ‘breakout time’ is short and any of these states could readily be expected to acquire such a capability if it felt necessary. Moreover, both Indonesia and Vietnam currently possess submarines capable of



minefield deployment.⁸² As a result, a future of mine warfare capability proliferation around Southeast Asia is one for which Australia must be prepared.

Section III: Conclusion & Recommendations

This report has sought to demonstrate that, for several reasons, the use of sea mines in both an offensive and defensive strategy are increasingly likely in the Indo-Pacific. It has attempted to illustrate the scenarios in which mine warfare might be employed and how it will shape Australia's region. The resurgence of naval mine warfare in the Indo-Pacific carries serious strategic implications, will affect Australia's top security interests, and will require some policy adjustments.

Firstly, Australian defence policymakers need to pay greater attention and resources towards mine warfare and conduct a thorough review of existing Australian MCM capability relative to increased interest in mine use in our region. The cycle set out in figure 1 will continue, leaving Australia and Australians exposed, unless there is a more serious commitment to understanding and preparing for mine warfare as a major feature of the regional security landscape. Senior commentators since at least the 1990s have been calling attention to maritime mining as 'a salient weak spot in the 'hull' of the Australian Ship of State',⁸³ and with tensions rising across the Indo-Pacific, Australia no longer has decades to waste.

Though commitments to replace the *Huon*-class mine countermeasure vessels are promising, as well as several programs examining unmanned surface vehicles, autonomous underwater vehicles and remotely operated (underwater) vehicles for MCM purposes, a sophisticated solution may still be insufficient to cope with a proliferation of sea mines across our region if only a small number are provided.⁸⁴ In assessing the requirements for Project SEA 1180 Phase 2 Future Mine Countermeasures and Rapid Environmental Assessment vessel, Navy should consider not just the specifics of crew



security and the potential of unmanned support systems but also the broader strategic picture. The new boats may be secure, world-class and successful in defusing even the most advanced of modern mine platforms, but if there are too few of them to cope with major mining campaigns across the Indo-Pacific, this newly-acquired capacity will be functionally useless.

Secondly, Australia needs to engage in dialogue with the US over its own MCM capability, perhaps suggesting a joint program for development and modernisation. Australian's foreign policy stance retains the US as a permanent ally in the region and a security guarantor, but at present, US MCM capability is widely considered to be insufficient to cope with the future regional landscape. The US has long had an awareness that its MCM capability is failing,⁸⁵ and devised the concept of the LCS – multi-purpose ships that could be 'modularly' fitted for MCM – to address its critical failings and upgrade its force.⁸⁶ With the failures of the LCS program,⁸⁷ US MCM capability is left limited and dated, and in the meanwhile, attention has drifted elsewhere. Australia needs to lead its allies in calling attention to the scale of the future impact of mine warfare and the need for a greater number of more sophisticated MCM vessels stationed in the region.⁸⁸ To survive the next decades together, Australia, as well as its allies, will need to learn from decades of lessons about sea mines, and seriously commit to dealing with them.

BIBLIOGRAPHY

Axe, David. 'America Is Getting Rid of Their Minesweepers'. *The National Interest*. April 3, 2019. <https://nationalinterest.org/blog/america-getting-rid-their-minesweepers-50552>.

China Power Team. 'How Much Trade Transits the South China Sea?' *China Power*. August 2, 2017. <https://chinapower.csis.org/much-trade-transits-south-china-sea/#easy-footnote-bottom-1-3073>.

Christensen, Thomas J. 'Posing Problems without Catching Up: China's Rise and Challenges for US Security Policy'. *International Security* 25, no. 4 (Spring 2001): 5-40.



Clark, Bryan. *The Emerging Era in Undersea Warfare*. Washington DC: Centre for Strategic and Budgetary Assessments, 2015.

Cordesman, Anthony H. *The Conventional Military Balance in the Koreas and Northeast Asia*. Washington DC: Centre for Strategic and International Studies, 2016. https://csis-prod.s3.amazonaws.com/s3fs-public/publication/160802_Korea_Conventional_Balance.pdf.

Donohue, Hector. *Mines, Mining and Mine Countermeasures*. Sydney: Australian Defence Industries, 1994.

Erickson, Andrew S. 'PLA Modernization in Traditional Warfare Capabilities'. Statement before the U.S.-China Economic and Security Review Commission, March 29, 2007. <https://www.uscc.gov/Hearings/hearing-chinas-military-modernization-and-its-impact-united-states-and-asia-pacific>.

Erickson, Andrew S., Lyle J. Goldstein, and William S. Murray. 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability'. Newport: Naval War College, 2009.

Eyer, Kevin. 'Charting a Course: Mine Warfare Is a Navy Conundrum.' *Proceedings Magazine*. November 2016. <https://www.usni.org/magazines/proceedings/2016/november/charting-course-mine-warfare-navy-conundrum>

Freedberg Jr., Sydney J. 'Minefields at Sea: from the Tsars to Putin.' *Breaking Defense*. March 23, 2015. <https://breakingdefense.com/2015/03/shutting-down-the-sea-russia-china-iran-and-the-hidden-danger-of-sea-mines/>.

Freedberg Jr., Sydney J. 'Sowing the Sea with Fire: The Threat of Sea Mines.' *Breaking Defense*. March 30, 2015. <https://breakingdefense.com/2015/03/sowing-the-sea-with-fire-how-russia-china-iran-lay-mines-and-how-to-stop-them/>.



Friedman, George. 'There Are 2 Choke Points That Threaten Oil Trade Between the Persian Gulf and East Asia.' *Business Insider*, April 18, 2017. <https://www.businessinsider.com/maps-oil-trade-choke-points-person-gulf-and-east-asia-2017-4?IR=T>

Friedman, Norman and Scott C. Truver. 'On the Cusp of an Undersea Revolution: Shaping New Ways to Deal with the Threat from Mines.' SLDinfo. *Second Line of Defense*. July 9 2016, <https://sldinfo.com/2016/09/on-the-cusp-of-an-undersea-revolution-shaping-new-ways-to-deal-with-the-threat-from-mines/>

Global Security. 'Korean People's Army Navy'. Updated November 13, 2016. <https://www.globalsecurity.org/military/world/dprk/navy.htm>

Goldrick, James. 'Anti-Access for Sea Control: the British Mining Campaign in World War I.' *Naval History Magazine* 32, no. 5 (October 2018).

Goldstein, Lyle J. 'China Could Announce a 'Total Exclusion Zone' at Any Time'. *The National Interest*. October 25, 2018. <https://nationalinterest.org/feature/china-could-announce-%E2%80%98total-exclusion-zone%E2%80%99-any-time-34297>

Goldstein, Lyle J. 'China's Secret Weapon in a War Against America'. *The National Interest*. August 17, 2018. <https://nationalinterest.org/blog/buzz/chinas-secret-weapon-war-against-america-28977>

Hinge, Alan. *Mine Warfare in Australia's First Line of Defence*. Canberra: ANU Strategic and Defence Studies Centre, 1992.

Hixenbaugh, Mike. 'Silent Threat: Are Sea Mines the Navy's Achilles' Heel?'. *The Virginian-Pilot*, April 5, 2014. https://pilotonline.com/news/military/article_b61595e0-33e5-59cb-a626-c125049f34d3.html.



Hooper, Craig. 'Mines Are Coming to the South China Sea.' *NextNavy* (blog). July 10, 2014. <http://nextnavy.com/mines-are-coming-to-the-south-china-sea/>.

Lundy, Derek. 'How to Respond to China's 'Salami Tactics' in South China Sea'. *The National Interest*. July 11, 2016. <https://nationalinterest.org/blog/the-buzz/how-respond-chinas-salami-tactics-south-china-sea-16914>.

Majumdar, Dave. 'Sea-Mines: The Most Lethal Naval Weapon On The Planet'. *The National Interest*. September 1, 2016. <https://nationalinterest.org/blog/the-buzz/sea-mines-the-most-lethal-naval-weapon-the-planet-17559>.

Melia, Tamara Moser. 'Lesson That Never Stays Learned'. *Mine Warfare Association*. http://www.minwara.org/history-locker/lesson_that_never_stays_learned/.

'Mine-hunters: Are They Still Needed?'. *Naval Technology*. February 17 2016, <https://www.naval-technology.com/features/featuremine-hunters-are-they-still-needed-4809232/>.

National Research Council Ocean Studies Board. *Oceanography and Mine Warfare*. Washington D.C.: National Academy Press, 2000.

O'Hanlon, Michael. 'Why China Cannot Conquer Taiwan'. *International Security* 25, no. 2 (Fall 2000): 51-86.

Pietrucha, Mike. 'The Antiship Mine Gets New Wings.' *The Diplomat* (blog). May 10, 2017. <https://thediplomat.com/2017/05/the-antiship-mine-gets-new-wings/>.

Pryce, Paul. 'North Korea and Asymmetric Naval Warfare'. *Center for International Maritime Security* (blog). February 15, 2016. <http://cimsec.org/north-korea-and-asymmetric-naval-warfare/21761>.



Rabirot, Jon. 'US Military Enters New Generation of Sea Mine Warfare.' *Stars and Stripes* (blog). May 9, 2011. <https://www.stripes.com/news/u-s-military-enters-new-generation-of-sea-mine-warfare-1.143170>.

Rogoway, Tyler. 'B-52 Tested 2,000lb Quickstrike-ER Winged Standoff Naval Mines During Valiant Shield.' *The War Zone* (blog). *The Drive*, September 20 2018. <http://www.thedrive.com/the-war-zone/23705/b-52-tested-2000lb-quickstrike-er-winged-standoff-naval-mines-during-valiant-shield>

Rogoway, Tyler. 'Naval Mines Are a Growing Threat Near the Mandeb Strait.' *The War Zone* (blog). *The Drive*, May 12, 2017. <https://www.thedrive.com/the-war-zone/10235/naval-mines-are-a-growing-threat-near-the-mandeb-strait>.

Savitz, Scott. 'Naval Mines and Unmanned Vehicles for Maritime Deterrence.' *RealClear Defense*. July 16, 2018. https://www.realcleardefense.com/articles/2018/07/16/naval_mines_and_unmanned_vehicles_for_maritime_deterrence_113609.html.

Slavin, Erik. 'Taiwan Gets Two Mine-Hunting Ships from US.' *Stars and Stripes* (blog). August 9, 2012 <https://www.stripes.com/news/taiwan-gets-two-mine-hunting-ships-from-us-1.185205>.

Slocombe, Geoff. 'Australia's Future Sea Mine Countermeasures.' *Asia-Pacific Defence Reporter* 44, no. 5 (June 2018): 45-47.

Sokolsky, Richard, Angel Rabasa, and C. Richard Neu. *The Role of Southeast Asia in U.S. Strategy Toward China*. Santa Monica, CA: RAND Corporation, 2000.

Spozio, Bernard Vincent. 'Naval Mine Countermeasures: The Achilles Heel of US Homeland Defence'. Newport: Naval War College, 2013.

Stefanus, Daniel. 'Terror in the Water: Maritime Terrorism, Mines and Our Imperiled Harbors.' *US Naval Institute* (blog). January 30, 2018. <https://blog.usni.org/posts/2018/01/30/terror-in-the-water-maritime-terrorism-mines-and-our-imperiled-harbors>



Thales. 'Meeting Navies' Needs for Next-Generation Mine Warfare'. October 26 2018. <https://www.thalesgroup.com/en/worldwide/defence/magazine/meeting-navies-needs-next-generation-mine-warfare>.

Thompson, Drew. 'Hope on the Horizon: Taiwan's Radical New Defence Concept.' *War on the Rocks* (blog). October 2, 2018. <https://warontherocks.com/2018/10/hope-on-the-horizon-taiwans-radical-new-defense-concept/>.

Tossavainen, Tyler. 'Mine Countermeasures Needed for Submarine Access.' *US Naval Institute* (blog). August 1, 2017. <https://blog.usni.org/posts/2017/08/01/mine-countermeasures-needed-for-submarine-access>

Trevithick, Joseph. 'Taiwan's Next Batch of Stealthy Catamarans Will Have Serious Mine-Laying Capabilities.' *The War Zone* (blog). *The Drive*, May 24, 2019. <https://www.thedrive.com/the-war-zone/28201/taiwans-next-batch-of-stealthy-catarmans-will-have-serious-mine-laying-capabilities>

Truver, Scott C. 'Naval Mines: Innovating in the Face of Benign Neglect.' *The Australian Naval Institute*. January 9, 2017. <https://navalinstitute.com.au/naval-mines-innovating-in-the-face-of-benign-neglect/>

Truver, Scott C. 'Taking Mines Seriously: Mine Warfare in China's Near Seas.' *Naval War College Review* 65, no. 2 (Spring 2012): 30-66.

US Marine Corps. *North Korea Country Handbook*. Quantico: US Department of Defense, 1997. <https://web.archive.org/web/20110718053044/http://www.dia.mil/public-affairs/foia/pdf/nkor.pdf>

'US Fleet Activities Sasebo.' *Naval Technology*. Accessed June 3, 2019. <https://www.naval-technology.com/projects/usfleetactivities/>



Williams, R.D. 'Mines in Littoral Warfare.' Lecture at Mine Warfare COMDEF '95 Conference, Canada, 1995.

Notes

¹ Scott C. Truver, 'Taking Mines Seriously: Mine Warfare in China's Near Seas,' *Naval War College Review* 65, no. 2 (Spring 2012): 3.

² Dave Majumdar, 'Sea-Mines: The Most Lethal Naval Weapon On The Planet', *The National Interest*, September 1, 2016, <https://nationalinterest.org/blog/the-buzz/sea-mines-the-most-lethal-naval-weapon-the-planet-17559>.

³ Tamara Moser Melia, 'Lesson That Never Stays Learned', *Mine Warfare Association*, http://www.minwara.org/history-locker/lesson_that_never_stays_learned/.

⁴ National Research Council Ocean Studies Board, *Oceanography and Mine Warfare* (Washington D.C.: National Academy Press, 2000), vii.

⁵ Tyler Tossavainen, *US Naval Institute*, 'Mine Countermeasures Needed for Submarine Access,' (blog), posted August 1, 2017, <https://blog.usni.org/posts/2017/08/01/mine-countermeasures-needed-for-submarine-access>.

⁶ Norman Friedman and Scott C. Truver, 'On the Cusp of an Undersea Revolution: Shaping New Ways to Deal with the Threat from Mines,' *SLDinfo.com*, July 9 2016, <https://sldinfo.com/2016/09/on-the-cusp-of-an-undersea-revolution-shaping-new-ways-to-deal-with-the-threat-from-mines/>.

⁷ National Research Council Ocean Studies Board, *Oceanography and Mine Warfare*, 9.

⁸ Friedman and Truver 2016, 'On the Cusp of an Undersea Revolution: Shaping New Ways to Deal with the Threat from Mines.'

⁹ Hector Donohue, *Mines, Mining and Mine Countermeasures*, (Sydney: Australian Defence Industries, 1994), 9.

¹⁰ Hector Donohue, *Mines, Mining and Mine Countermeasures*, 9.

¹¹ Hector Donohue, *Mines, Mining and Mine Countermeasures*, 4.

¹² Williams, 'Mines in Littoral Warfare.'

¹³ Truver, 'Taking Mines Seriously: Mine Warfare in China's Near Seas,' 31.

¹⁴ Donohue, *Mines, Mining and Mine Countermeasures*, vi.

¹⁵ Alan Hinge, *Mine Warfare in Australia's First Line of Defence*, (Canberra: ANU Strategic and Defence Studies Centre, 1992), 49.

¹⁶ Andrew S. Erickson, Lyle J. Goldstein, and William S. Murray, 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', (Newport: Naval War College, 2009), 41.

¹⁷ Donohue, *Mines, Mining and Mine Countermeasures*, 3.

¹⁸ *Ibid.*, 17.

¹⁹ Mike Pietrucha, *The Diplomat*, 'The Antiship Mine Gets New Wings,' (blog), posted May 10, 2017, <https://thediplomat.com/2017/05/the-antiship-mine-gets-new-wings/>.

²⁰ Donohue, *Mines, Mining and Mine Countermeasures*, 3.

²¹ Hector Donohue, *Mines, Mining and Mine Countermeasures*, 10.

²² Hinge, *Mine Warfare in Australia's First Line of Defence*, 4-7.

²³ Hinge, *Mine Warfare in Australia's First Line of Defence*, 1.

²⁴ National Research Council Ocean Studies Board, *Oceanography and Mine Warfare*, 159.

²⁵ Donohue, *Mines, Mining and Mine Countermeasures*, 5.

²⁶ Geoff Slocombe, 'Australia's Future Sea Mine Countermeasures,' *Asia-Pacific Defence Reporter* 44, no. 5 (June 2018): 45.



- ²⁷ Pietrucha, 'The Antiship Mine Gets New Wings.'
- ²⁸ China Power Team, 'How Much Trade Transits the South China Sea?' *China Power*, August 2, 2017, <https://chinapower.csis.org/much-trade-transits-south-china-sea/#easy-footnote-bottom-1-3073>.
- ²⁹ Pietrucha, 'The Antiship Mine Gets New Wings.'
- ³⁰ George Friedman, 'There Are 2 Choke Points That Threaten Oil Trade Between the Persian Gulf and East Asia,' *Business Insider*, April 18, 2017, <https://www.businessinsider.com/maps-oil-trade-choke-points-person-gulf-and-east-asia-2017-4?IR=T>
- ³¹ Tyler Rogoway, *The War Zone*, 'Naval Mines Are a Growing Threat Near the Mandeb Strait,' (blog), posted May 12, 2017. <https://www.thedrive.com/the-war-zone/10235/naval-mines-are-a-growing-threat-near-the-mandeb-strait>.
- ³² Donohue, *Mines, Mining and Mine Countermeasures*, 7.
- ³³ Pietrucha, 'The Antiship Mine Gets New Wings.'
- ³⁴ Erik Slavin, *Stars and Stripes*, 'Taiwan Gets Two Mine-Hunting Ships from US,' (blog), posted August 9, 2012 <https://www.stripes.com/news/taiwan-gets-two-mine-hunting-ships-from-us-1.185205>.
Jon Rabirow, *Stars and Stripes*, 'US Military Enters New Generation of Sea Mine Warfare,' (blog), posted May 9, 2011. <https://www.stripes.com/news/u-s-military-enters-new-generation-of-sea-mine-warfare-1.143170>.
- ³⁵ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 32.
- ³⁶ Sydney J. Freedberg Jr., 'Minefields at Sea: from the Tsars to Putin,' *Breaking Defense*, March 23, 2015, <https://breakingdefense.com/2015/03/shutting-down-the-sea-russia-china-iran-and-the-hidden-danger-of-sea-mines/>.
- ³⁷ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 2.
- ³⁸ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability'.
- ³⁹ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 1.
- ⁴⁰ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 41.
- ⁴¹ Lyle J. Goldstein, 'China Could Announce a 'Total Exclusion Zone' at Any Time,' *The National Interest*, October 25, 2018, <https://nationalinterest.org/feature/china-could-announce-%E2%80%99total-exclusion-zone%E2%80%99-any-time-34297>
- ⁴² Andrew S. Erickson, 'PLA Modernization in Traditional Warfare Capabilities', (statement before the U.S.-China Economic and Security Review Commission, March 29, 2007), <https://www.uscc.gov/Hearings/hearing-chinas-military-modernization-and-its-impact-united-states-and-asia-pacific>.
- ⁴³ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 5.
- ⁴⁴ Slavin, 'Taiwan Gets Two Mine-Hunting Ships from US.'
- ⁴⁵ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 52.
- ⁴⁶ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 49.
- ⁴⁷ Mike Hixenbaugh, 'Silent Threat: Are Sea Mines the Navy's Achilles' Heel?', *The Virginian-Pilot*, April 5, 2014, https://pilotonline.com/news/military/article_b61595e0-33e5-59cb-a626-c125049f34d3.html.
- ⁴⁸ 'US Fleet Activities Sasebo,' *Naval Technology*, accessed June 3, 2019, <https://www.naval-technology.com/projects/usfleetactivities/>.
- ⁴⁹ David Axe, 'America Is Getting Rid of Their Minesweepers', *The National Interest*, April 3, 2019, <https://nationalinterest.org/blog/america-getting-rid-their-minesweepers-50552>.
- ⁵⁰ Sydney J. Freedberg Jr., 'Sowing the Sea with Fire: The Threat of Sea Mines,' *Breaking Defense*, March 30, 2015, <https://breakingdefense.com/2015/03/sowing-the-sea-with-fire-how-russia-china-iran-lay-mines-and-how-to-stop-them/>.
- ⁵¹ Richard Sokolsky, Angel Rabasa, and C. Richard Neu, *The Role of Southeast Asia in U.S. Strategy Toward China*, (Santa Monica, CA: RAND Corporation, 2000), 17.
- ⁵² Sydney J. Freedberg Jr., 'Sowing the Sea with Fire: The Threat of Sea Mines.'
- ⁵³ Michael O'Hanlon, 'Why China Cannot Conquer Taiwan', *International Security* 25, no. 2 (Fall 2000): 67.
- ⁵⁴ Michael O'Hanlon, 'Why China Cannot Conquer Taiwan.', 78.
- ⁵⁵ Thomas J. Christensen, 'Posing Problems without Catching Up: China's Rise and Challenges for US Security Policy,' *International Security* 25, no. 4 (Spring 2001): 29.



- ⁵⁶ Scott Savitz, 'Naval Mines and Unmanned Vehicles for Maritime Deterrence,' *RealClear Defense*, July 16, 2018, https://www.realcleardefense.com/articles/2018/07/16/naval_mines_and_unmanned_vehicles_for_maritime_deterrence_113609.html.
- ⁵⁷ Joseph Trevithick, *The War Zone*, 'Taiwan's Next Batch of Stealthy Catamarans Will Have Serious Mine-Laying Capabilities,' (blog), posted May 24, 2019, <https://www.thedrive.com/the-war-zone/28201/taiwans-next-batch-of-stealthy-catamarans-will-have-serious-mine-laying-capabilities>.
- ⁵⁸ Savitz, 'Naval Mines and Unmanned Vehicles for Maritime Deterrence.'
- ⁵⁹ Trevithick, 'Taiwan's Next Batch of Stealthy Catamarans Will Have Serious Mine-Laying Capabilities.'
- ⁶⁰ Savitz, 'Naval Mines and Unmanned Vehicles for Maritime Deterrence.'
- ⁶¹ O'Hanlon, 'Why China Cannot Conquer Taiwan', 67.
- ⁶² Drew Thompson, *War on the Rocks*, 'Hope on the Horizon: Taiwan's Radical New Defence Concept,' (blog), posted October 2, 2018. <https://warontherocks.com/2018/10/hope-on-the-horizon-taiwans-radical-new-defense-concept/>.
- ⁶³ Global Security, 'Korean People's Army Navy', November 13, 2016, <https://www.globalsecurity.org/military/world/dprk/navy.htm>.
- ⁶⁴ US Marine Corps, *North Korea Country Handbook*, (Quantico: US Department of Defense, 1997), 101.
- ⁶⁵ Paul Pryce, *Centre for International Maritime Security*, 'North Korea and Asymmetric Naval Warfare,' (blog), posted February 15, 2016. <http://cimsec.org/north-korea-and-asymmetric-naval-warfare/21761>.
- ⁶⁶ Anthony H. Cordesman, *The Conventional Military Balance in the Koreas and Northeast Asia*, (Washington DC: Centre for Strategic and International Studies, 2016), https://csis-prod.s3.amazonaws.com/s3fs-public/publication/160802_Korea_Conventional_Balance.pdf, 31.
- ⁶⁷ Global Security, 'Korean People's Army Navy.'
- ⁶⁸ Anthony H. Cordesman, *The Conventional Military Balance in the Koreas and Northeast Asia*, 31.
- ⁶⁹ Global Security, 'Korean People's Army Navy.'
- ⁷⁰ Hinge, *Mine Warfare in Australia's First Line of Defence*, 5.
- ⁷¹ 'Mine-hunters: Are They Still Needed?', *Naval Technology*, February 17 2016, <https://www.naval-technology.com/features/featuremine-hunters-are-they-still-needed-4809232/>.
- ⁷² Bernard Vincent Spozio, 'Naval Mine Countermeasures: The Achilles Heel of US Homeland Defence,' (Newport: Naval War College, 2013), 8.
- ⁷³ Hinge, *Mine Warfare in Australia's First Line of Defence*, 55.
- ⁷⁴ Spozio, 'Naval Mine Countermeasures: The Achilles Heel of US Homeland Defence,' 5.
- ⁷⁵ Hixenbaugh, 'Silent Threat: Are Sea Mines the Navy's Achilles' Heel?'
- ⁷⁶ Daniel Stefanus, *US Naval Institute*, 'Terror in the Water: Maritime Terrorism, Mines and Our Imperiled Harbors,' (blog), posted January 30, 2018. <https://blog.usni.org/posts/2018/01/30/terror-in-the-water-maritime-terrorism-mines-and-our-imperiled-harbors>.
- ⁷⁷ Spozio, 'Naval Mine Countermeasures: The Achilles Heel of US Homeland Defence,' 7.
- ⁷⁸ Craig Hooper, *NextNavy*, 'Mines Are Coming to the South China Sea,' (blog), posted July 10, 2014, <http://nextnavy.com/mines-are-coming-to-the-south-china-sea/>.
- ⁷⁹ Derek Lundy, 'How to Respond to China's 'Salami Tactics' in South China Sea,' *The National Interest*, July 11, 2016, <https://nationalinterest.org/blog/the-buzz/how-respond-chinas-salami-tactics-south-china-sea-16914>.
- ⁸⁰ Hooper, 'Mines Are Coming to the South China Sea.'
- ⁸¹ Hinge, *Mine Warfare in Australia's First Line of Defence*, 229.
- ⁸² Hinge, *Mine Warfare in Australia's First Line of Defence*, 58.
- ⁸³ Hinge, *Mine Warfare in Australia's First Line of Defence*, 81.
- ⁸⁴ Slocombe, 'Australia's Future Sea Mine Countermeasures,' 45.
- ⁸⁵ Tossavainen, 'Mine Countermeasures Needed for Submarine Access.'
- ⁸⁶ Erickson et al., 'Chinese Mine Warfare: A PLA Navy 'Assassin's Mace' Capability', 48.
- ⁸⁷ Kevin Eyer, 'Charting a Course: Mine Warfare Is a Navy Conundrum,' *Proceedings Magazine*, November 2016, <https://www.usni.org/magazines/proceedings/2016/november/charting-course-mine-warfare-navy-conundrum>.
- ⁸⁸ Christensen, 'Posing Problems without Catching Up: China's Rise and Challenges for US Security Policy,' 35.