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Unmanned underwater systems: their advantages for closing and opening spaces within the First Island Chain

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Abstract

The maritime scenarios that predominate in conflict between powers, close to coasts and heavily defended, require the deployment of capabilities suitable for high-risk, long-duration missions. Therefore, unmanned systems are becoming an essential complement to traditional forces. In this article, we will analyze unmanned submarine systems, both current and under development, describing the benefits they bring to operations, the missions and tasks they perform, and the different types of systems available. Furthermore, the integration of these units into hybrid fleets is expected to entail profound changes in the operations of manned submarines. Given that the First Island Chain scenario is the one that mobilizes the main advances in submarine warfare, this study will focus on China as one of the most relevant developments of the actors involved in this strategic competition.

Keywords: Submarines; Unmanned Systems; China; First Island Chain.

1. Introduction

With the advanced development of China's missile capabilities, the waters surrounding its periphery would no longer be safe for allied surface vessels in an escalation situation. The much-discussed anti-access and area restriction (A2/AD) strategy, which China calls counter intervention, is beginning to consolidate a true stronghold within the First Island Chain (Lacey, 2020). The First Island Chain is a strategic geopolitical term referring to a series of islands in the western Pacific Ocean (Figure 1). The chain includes Japan, the Ryukyu Islands, Taiwan,

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and parts of the Philippines reaching Borneo. The South China Sea, the Taiwan Strait, and the East China Sea are included within this first chain. It is a semi-enclosed space, entered through the straits of Luzon, Taiwan, San Bernardino, Surigao, Sunda, Lombok-Macassar, Malacca, and Singapore (Vorndick, 2018).

Faced with this fait accompli, if current tensions were to lead to open hostilities, the United States would face the challenge of operating in a highly congested and dangerous maritime environment. The perception that the United States could leverage its remaining superiority in submarine technology to enter the First Island Chain undetected was well established. The Chinese Navy's Achilles heel has always been submarine warfare (Goldstein, 2022). Masked by biological and seafloor noise, low-noise attack submarines could penetrate the bastion undetected to attack key targets (C2 centers, missile launchers, air defenses) early in the conflict, facilitating later access for surface assets, bombers, and fighters (Larter, 2019).

Figure 1. First and second Island chains

First and Second Island Chains plans are far from guaranteed success and is under constant review. China has been seeking to reverse its weakness in submarine operations for a decade, compensating for its inferior technology with its ability to innovate and produce on a large scale. It currently has some 66 submarines with diverse technologies (mostly diesel-powered), dozens of anti-submarine surface units, and a huge number of fixed and mobile sensors deployed that would prevent some submarines from relying on their stealth to enjoy freedom of action (https://www.economist.com/china/2017/01/19/chinas-first-aircraft-carrier-bares-itsteeth).

Although little is known about its developments and employment doctrine, Beijing makes extensive use of its unmanned units as part of its A2/AD strategy, many of which are dual-use. Faced with China's new capabilities, especially missile-based capabilities, according to the concept of "distributed lethality" as the cornerstone of its strategy. This essentially proposes a transition toward a lower proportion of large vessels and a greater number of smaller vessels and large unmanned systems, coordinated in multi-domain operations (O'Rourke, 2023).

The great emphasis that top-tier players are placing on the development of their unmanned systems to complement their traditional units, forming hybrid fleets, compels us to focus on this issue. Sensors, submarines, and unmanned systems are the vertices of the triangle that today guides both powers' pursuit of submarine superiority. In this paper, we seek to provide a first approximation of a topic that will be key to considering naval strategy far beyond the China Seas scenario. The features and advantages represent that how unmanned vehicles are offered for submarine warfare, describe the missions that each system can perform in an integrated operation, and explain the different taxonomies that have been proposed to organize the multiplicity of available platforms. Finally, the capabilities of China for possible employment in the hottest part of the Indo-Pacific will be explored: the space contained within the First Island Chain (Harker *et al*., 2021).

2. Results and Discussion

2.1. The Advantages of Unmanned Systems

Unmanned systems are becoming a powerful force multiplier, and their capabilities are becoming a game changer in conflict scenarios (Brixey-Williams, 2020). Unlike the technological revolutions of the past, the most dynamic innovations associated with unmanned systems are coming from the commercial sector (Supervielle Bergés, 2020). Many systems are dual-use, and thanks to their modularity, it is possible to develop military assets from commercial systems (usually referred to as off-the-shelf), as is being demonstrated in Ukraine. The technological vectors enabling this revolution in automation are multiple, and we will not address them in this article. The Observatory will publish a specific article in future issues on the technological aspects behind this paradigm shift. Unmanned systems are designed to operate autonomously or in coordination with sensor platforms and manned units to achieve superiority in the underwater domain. Their presence will be especially relevant in places where manned platforms cannot enter due to high risk or where persistent, low-complexity operations are involved. They are said to be optimal for missions classified as the "three Ds": dull, dirty, or dangerous (O'Rourke, 2022).

The incorporation of unmanned systems offers a significant number of additional advantages for submarine warfare (Alleslev, 2019), such as:

- They provide additional combat and surveillance capabilities to traditional units, increasing lethality, survivability, operational tempo, deterrence, and operational readiness.
- They are completely payload-focused, as they do not require the provision of space and systems for the crew.
- They are highly modular and scalable.

- They are persistent, as they can remain operational for a long time, once the energy and communications challenges are fully resolved (Supervielle Bergés, 2020).
- They have a more agile production cycle, contributing to medium-term cost reduction.
- They have an important advantage in cost savings of the crew (Lafte *et al*., 2018).
- They are capable of operating in high-risk environments without endangering human lives.
- They can take detection risks, such as using active sonars, which are estimated to be prevalent in the future (Grant, 2022).
- They can lead to the optimization of human resources and help solve recruitment problems.
- They allow expensive and limited manned systems to be preserved for specific types of operations, especially those requiring human supervision (man-in-the-loop).
- They offer greater speed and accuracy in data processing, allowing for faster decision-making. They are more difficult to detect due to their size.
- They offer the ability to operate in swarms, thus enhancing their capabilities, although each system individually will be more limited than traditional platforms. The swarm is made up of redundant units, which individually constitute low-interest targets.
- They can be deployed from different platforms: submarines, larger unmanned submarines, aerial drones, airplanes, almost any ship, docks, etc.
- They perform a wide range of missions, both civil and military. Dual-use is a relevant feature of unmanned systems, as the commercial sector has often taken the lead, linked to mining, hydrocarbon exploitation, cable laying, underwater archaeology, oceanography, and other fields of science. They are also used for search and rescue operations and port and coastal surveillance and protection, among other tasks.

The diagram developed by Indian researcher Nitin Agarwala, which offers a complete overview of their dual use (Figure 2):

Main Missions of Military Unmanned Underwater Vehicles (UUVs) for an overview of the missions that unmanned systems are capable of deploying in the military field, we refer to the US Navy's 2016 Report to Congress on Autonomous Undersea Vehicle Requirement for 2025, which identifies the following missions and tasks for each type of vehicle, looking ahead to 2025. It includes extensions from other, more up-to-date sources cited throughout this work. As the cited document points out, there is evidence of the emergence of new missions aimed at responding to the changing strategic and technological environment, such as war in the maritime technology and research funds, anti-UUV warfare, electronic warfare, and deception operations in underwater space (Supervielle Bergés, 2020).

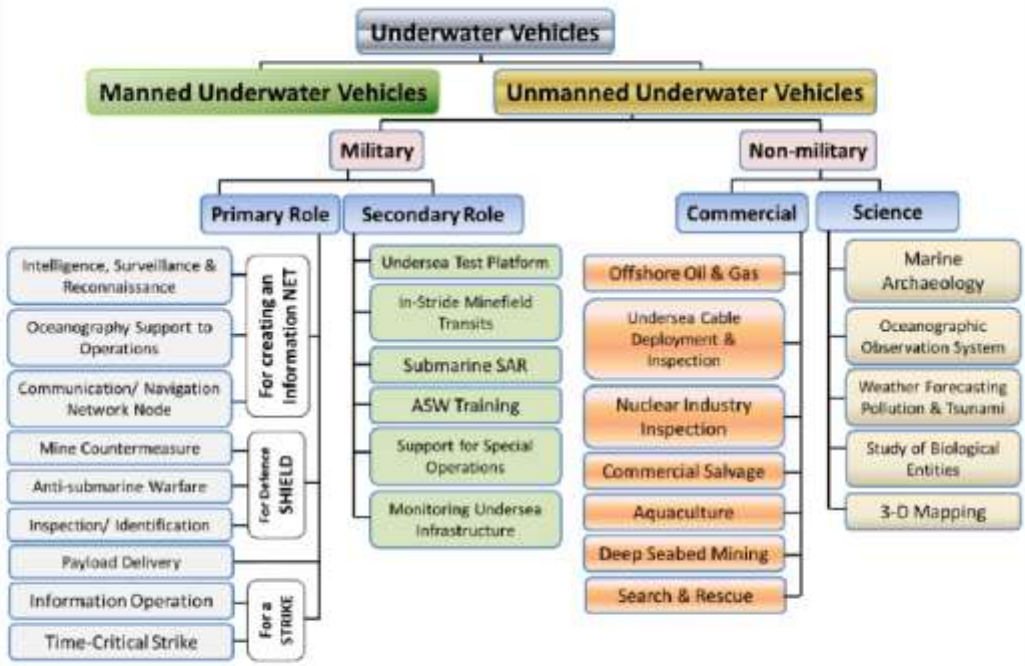

Figure 2. Integrating UUVs for naval applications (Agarwala, 2021)

It is worth remembering that the maximum depth reached by submarines is around 300 meters for conventional submarines and 600 meters for nuclear submarines, and here we are talking about systems such as cables, sensor networks, and logistics nodes, which would be found at typical depths of 3,000 meters or more. Furthermore, the challenges associated with underwater communication and mission (Table 1), which is mostly sound due to the poor propagation of light and radio waves, cannot be overemphasized.

Solving the problems of underwater communication and the interface for communication with the surface constitutes a key challenge for the advancement of unmanned vehicles and for hybrid or swarm operations. There does not appear to be a "silver bullet" in this regard, but rather an engineering of different technologies that interconnect and complement each other, using underwater, aerial, and unmanned drones, buoys, satellites, and acoustic, optical, and even magnetic methods. Solutions are constantly evolving, although the coordination of these systems is very complex, still generates some latency, and their reliability is not completely reliable for carrying out lethal operations for the moment. While these tools are being fine-tuned, work is underway to grant shorter and more automatic missions to the systems already developed (Clark and Walton, 2023).

Table 1. Different submarine's missions and tasks

Mission/task	Description	Support
Intelligence, Surveillance, and Reconnaissance (ISR) Intelligence Preparation of the Operating Environment (IPOE) Anti-Surface Warfare (ASUW) Anti-Submarine Warfare (ASW) Attack Mine Countermeasures (MIW)	Using optical, electromagnetic, and acoustic sensors. Includes bottom mapping and bathymetry and water column analysis. Detection, classification, and warning tasks, without engaging in engagements. Role in detection and support through UUVs, gliders, and sensors. Attacks on land or manned units are not currently considered. It can be carried out by different types of UUVs. UUVs are considered key to mine clearance tasks.	Medium and large vehicles. Gliders and fixed sensors. Small, medium, and large UUVs are involved. Small Unmanned Underwater Vehicles (SUUVs) operate at a depth of 3,000 meters, with side-scanning sonars and electro-optical and infrared sensors for environmental mapping and sensor detection. Larger UUVs are used to destroy sensors, drones, or sensitive infrastructure. Medium and large UUVs. Gliders. UUVs are equipped with chemical, optical, and geomagnetic sensors. Additionally, UUVs with towed sonar arrays are deployed; SUUVs can deploy active sonars within a multi-static active coherent (MAC) system; swarms with sensors; Extra-Large Unmanned Undersea Vehicles (XLUUVs) deploy various devices. The goal is to ensure human oversight of lethal operations to verify compliance with the rules of engagement. In the US, only manned submarines would fulfill attack functions, both on land and anti-ship, due to the latency of underwater communications and the still limited reliability of underwater systems.

Mission/task	Description	Support
Mine Countermeasures (MCM) Special Operations Force (SOF) Seabed Warfare Electronic Warfare (EW) Deception Command, Control, and Communications (C3)	They cannot accommodate personnel, but they can conduct preliminary surveys and transport equipment. Detection and classification, warning, and tracking. Protection of critical infrastructure, monitoring of submarine cables. They can monitor enemy signals and inject their own signals. They can do this using physical, electromagnetic, and acoustic means. They can transfer data, issue alarm warnings, and support special operations forces. They will enable non-lethal sea control.	XLUUVs and LUUVs (Orca, Snakehead, and HSU001 types) specialize in covertly deploying smart minefields. Medium Unmanned Underwater Vehicles (MUUVs) can lay clandestine mines from submarines, which are operated via a network. Modern mines can be remotely activated or deactivated at will, and their target can even be changed, so they can be laid in peacetime. MUUVs perform anti-mine clearance tasks from submarines or ships. Small, medium, and large UUVs can engage critical infrastructure and carry out the operation. In addition, they protect fixed installations linked to UUV operations. Small, medium, and large UUVs are involved. Specifically, medium and large UUVs are used for the deployment of decoys and jamming systems that introduce various acoustic elements into the scene to deceive detection systems and facilitate the operation of manned units. For communications, progress is being made in combining multiple systems that interconnect submarine and surface communications, with gateway-type vehicles of different sizes (buoys or drones that triangulate acoustic and radio frequency communications). The UUV would communicate with the buoy, and the buoy would communicate with the outside world via satellite or radio frequency. Communications can also be integrated with buoys towed by submarines (near the surface), and progress is being made in laser communication.

2.2. An approach to different taxonomies

Although, it will be focused on underwater drones here, they are typically part of a system of systems, comprised of satellite assets and underwater, surface, and aerial systems, both manned and unmanned, to accomplish their missions. Most unmanned systems operating on the underwater battlefield are known as Underwater Unmanned Vehicles (UUVs), but Surface Unmanned Vehicles (SUVs) and Unmanned Aerial Vehicles (UAVs) are also involved. The latter two have considerable advantages for communication, which is the main challenge facing UUVs, which is why their widespread use in submarine warfare operations is expected.

Different criteria can be found in specialized sources to classify unmanned systems operating underwater. A first criterion differentiates unmanned platforms, characterized by the physical removal or remote location of humans from the platform, from their autonomous nature, which is their ability to interactively adapt to the dynamic maritime environment. For example, Remotely Operated Vehicles (ROVs) are unmanned but not autonomous, as they are controlled by their controller unit, usually located on a vessel, to which they are connected by a cable that provides electrical power, data, and control signals. Autonomous vehicles, on the other hand, can respond to their environment and make decisions on the fly without a human operator. While ROVs are relevant for some tasks, especially those requiring detail and precision, and are more accessible, autonomous UUVs are those that offer the greatest number of features related to surveillance and underwater warfare. Among the autonomous vehicles are gliders or marine gliders, which can be considered Autonomous Underwater Vehicles (AUVs) depending on the control system they carry. Some are driven by ocean currents and waves and periodically surface to transmit information. Their main advantage is their high durability.

Another of the most relevant and widely used criteria for classifying UUVs relates to the unit's size, as the missions they can perform, their autonomy, and the means by which they can be deployed depend on this.

There are four key systems that will determine UUV capabilities:

• Operational range (Vandenberg, 2010): refers to how far and fast it can travel and how many sensors it can carry,

• Sensors/payload: what it can perceive and how it can interact,

• Autonomy: what decisions the UUV can make, based on what it can know and how it can communicate,

• C3: Command, control, and communications.

As a vehicle's functionality and the intensity of the threat environment increase, the number of decisions and actions that need to be accommodated in a vehicle increases, which decreases the amount of time it can operate without external support. Based on operational requirements, the following will be selected on each occasion (Table 2):

Table 2. Unmanned systems and their characteristics

Type	Diameter/ Range	Deployment	Missions	Examples
SUUV (Small UUV)	Less than 25 cm 10 inches Up to 20 hours	From the surface, aircraft, or submarines. Portable.	Preparation Environment Mine-Based Anti-Mine Float Warfare Electronic Warfare/C3 Deception	(China and US only) Swordfish (Mk18-1 - US) Haiyi (Sea Wing China)
MUUV (Medium UUV)	25-53 cm 10 to 21 inches Between 10 and 40 hours	From surface or submarines: Standard diameter of heavy torpedoes.	Environmental Preparation Surveillance and Reconnaissance Anti-Submarine Warfare Mine-Warfare Army Support Float Warfare Electronic Warfare/Deception C3	Kingfish (Mk18-2 - United States) Razorback (United States) Qianlong 3 (China)
	53-213 cm	From surface	Preparation	Snakehead
LUUV (Large UUV) Snakehead (United States) HSU-001 (China)	21 and 84 inches. Between 20 and 80 hours.	From submarines: they can be attached to submarines using Dry Deck Shelters (for Special Forces) or vertical missile launch tubes.	Environment: Surveillance and Reconnaissance Anti-Submarine Warfare Mine-Warfare Anti-Mine-Warfare Army Support Float Warfare Electronic Warfare/Deception C3	HSU-001 (China)
XLUUV (X-large UUV)	Over 213 cm. 84 inches. From 100 to over 400 hours.	Only from docks on land.	Surveillance and Reconnaissance Mine-Firing Anti-Submarine Warfare Transportation	Orca (United States) Possible prototype (China)

A third criterion concerns launch platforms. UUVs can be deployed from shore-based docks, surface vessels, manned and unmanned aircraft, and submarines (SLUVs). Depending on the size, submarines can deploy UUVs from the torpedo tube, through dry deck shelters used for Special Forces, through vertical missile launch tubes, and, in the case of smaller submarines, through waste disposal or countermeasures launch systems. The suitability of each platform is associated with the volume required to carry them within the unit, the impact of weather conditions, the impossibility of deploying systems undetected in A2/AD zones, and the challenges of recovering them, in the case of non-expendable systems (Supervielle Bergés, 2020).

Having described the advantages, missions, and types of drones, in the next section we will return to the First Island Chain scenario near China, as the two most advanced powers of our time are preparing to deploy their military capabilities there (it is worth noting that Russia, the United Kingdom, France, India, and Japan, among others, also have significant submarine capabilities, which will not be addressed here). The configuration of these actors' pursuit of submarine superiority through the integration of different systems is in full swing, and it is estimated that their effective integration will become a reality within five years.

2.3. The role of unmanned systems in submarine operations within the First Island Chain

The area contained within the First Island Chain covers approximately 3.5 million km² and is enclosed by a series of straits. It presents particular challenges for submarine operations due to the shallow depths over much of its expanse and the intensity of maritime traffic throughout the area. Multiple sensor networks, unmanned systems, and submarines can be found in this complex and enclosed space.

It is a high-priority space for China, which considers the area within the "Nine Scripts" to be jurisdictional. For about 10 years, China has been deploying a multitude of hydrophones, magnetic anomaly detectors, and all types of fixed and mobile sensors at depths of up to 2,000 meters, which it has dubbed the "Great Underwater Wall." It thus seeks to update its knowledge of its marine operational environment to conduct submarine and anti-submarine warfare operations, both within and outside the First Island Chain. China was lagging behind in anti-submarine warfare, but a few years ago it incorporated corvettes with very low frequency active sonars (LFA) with variable depth, specialized helicopters and aircraft, with all types of sensors, completing the system with unmanned units, different types of mines and fixed sensors (Goldstein, 2022, Ruan *et al.*, 2020).

To interpret the information from these sensors, China is advancing deep learning and working on systematizing signatures for underwater target detection and recognition. In particular, researchers at Harbin Engineering University have pioneered an artificial intelligence-based “seafloor image mosaic system” for sonar image processing (Fedasiuk, 2021). A new digital bathymetric model of the South China Sea based on the sub-regional fusion of even global seafloor topography products (Figure 3).

In August 2023, the theoretical development of a technology was announced that allows the detection of submarine traces by the bubbles generated by a high-speed nuclear-powered submersible, with ultra-sensitive magnetic detectors that detect extremely low frequency (ELF) signals (Chen, 2023). So far, this theoretical development has been made public, so it is not expected to be disruptive, but it sends a message about their efforts in detection.

They are also working on the development of highly capable UUVs to perform research and reconnaissance tasks, mine warfare and countermeasures, submarine cable inspection, and anti-submarine warfare. According to the analysis by Ryan Fedasiuk published on the specialized website CIMSEC, although it is a priority line, advanced UUV systems have not yet been achieved. For the development of unmanned systems, China is concentrating its efforts on three major centers Harbin Engineering University (HEU); China Shipbuilding Industry Corporation (CSIC); and Shenyang Institute of Automation (SIA). The cross-cutting nature of scientific and military initiatives is notable, conceptually framed within the so-called civil-military fusion that characterizes China's strategy, but which also reflects the synergy of dual-use capabilities evident worldwide.

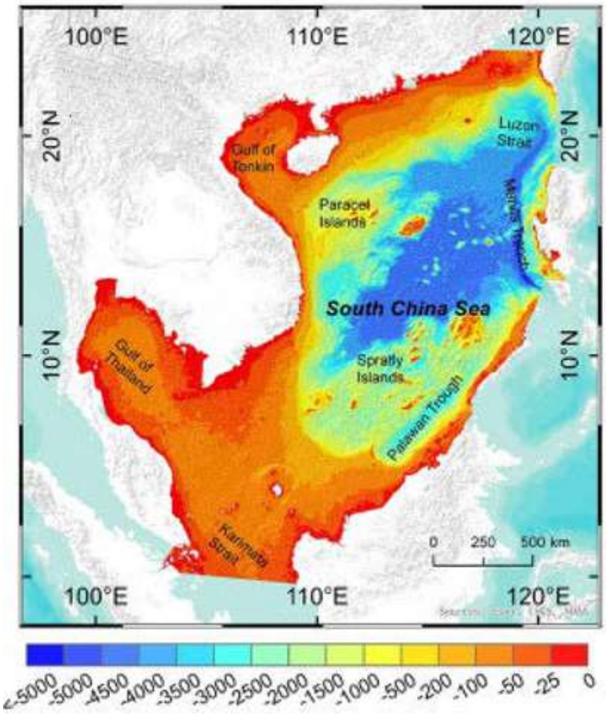

Figure 3. A new digital bathymetric model of the South China Sea, Ruan *et al.* (2020)

Among its unmanned units, China has a significant fleet of gliders, which map the seafloor, survey oceanographic conditions, and can detect underwater units. These include the Haiyi (Sea Wing), the Haiyan (Sea Swallow), and the Hai Xiang (Sea Flyer). The Haiyan is capable of sailing for 141 days over 3,600 kilometers, at depths of up to 1,500 meters, and the Haidou-1 can reach depths of over 10,000 meters (Figure 4).

Among the medium-sized vehicles are the Qianlong, in its different versions (1, 2, and 3), which carries various sensors, and the Haishen or Poseidon 6000, equipped to operate in deep waters up to 6,000 meters. The first large-scale UVV unveiled by China in 2019 is the HSU-001, which would be suitable for minelaying missions, attack (it could carry torpedoes), and for providing intelligence on surface, air, coastal, and underwater targets. China has a variety of 26 different types of floating and underwater mines, developed by CSIC, and has the capability to lay them in the straits and even outside the First Island Chain. Its masts indicate that it would house an advanced electro-optical detection system, as well as several underwater cameras and communications systems for the Haiyan (Sea Swallow) and the Hai Xiang (Sea Flyer) to operate in swarms. Its configuration suggests it is suitable for performing persistent intelligence tasks, perched on the seafloor, transporting a limited number of special forces, and conducting surveillance in the South China Sea (Goldstein, 2022). Satellite images consistent with two XL UUVs have also been recorded in open sources, although it is not yet clear whether they are manned or unmanned units (Sutton, 2022). Large UUV: HSU-001, Medium UUV: Sea-Whale 2000 Qianlong 3 Medium UUV: Haishen 6000 Gliders: Haiyi Haiyan Hai Xiang.

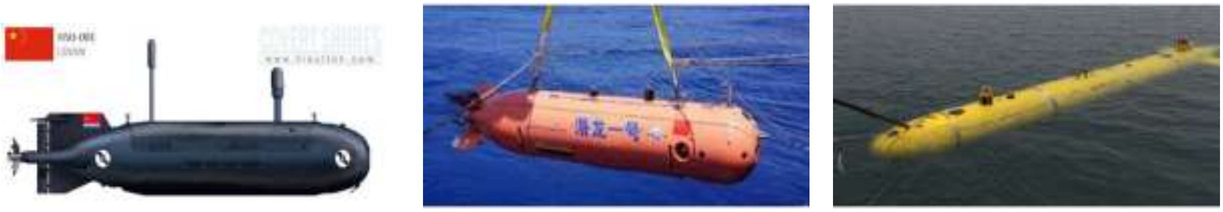

Figure 4. Autonomous surface, underwater, and aerial unmanned vehicles

In 2023, China incorporated a mother ship for unmanned vehicles, the Zhu Hai Yun, which can carry more than 50 autonomous surface, underwater, and aerial units, for both scientific research and military missions. It has an artificial intelligence system that allows it to be remotely controlled, and it can navigate autonomously in the open sea (Panneerselvam, 2023).

Beyond this, it remains a question mark whether China will be able to develop the undersea communications and artificial intelligence technologies necessary to realize its vision of a networked system of underwater sensors, platforms, and weapons. Another question is whether China will arm its UUVs, a task the United States assigns exclusively to manned units (Erickson, 2016.).

The family of unmanned submarines complements a large force of manned submarines, of various technologies (60 units: 6 SSBNs, 6 SSNs, and 48 SS). Most of them would operate within the First Island Chain, primarily to provide security for the six Jin-class (Type 094) nuclear-powered ballistic missile submarines (SSBNs), which form the third pillar of the nuclear deterrence triad. Equipped with the JL-3 ballistic missile (SLBM), with a range of 10,200 km, the Jin can strike the US mainland from Chinese waters (O'Rourke, 2023). Therefore, ensuring the survival of this force within the First Island Chain is vital for China.

During the Cold War, locating an enemy submarine in the open sea led to its tracking, ensuring that it would not become a threat. In today's logic, where A2/AD coastal environments predominate, the consequences of detection in an escalation environment would be extremely high risk. Submarines could shift, according to Kallenborn, from a "find-seek-find" logic to a "find-pursue-kill" logic (Kallenborn, 2019). This is why some studies are adopting new ways to "operate within the bastion" within the framework of a conflict. These are based on at least two axes in Figure 5 which are creating a family of submarine systems that work together to carry out offensive operations, and using unmanned systems as soon as possible to free manned submarines (Clark and Walton, 2023).

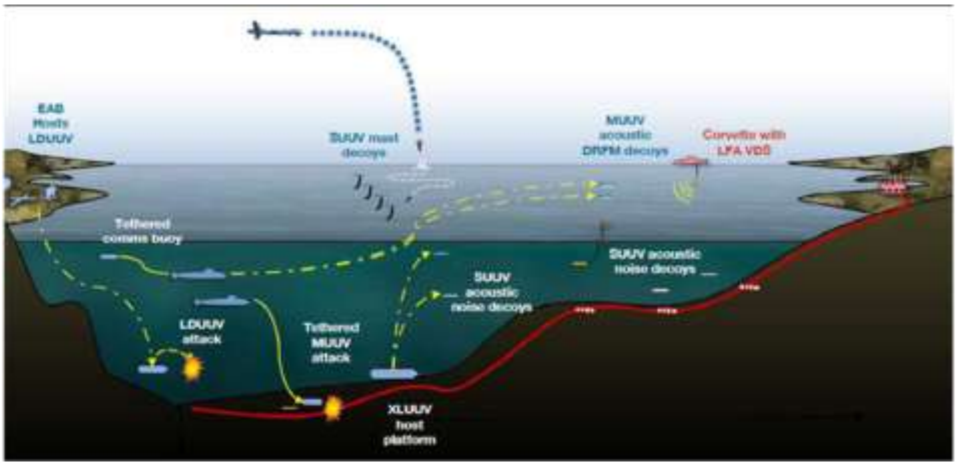

Figure 5. The elimination of submarine defenses using UUVs (Cark and Walton, 2023)

As a result, submarines will have to operate closer to the fleet and one starting point is that the submarine will not be able to provide itself with the quantity and variety of unmanned vehicles it will need to operate safely. UUVs compete for space with the weapons load inside the submarine, and their deployment can alert anti-submarine systems within the bastion. For this reason, drones—which will be aerial, surface, and underwater—will be deployed from land, from different types of vessels, such as amphibious assault units, from the coast of allied countries, from the air, from other drones with greater autonomy and size, as well as from submarines themselves. Furthermore, they will have to operate closer to the fleet and acquire an operational image in near real time, without revealing their location—a host of advantages that submarines have not previously enjoyed (Eckstein, 2022).

Other systems in development relate to those applied to mine and anti-mine clearance. For mine clearance, submarine-launched mobile mines will be replaced by the expendable Medusa UUV. For anti-mine clearance, the Lionfish program will replace the Mk 18 Mod 1 Swordfish UUV, and the Barracuda system will now be fully autonomous. Likewise, the LUUV Snakehead program was put on hold until details are available regarding the next attack submarine, still under development (SSNX), with which it will be assembled. During this transition, it was decided to cover its performance with commercial vehicles (Katz, 2023).

In another study, it was offered a comprehensive infographic on the UUV systems spectrum, which should be updated according to the plans mentioned in Figure 6 (Small, 2019). The unmanned submarine systems regarding manned submarines, about two dozen attack submarines are assigned to the Pacific Fleet. However, it is at the beginning of an ambitious technological replacement plan, which will leave the attack submarine force with a minimum of 46 units by 2030, exceeding 60 again by 2053 (O'Rourke, 2023). The AUKUS agreement, which includes the sale of three Virginia-class submarines to Australia in a first phase (with the option to increase to five), may also cause further temporary complications (Salisbury, 2023). It is hoped that the upcoming development of large Orca-class unmanned systems, which is facing difficulties but is progressing on its first unit, may make up for the temporary shortage of submarines.

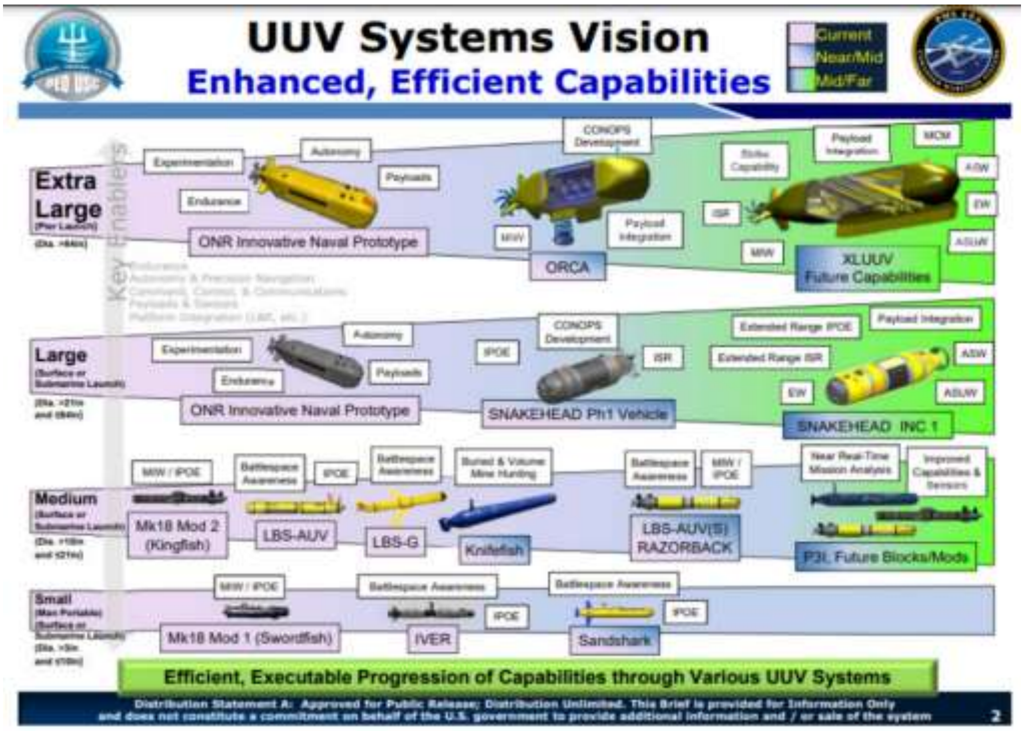

Figure 6. Updated plan for UUV systems spectrum

Final comments about the incorporation of unmanned systems for submarine warfare is already a reality, but the extent of their benefits is still debated. To what extent can they complement the operations of manned submarines? How vulnerable and effective are they?

Some critics raise doubts about their ability to revolutionize the battlefield. CL Gower of the UK Navy, for example, considers underwater drones to be "the least likely innovation to make a difference to the decline of submarine stealth." 45 Many drones would be needed, data transmission speeds are excessively slow, and a drone's transmission range is short. Furthermore, drones are noisy and very easy to detect, and their usefulness could be limited to choke points, he notes. Certainly, many systems are far from consolidated, and year after year, the optimal integration of unmanned systems and the balance of the hybrid fleet are being reconsidered. However, the new capabilities offered by technology and the environment of fierce competition between powers ensure that this trend will only deepen.

Conclusion

The area within the First Island Chain is undoubtedly a window into the future for these developments. In an extremely high-risk scenario, congested with sensors, the advantages that the submarine will gain by operating with advanced unmanned protection to map the scene, identify and engage targets, and perform mine and anti-mine tasks will be essential for both sides. The challenges are much greater for the powers seeking to breach the stronghold than for those defending it, but the systems are key for both defense and offense. No actor will forgo the benefits of the systems succinctly described in this paper. In conclusion, we can affirm that the spectrum of knowledge associated with unmanned underwater systems is broad, and the technologies involved present varying degrees of complexity. As noted, many of these technologies are dual-use and have been developed primarily by the commercial sector and later adapted for military use. This facilitates the democratization of systems, understood as the possibility for actors with less knowledge to access their benefits without the need for complete development. Although integrating systems for military utility can be a complex process of learning and experimentation, the first steps appear to be within reach through the incorporation of simpler technologies associated with complementary national interests, such as knowledge of the marine environment, in coordination with scientific and environmental agencies; the surveillance of critical infrastructure, such as submarine cables and offshore platforms; and port and coastal security, among others.

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