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Journal of Marine Science

Volume 4 | Issue 2 | April 2022 | ISSN 2661-3239(Online)



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Volume 4 Issue 2 • April 2022 • ISSN 2661-3239 (Online)

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REVIEW

Study on Legal Issues of Ocean Fishing in China

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ARTICLE INFO

Article history

Received: 18 February 2022

Revised: 5 March 2022

Accepted: 24 April 2022

Published Online: 30 April 2022

Keywords:

Pelagic fishery

Pelagic fishing

Laws and regulations

Supervision

ABSTRACT

“The 21st century is the century of the ocean.” In recent years, China has paid more and more attention to the promotion and development of the marine industry, especially the ocean fishery has brought immeasurable economic benefits to China. The development of the marine field is becoming more and more important in the national political, economic and cultural development. All coastal countries have included marine development in their national development strategies and continuously improved their marine legislation under the provisions of the United Nations Convention on the law of the sea. China’s pelagic fishing began in 1985, but because China’s pelagic fishing started too late, after the entry into force of the United Nations Convention on the law of the sea at the end of 1994, nearly 36% of the richest high seas on earth became the exclusive economic zone of coastal countries, and the development space of China’s pelagic fishing has become very limited. After just more than 30 years of development. However, before that, China’s pelagic fishing was still subject to the dual norms of international conventions and domestic laws, and China had not yet formulated a special law on pelagic fishing, and there were still many deficiencies in the legal system norms of pelagic fishing. Therefore, the biggest problem facing China’s pelagic fishery is how to better develop the marine industry under the system of laws and regulations, drive the coordinated economic development, provide legal guidance and help for pelagic fishermen, and provide solid technical support for building a marine power with Chinese characteristics.

1. Overview and Development Status of Pelagic Fisheries in China

1.1 Basic Content of China Yue Ocean Fishery

Firstly, according to Article 2 of the regulations on

the administration of Pelagic Fisheries (Order No. 27 of the Ministry of agriculture of the People’s Republic of China), Pelagic Fisheries refers to the fishing activities of citizens, legal persons and other organizations of the People’s Republic of China on the high seas and sea areas under the jurisdiction of other countries, such as marine

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DOI: <https://doi.org/10.30564/jms.v4i2.4454>

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fishing and supporting processing, supply and product transportation, but does not include fishing in the Yellow Sea Fishing activities in the East and South China seas. Secondly, Huang Xichang (2003), a Chinese fishing scientist, defined pelagic fishing as fishing activities in the deep sea and high sea with an isobath of more than 200 meters. Some scholars also believe that pelagic fishery refers to fishery production and management activities in China's territorial waters and waters outside the 200 nautical mile exclusive economic zone. Its essence refers to fishing and other fishery activities that are far away from their own fishing ports and fishery bases and are engaged in sea areas not managed by their own countries^[1].

1.2 Development Status of Pelagic Fisheries

Firstly, according to China's definition of pelagic fishery, it can be divided into Oceanic Fishery and transoceanic fishery^[2]. Oceanic Fishery refers to the fishery activities in the high seas, while transoceanic fishery refers to the fishery activities in the 12-200 nautical mile exclusive economic zone of other countries. Oceanic Fisheries mainly focus on the production of tuna, squid and bamboo pod fish. In 2008, there were 20 new oceanic production fishing vessels in China, with a total number of more than 680 vessels put into operation. In terms of the number, output and efficiency of fishing vessels, it has been close to or more than half of the total amount of Pelagic Fisheries. At present, there are more than 650 fishing vessels in transoceanic Pelagic Fisheries, which are distributed in the waters of West Africa, West Asia, Southeast Asia and other countries. They cooperate in fishing, mainly bottom trawling, mainly catching hard fish, octopus, cuttlefish and other soft fish^[3]. There are differences between transoceanic and oceanic Pelagic Fisheries in many aspects. The production mode of oceanic fisheries is mainly Purse Seine and large trawl, and the production area is mainly concentrated in the high seas, which is under the jurisdiction of international regional organizations. Trawling is the main production mode of transoceanic fisheries. The production area is mainly concentrated within 12-200 nautical miles of the exclusive economic zone of other countries, which is under the jurisdiction of the countries and relevant institutions to which the exclusive economic zone belongs.

Secondly, according to the mode of fishery production and operation, it can be mainly summarized into Pelagic Fisheries such as bottom trawl, squid fishing, longline fishing and large purse seine^[4], among which trawl and purse seine are the main operation modes of oceanic fisheries, and the main economic types of fishing are tuna, cephalopods, bonito, etc.

In short, after the promulgation of the United Nations Convention on the law of the sea, countries all over the world began to pay attention to the maintenance of marine rights and interests, and took Pelagic Fisheries as a strategic industry for development, so as to compete for the proportion of marine resources, expand international development space, participate in international affairs management, stabilize the international order, drive economic development, and establish a three-dimensional marine development model^[5].

2. On the Legal Regulation and Existing Legal Problems of Ocean Fishing in China

2.1 The Development of My Country's Ocean Fishing Law

At the beginning of the founding of the People's Republic of China, China had insufficient understanding of the huge benefits that marine resources and its industrial chain could bring to the society. The development of pelagic fishery started late and missed some development opportunities. However, after more than ten years of continuous struggle and efforts, China's fishery management has made considerable development and great progress. Breakthroughs have also been made in the construction of fishery legal system and the team of fishery administration institutions. In 1986, China promulgated the fundamental law of fisheries, the Fisheries Law of the People's Republic of China, which was revised four times in 2000, 2004, 2009 and 2013, established the basic system of fishing industry, clarified the fishing quota system, and made punishment provisions for relevant illegal acts. The detailed rules for the implementation of the Fisheries Law of the People's Republic of China (hereinafter referred to as the "detailed rules") promulgated in 1987 have made more detailed provisions on the relevant systems and penalties in the Fisheries Law, and defined the approval unit and fishing scope in the fishing license system for ocean fishing. The Ministry of agriculture and all provinces have also successively formulated some laws and regulations supporting the fishery law and detailed rules, so that China's aquatic production has ended the history of being unable to rely on and basically brought into the track of legal system^[17]. The regulations of the People's Republic of China on fishery ship inspection (hereinafter referred to as the regulations on ship inspection) promulgated in 2003 stipulates the conditions for the initial, operation and temporary inspection of ships, and defines the conditions and legal responsibilities for supervision and management, so as to ensure the safe navigation of ships and the

protection of the environment. Many mainland scholars and experts have conducted in-depth research on fishery law from different angles and ways. For example, Mr. Liu Zheng's "How to establish and improve China's fishery legal system" and "Research on China's fishery economy" put forward scientific analysis and reasonable suggestions on China's fishery development from the perspective of improving China's fishery laws and regulations and fishery economy. The impact of the United Nations Convention on the sea on high seas fisheries studied by Mr. Huang shuolin analyzes the challenges of the Convention to China's fishery rights and interests, traditional fisheries and Pelagic Fisheries, and puts forward that China should amend the fisheries law as soon as possible in order to adapt to the fisheries management system in the 200 nautical mile exclusive economic zone ^[6].

2.2 Legal Problems Faced by ocean fishing in China

1) A single legal regulation of ocean fishing

China's marine fishery has formed a development situation dominated by the fishery law of the People's Republic of China and oriented by the detailed rules for implementation. Although it has been revised and improved for many times, the specific implementation methods of ocean fishing, the provisions of the supervision and management system and the protection of fishermen's rights and interests are still vague, and there are still deficiencies. As the basic law of fisheries, the current effective version of the fisheries law has been amended four times. Among them, the regulation on fishing is basically aimed at fishing activities in the waters under China's jurisdiction. From the perspective of the regulation on ocean fishing alone, the fisheries law does not cover much, but only refers to the fishing license system. Compared with the Fisheries Law, the implementation rules have added some provisions on fishing rights and detailed provisions on fishing licenses, but there are still no more provisions on ocean fishing. It can be seen that China's pelagic fishing is also facing problems such as lack of legislation, no exact protection of some rights and interests, unclear law enforcement direction of supervision and management personnel ^[7].

2) Some domestic regulations conflict with international regulations

China's fishery is gradually forming a legal operation mode based on the fishery law. Firstly, although the fishery law has relevant provisions on pelagic fishery, the provisions pay too much attention to entities, lack of performance in procedural legislation, and lack of operability in practical operation. The fisheries law was revised twice in 2004, but the implementation rules were not issued.

Therefore, there will be contradictions and lag between the two laws, which will affect the implementation of the domestic fisheries law. In addition, the implementation of the United Nations Convention on the law of the sea has enabled the international fisheries management to form a fisheries management system with the United Nations Convention on the law of the sea as the core, restrict and manage various countries and their relevant sea areas, and gradually form a fishery management system guided by the United Nations Convention on the law of the sea among countries. Comply with the legal provisions on pelagic fishing in the United Nations Convention on the law of the sea. In this way, China's pelagic fishing is subject to the dual norms of domestic laws and international conventions. However, due to the lack of detailed provisions on the fishing standards of pelagic fishing in China's fisheries law, many data are lower than the standards stipulated in international conventions and cannot be normally connected with international law. For example, the United Nations Convention on the law of the sea stipulates that fishery countries should carry out fishery data statistics when fishing in Pelagic Fisheries, and clearly stipulates the specific requirements for fishery data statistics. However, China's law only makes principled provisions on fishery data statistics, and the relevant requirements are not clear, which can not be in line with the international provisions on pelagic fishery data statistics. The provisions on fishery statistics in the fisheries law are only listed in the sentence "large and medium-sized fishing vessels shall fill in fishing logs" in Article 25, and there are no specific requirements. It can be seen that the legal provisions of China's pelagic fishing have not been effectively connected with the international provisions, and even lower than the international standards, which is easy to cause the unclear data of China's pelagic fishing, which is a legal act under the standards of domestic law, but an illegal act in international law, which is not conducive to China's international image.

3) Responsibility subject is ambiguous

As ocean fishing is regulated by both domestic and international law and operates at a distant sea, it should not only comply with domestic legal norms, but also comply with international conventions, which makes the responsibility of ocean fishing unclear in law enforcement. China's Fisheries Law stipulates the principle of territorialism. Fishing in other countries' exclusive economic zones and on the high seas should abide by the relevant conventions to which China is a party and the laws and regulations of coastal countries. It also clearly stipulates that China's ocean fishing rights shall be established by the fishery administrative department of the State Council, and viola-

tions of fishing licenses shall be punished by China's fishery administrative department. The United Nations Convention on the law of the sea stipulates that organizations or individuals fishing in the exclusive economic zone of other countries shall abide by the legal provisions formulated by the coastal state for their exclusive economic zone, and the coastal state has the right to confiscate their catch, fishing vessels and fishing gear, as well as fine and imprisonment for illegal foreign fishing vessels. Through the comparison of domestic law and international law standards, a new problem arises. That is, whether China has the right to punish such acts, and whether the fishing vessels and personnel who have been punished need to be punished by China's fishery administrative department again. These problems can not be clearly stipulated in the law^[7]. In addition, China's lack of maritime law enforcement action force makes the law enforcement team have redundant institutions and lack of talents in some matters, resulting in a variety of problems in the punishment of ocean fishing. Although China incorporated the Chinese maritime police into the armed police force in 2018 and was under the unified management of the Central Military Commission, the administrative functions and responsibilities of various departments were still unclear, resulting in low law enforcement efficiency, vague rights and unclear subjects of responsibility.

3. Methods to Solve the Legal Problems of Ocean Fishing in China

At present, China has initially formed a basic fishery management system, but the laws and regulations on ocean fishing are still relatively general and there is no clear implementation standard, resulting in a shortage of legislation, the inability to protect the rights and interests of the state and relevant personnel, the unclear rights and responsibilities of the law enforcement team, ineffective supervision, the inability to establish the subject of responsibility, and contradictions and conflicts between international and domestic laws. Some regulations cannot be connected. Therefore, while establishing and improving the fishery supervision system, China should also pay attention to the formulation and improvement of special laws and regulations such as ocean fishing, regulate ocean fishing with clear legal provisions, and better connect with international law, so as to reduce the occurrence of illegal acts of ocean fishing.

3.1 Formulate Specific Laws and Regulations on Ocean Fishing

Although China has laws and regulations on fishery

regulation such as the Fisheries Law and the detailed rules for implementation, as well as the regulations on the management of Pelagic Fisheries and many policy documents to promote the development of Pelagic Fisheries, the regulations on the management of Pelagic Fisheries is only a departmental regulation. There is still no more specific legal regime for pelagic fishing. Therefore, China's pelagic fishery is still facing the problem of insufficient legislation. China needs to develop ocean fishing for a long time to make the marine industry go fast and stable^[14]. First, we need to formulate a more detailed legal system on ocean fishing, make it rise to the height of the law, and have the normative standards and detailed implementation guidelines formulated by the law. Secondly, we should take the fishery law as the criterion and formulate the implementation rules in line with it, so as to effectively avoid the legal conflict caused by the lag between the fishery law and the implementation rules. All provinces and departments should implement the legal provisions according to the specific actual situation and supplement them. Finally, through the formulation of the special law "ocean fishing law", we can clarify China's ocean fishing norms, provide direction for the formulation of ocean fishing policies, establish a detailed legal system on the content and scope of ocean^[12] fishing rights from the national system level, and improve the legal regulation of ocean fishing rights.

3.2 Improve Domestic Laws and Regulations and Strengthen International Cooperation

According to the Convention on the law of the sea, the scope of pelagic fishing stipulated by China includes fishery production and business activities in the territorial sea of China and the waters outside the 200 nautical mile exclusive economic zone, but does not include fishery activities in the Yellow Sea, the East China Sea and the South China Sea^[15]. According to the Convention on the law of the sea, pelagic fishing is generally defined as far away from its base to engage in marine fishing production in the exclusive economic zone or high seas of other countries, as well as for its production, production Economic activities of postpartum supporting services^[8]. As pelagic fishery is a development undertaking of international competition and cooperation on a global scale, involving a wide range and wide differences in the distribution of international resources, it is more difficult to develop pelagic fishery, especially to formulate domestic laws and regulations on pelagic fishery to adapt it to international laws and regulations^[16]. Any effective and post effective laws and regulations will not only make China's developing pelagic fishery face new difficulties and challenges,

but also have a great impact on the world fishery. Since China's fisheries law, implementation rules and other laws and regulations have jurisdiction and jurisdiction conflicts with international regulations in terms of the provisions of fishing standards for Pelagic Fisheries, when perfecting the Fisheries Law and formulating the Pelagic Fisheries Law, we should fully take into account the United Nations Convention on the law of the sea and achieve a clear connection with international regulations. It is particularly important to clarify the main responsibilities such as fishing rights. In the regulations on the management of Pelagic Fisheries just promulgated and implemented in 2020, there are relevant supervision and management measures for pelagic fishery enterprises, ships and crew connected with international regulations. When formulating the special law on Pelagic Fisheries, we should take the new regulations on the management of Pelagic Fisheries as the guide to clarify the rules that Chinese fishermen (crew) should abide by. We will formulate laws and regulations that link up with the provisions of international law to further improve China's legal norms for ocean fishing. At the same time, when combining international laws and regulations with China's laws and regulations, we should pay attention to raising the standards of China's laws and regulations above international standards, and strengthen the extraterritorial scope of effectiveness stipulated in China's fishery laws^[9], so as to reduce the extraterritorial illegal acts of China's ocean fishing, create a good international fishery competition environment and establish the international image of China's responsible big country.

3.3 Improve the Capacity of Law Enforcement Officers and Clarify Their Responsibilities

The concepts of the use of fishery rights, fishing rights, Punishment Rights and other rights and interests between international conventions and domestic fishery laws are vague, resulting in the weak understanding of law enforcement personnel on how to enforce the law and whether China's laws should be applied to deal with illegal events. In addition to formulating the special law on ocean fishing, law enforcement personnel should also improve their knowledge reserves and carry out practical training, enhance the ability to respond to international affairs^[13]. In view of the foreign-related act of pelagic fishery fishing, a special fishery administration team can be established, the subject of law enforcement responsibility can be established according to the level and region, and the illegal acts in pelagic fishery fishing can be dealt with intensively according to the principle of unity of rights and responsibilities. However, due to the serious brain drain in pelagic fishery management, it is more necessary to rely on na-

tional means to strengthen the top-level design of pelagic fishery talents, establish a "order type" training mode of mutual connection and cooperation among relevant national departments, relevant marine (aquatic) colleges and universities in coastal provinces and cities, pelagic fishery enterprises^[10], and cultivate pelagic fishery management talents that meet the actual needs of the country^[11].

4. Conclusions

China's pelagic fishing plays an important role in the strategy of developing a blue ocean power. Although there are many problems in the application of laws, with the continuous addition of laws and regulations on fishery regulation such as the Fisheries Law and the detailed rules for implementation, and the improvement of the technical level of law enforcement teams and law enforcement personnel. The development potential of China's pelagic fishery is still huge, accounting for a large proportion in the development of blue economy, and gradually moving towards the international stage.

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ARTICLE

UXO Assessment on the Romanian Black Sea Coast

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ARTICLE INFO

Article history

Received: 8 March 2022

Revised: 8 April 2022

Accepted: 24 April 2022

Published Online: 30 April 2022

Keywords:

Unexploded Ordnance

Black Sea

Side-scan sonar

UXO survey

Romanian Navy

Historical minefield

Second World War

Mine Warfare Data Center

ABSTRACT

This paper aims to provide the reader with the results of the Unexploded Ordnance (UXO) survey of the defensive historical naval minefields launched by the Romanian and German Navies on the Romanian Black Sea coast, during the Second World War. This UXO survey was carried out between 2015-2018 by the Romanian Navy's hydrographic ship “Commander Alexandru Cătuneanu” and Romanian Mine Warfare Data Center, using towed side-scan sonar technology and oceanographic observations. After explaining the materials and methodology, the results are presented and discussed: mosaics of the minefields, side-scan images of UXO contacts, side-scan images of the wrecks that were sunk in the minefields and some visible natural geological features of the seafloor. It was concluded that most of the objects discovered are sinkers, wreck debris or parts of chains, which does not represent a danger to navigation.

1. Introduction

Underwater explosive ordnance (EO) and abandoned explosive ordnance (AXO) are placed in territorial or international waters worldwide and subject to an arming sequence that has been failed to explode and constitutes

a major environmental and safety issue. The disposal of the projectiles in the sea was a standard until the 1970s that occurred mainly immediately after World War II. For example, the ships or planes' wrecks contained substantial amounts of AXO that prevailed along the coasts. Historically, comprehensive efforts have been

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DOI: <https://doi.org/10.30564/jms.v4i2.4497>

made to develop data standards for Unexploded Ordnance (UXO) applications of geophysical surveys^[1-4]. Qualitative descriptions of the workflows with the threshold values partly related to the reference object for marine geophysical surveys, and some extent for UXO campaigns, are well documented in relevant guidelines on UXO marine surveys or hydroacoustic mapping^[4-7].

For offshore activities, UXO represents a threat and in response, Frey^[8] developed the “Quality Guideline for Offshore Explosive Ordnance Disposal (EOD)” that addresses the four phases: (a) a desk-based preliminary survey of historical data, (b) a technical survey in the field, (c) an investigation of suspected UXO sites, and (d) UXO clearance and disposal^[9].

Unfortunately, the ecological impact of the EO is not widely understood, and environmental assessments should be conducted to analyse the impact on the marine ecosystem. Tactically, assessments should be considered in the planning phase to determine whether the impact justifies the time, risk and effort required to survey and ordnance clearance.

Recent information was achieved from the European seas projects on chemical munitions dumpsites attained using hydrographic and geophysical mapping. New efficient methods and technology were applied like advanced AUV-based data acquisition, applying artificial intelligence, and developing data quality factors (e.g.^[10]), or enabling near-real-time detection of dissolved explosive compounds in the water column (e.g.^[11]). Furthermore, various methods are used to accurately establish the site of submerged UXO or artefacts, like magnetic sonars or optical technologies. From the technologies mentioned above used for seabed mapping, the most effective has proved to be the magnetic method for ferro-metallic objects masked by seafloor sediments or buried under the seabed^[12]. Recently, various methods and adaptive technologies for shallow waters are used, such as an alternative approach as combined surveys using unmanned surface vehicles (USV) integrated with side-scan sonar (SSS) and magnetometers in a gradiometer set-up. The same configuration was recently used on UXO clearance for offshore drilling campaigns^[13]. At the ecological level, a marine UXO risk assessment tool was identified that could aid managers working in marine industries in mitigating the risks presented by marine UXOs^[14,15].

Small objects detection is one of the key components in underwater operations for the North-Western Black Sea as similar to other regions, during the two World Wars (WWI and WWII). Significant quantities of explosive ordnance were dropped from the air or placed on and around the beaches of the Romanian Black Sea coast, including

bombs and mines. Laid by surface vessels, the moored naval mines were intended for primary use against submarines: the UMA mine was deployed first in 1928, UMB mine in 1941 and appeared in four forms, EMC I and II often actuated in heavy seas, FMB completed in 1928 was a chemical-horn mine using a cylindrical preset-type anchor^[16].

This assessment is based on the archival research done by the Romanian Mine Warfare Data Center (MWDC) at the Historical Service of the Army - Bucharest. One hundred twelve files from the Romanian Royal Navy Command archive, the Sea Division and the Modern Romanian Navy Command were studied, related to the mining/demining activities, naval combat actions, and anti-submarine combat in the Western Black Sea during the Second World War.

Moreover, the Notices for Navigators from 1952 to 2011 were examined, extracting data referring to submarine obstacles, wrecks, pipelines, and other contacts.

More than twenty minefields were installed during the Second World War on the current Romanian coast, totalling approximately 3000 sea mines of various types (UMA, UMB, VICKERS, EMC I, EMC II, FMB, UC, etc.) and more than 3000 protection mines and anti-sweep devices, generally known as Unexploded Ordnance, as seen in Figure 1.

The Romanian and German forces launched the historical minefields on the Romanian Black Sea coast with specialised ships (minesweepers: Dacia, A.Murgescu, Durostor cargo, German submarines, Aurora tug-arranged as minesweepers), according to Ioan Damaschin^[18]. During the same period, an unknown number of magnetic minefields were launched on the Romanian coast by Soviet forces. Soviet forces between 1946-1948 carried out the first dredging operations. As a result, the minefields located on the Romanian coast were dredged, and a considerable number of mines were neutralised by dredging or shooting.

Between 1948-1978, the Romanian Naval Forces constantly carried out dredging activities on the mined areas. During this period, although the Romanian dredging forces made great efforts to clean up the coast, there were still dangerous districts in the Mangalia area, south and north of Constanța, south of Sf. Gheorghe and Sulina areas, as shown in Figure 2. Furthermore, freedom of navigation on all means of communication on the Romanian coast was restored only in 1979, as stated by the Navigators' Notice no. 11 from 1979.

Between 1946 and 1960, the documents studied so far showed that approximately 600 mines and 300 protection buoys were destroyed by dredging, shooting, or blasting.

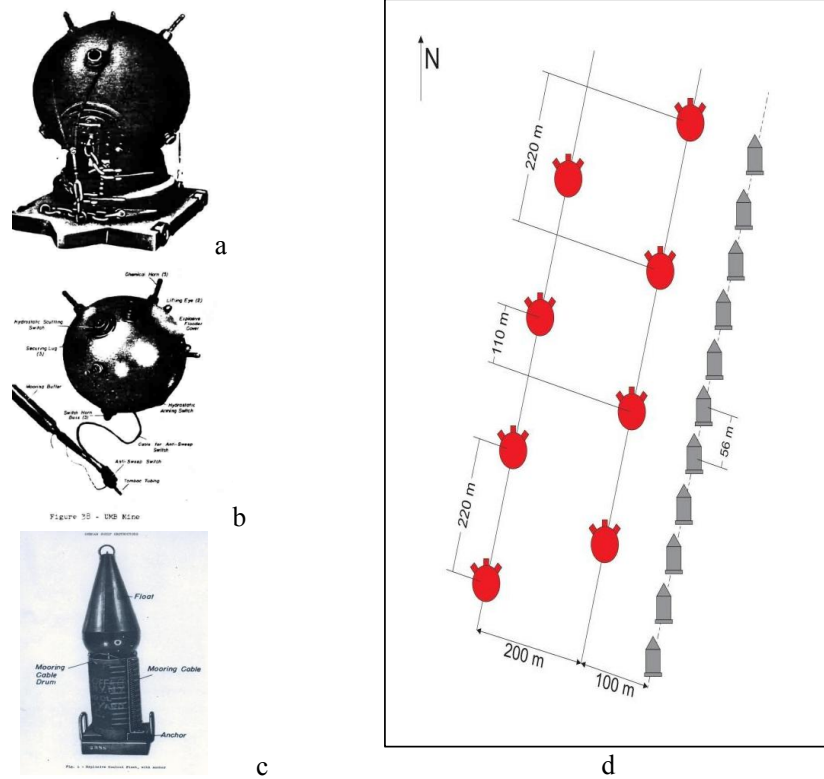


Figure 1. Types of mines launched during WW2 in the Western Black Sea^[17]: a.UMA mine - anchored contact mine used against submarines, b. UMB mine - anchored contact mine used against submarines and surface ships, c. Explosive conical float-anti-sweep device, d. historical minefield layout

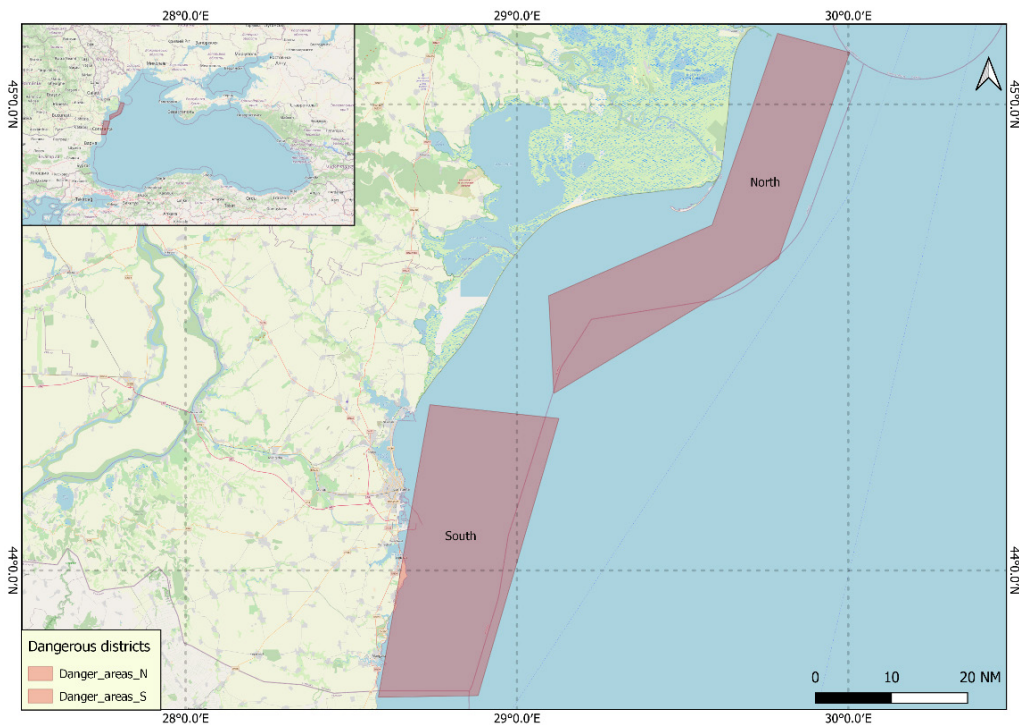


Figure 2. Dangerous areas after the dredging campaign

So, a significant number of contacts and debris from the historical minefields are still lying on the Romanian Black Sea seafloor, posing a potential environmental threat and a real danger for the fishery sector, as seen in Figure 3. Moreover, the UXO threat must be taken away for the safe construction of offshore windfarms in the renewable market sector, which is constantly growing^[19].



Figure 3. UXO caught in fishnet on the Romanian Black Sea coast

Romanian Mine Warfare Data Centre (MWDC) based in the Maritime Hydrographic Directorate (MHD) conducted a project between 2015 and 2018, using different hydrographic and oceanographic survey equipment on-board the Romanian's Navy hydrographic ship "Commander Alexandru Cătuneanu", to assess the remaining UXO on the Romanian Black Sea shelf.

Naval Mine Warfare doctrine describes four stages of naval mine hunting procedures, from discovering a submerged contact during data collection using different methods to neutralisation. This UXO survey's main goal was to achieve the first two stages of the Naval Mine Warfare hunting procedure. MHD conducted this project in cooperation with the Romanian Navy Diver Centre to perform the last two stages of the Naval mine hunting procedure.

2. Material and Methods

The side-scan sonar is known to be a valuable tool in the Naval Maritime Mine Countermeasures (MCM) survey due to its capabilities to provide an accurate acoustic image of the seafloor and contacts above it.

A side-scan sonar emits sound beams in a fan shape perpendicular to its axis, as seen in Figure 4. In addition, it records the acoustic response (backscatter) to form a geo-referenced seafloor image^[20]. For this project, an Edgetech 4200 Multi Pulse (MP) side-scan sonar system was used,

combined with a Vector VS 330 Hemisphere Global Navigation Satellite System (GNSS) Compass with SBAS and Atlas live corrections. The MP configuration accepts two pulses in the water during each ping cycle. Thereby, at typical survey speeds, this system can achieve twice the data density compared with a Single Pulse configuration^[21]. These benefits of MP technology offer better contact detection and classification capabilities.

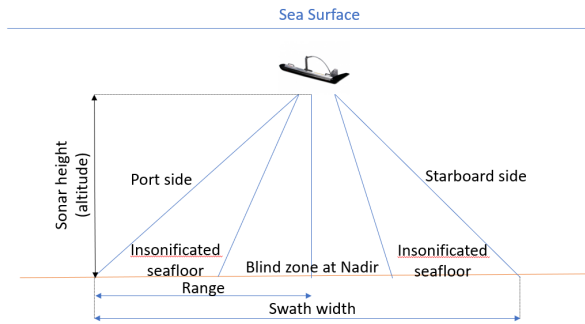


Figure 4. Side-scan sonar operations

For achieving a higher swath width, the sonar's lower frequency (300 kHz), in MP configuration, was chosen for this UXO survey. The higher 900 kHz frequency provides more pixel resolution, thus, greater detail of the acoustic picture, and was used for wreck investigation.

The positioning information (latitude, longitude, heading, speed) from the GNSS sensor is combined with the attitude sensor of the tow fish (pitch, roll) for an accurate location of the sonar echoes on the seabed.

The sonar's acoustic signals were calibrated at least twice a day using a Valeport Sound Velocity Profiler (SVP) that provided in-situ sound velocity profiles observations. In the Northern part of the surveyed area, more oceanographic stations were needed due to the rapid change of the halocline, based on the Danube River outflow.

In the survey planning, the following factors were considered: the depth of the water, characteristics of the historical minefields, the seafloor's topography, and the overlapping percentage of the planned survey lines (to cover the blind area of the sonar's Nadir region). After the assessment of the initial planning, three main survey areas resulted: North, Center and South, as shown in Figure 5.

Additionally, the ship's single-beam or multi-beam hydrographic sonars were used to complement the survey and determine underwater obstacles that could damage the towed sonar.

The mission's success was also attributed to the vessel's new autopilot system that processed data from the GNSS system, compass, and other instruments to accurately maintain the ship on the survey track. The speed vessel for the side-scan survey ranged between 4 knots

to 6 knots, and the sonar was towed at a distance of 150 meters to 200 meters backward ship. However, several challenges made the survey difficult, like high sea states, inaccuracy in the positions of the historical minefields and the rapid change of the vertical structure of the water column that influenced the sonar operations.

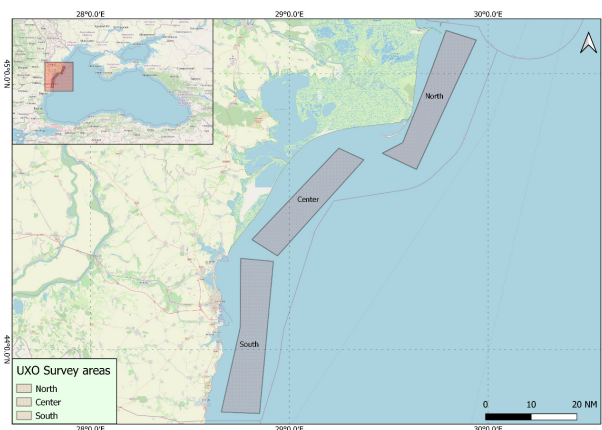


Figure 5. UXO survey area areas based on the location of the historical minefields

The side-scan data were calibrated with altitude, attitude, layback and GNSS data, saved as sonar native format and more generally used eXtended Triton Format (.xtf). Recorded acoustic data was processed using the HYPACK software suite. Bottom track, gain and slant corrections (picking up the first return from the seafloor, thus separating the nadir blind area on the sonograms and removing it) were applied, and the resulting sonograms were compiled to form a mosaic.

A comprehensive contact analysis was performed, for every survey line, to determine and classify the minelike echoes from the sonar into a minelike contact. Minelike contacts are selected by assessing their sonar echo intensity, shape, size and shadow.

3. UXO and the Black Sea Physical Marine Environment

The Black Sea is a semi-enclosed basin ^[22,23] and communicates with the Mediterranean Sea through a complex straits system: the Kerch Strait connects the Black Sea with the Azov Sea; the Bosphorus Strait with the Marmara Sea, which through the Dardanelles Strait connects with the Mediterranean Sea.

The physical conditions that prevail within the marine environment and their behaviour over time can significantly impact objects' position and state, like UXO. In particular, the following physical aspects are described below, alongside an overview of how these physical conditions and changes can interact with UXO.

Regarding the geology and sediments, much of the marine environment comprises underlying rock overlain by less consolidated sediments, such as silts, clays, sands and gravels ^[24,25]. The extent of overlying sediment cover can vary significantly between areas of little or no sediment cover, such as areas of exposed rock, as seen in Figure 7(a), and areas of the seabed with a sediment thickness greater than tens of meters (Danube outflow areas). As an effect, the composition of the present sediment cover and the underlying geology will determine the depth to which deployed UXO initially penetrates the seabed or shore and to what extent such objects may subsequently become buried by natural processes. The shallow waters characteristic for the North-Western Black Sea coastal area (littoral), represents a significant issue in the underwater acoustics, used by mine warfare communities. Moreover, there is a high rate of false alarms within shallow waters from irregularities of the seabed or magnetic anomalies ^[26].

Bedforms may form depressions, such as channels and extrusions across large areas of the seabed and typically include mobile sediments, such as mega ripples and sand waves. Subsequently, many areas of the seabed are not uniformly flat. More notable features, such as sand ridges, sand ribbons and sand or gravel banks, may also be present in some cases. Bedform features often indicate the relationship between the physical processes and sediments, and the bedforms asymmetry can demonstrate active sediment erosion, transport, and deposition processes. As seen in Figure 6, these areas can significantly impact the acoustic signal received by the side-scan sonar, but they provide essential information regarding the potential burial of UXO.

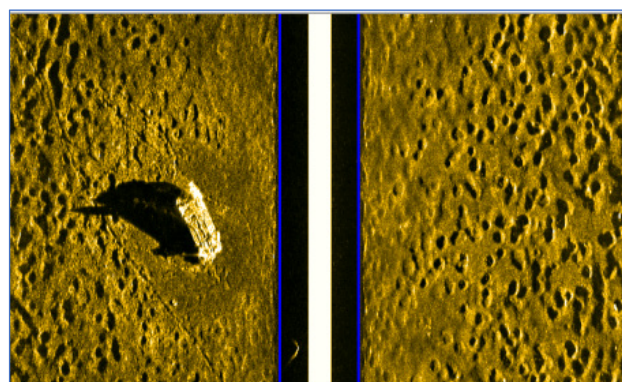


Figure 6. Seabed sand features

Coastal processes ^[27-29] can significantly impact the objects lying on the seafloor, especially in shallow waters. These mechanisms are accelerated from the energy generated from physical processes, such as winds, water, and tides, which have the most significant effects on a water body's surface. These forces may be affected by the mod-

ification of both wave and tidal processes in nearshore areas, which can cause larger forces to be exerted on objects or sediments on the seabed. The relationship between water depth and wavelength affects the strength of these coastal processes [30-34]. Therefore, information about these factors can be used to determine the depth of a wave's influence and whether the wave will have significant interaction with objects like UXO present on the seabed.

Sediment transport can take the form of a gradual, progressive trend or can occur rapidly as a result of storm or surge events. Significant sediment movement is therefore difficult to determine, and any resulting morphological change can affect the exposure and movement of the present UXO.

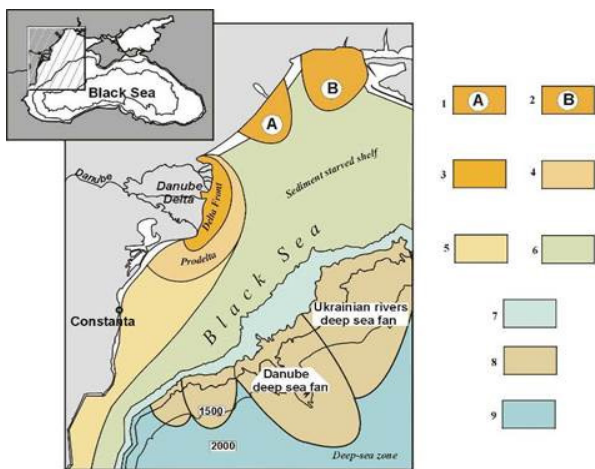


Figure 7. Main sedimentary environments in the northwestern Black Sea (after [35,36])

These physical marine conditions can interact with UXO present in the marine environment in the following three main approaches: a) the exposure or penetration into the seabed or shore; b) the subsequent burial or uncovering, and c) migration of UXO. Surface waves and underwater currents significantly impact the seafloor [22,37-39] and drifting objects inside the Black Sea basin. Underwater buried objects migration decreases with water depth, with munitions in a minimal burial state being particularly susceptible to movement when influenced by a large wave or strong current [40,41].

Historical documents revealed that not all the naval mines were deployed correctly. Thus, some UXOs were drifting with the underwater and surface currents, following the thermohaline circulation process of the Black Sea generated by density gradients [42]. Mathematical models of the waves and currents in the Black Sea may bring an operational value to the Romanian Navy by providing circulation predictions that have a considerable impact on the Romanian Navy operations [43].

Further research is needed on the estimation of bathymetric variation and to predict with parameterised models driven by wave observations [33,34,37,38]. Another tool to be included in the detection and migration of UXO or artefacts expert system is represented by the bedform migration modelling as a new mechanism for buried and exposed objects [44-47].

4. Results

The survey results and analysis allowed the detection and identification and afterwards to classify more than 2000 contacts using the side-scan sonar processed images. Most of the contacts are mine sinkers (anchors of naval moored mines) as seen in Figure 8, debris from the naval mines or parts from the wrecks placed near these locations.

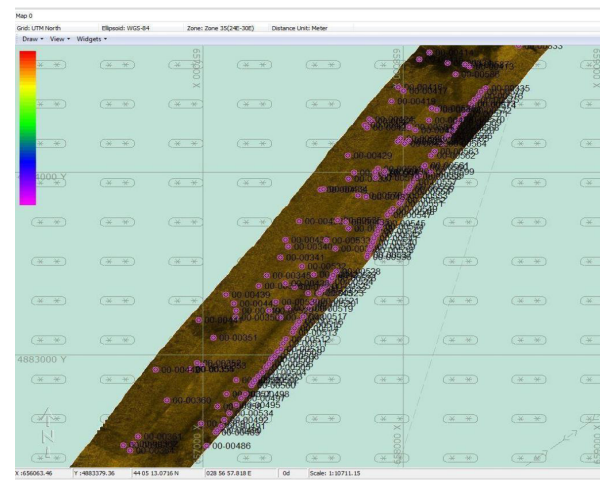


Figure 8. Contacts discovered on a historical minefield (Side-scan mosaic created with Hypack software)

However, a few contacts were observed and classified as naval mines, as it can be observed from Figure 9. Once a submerged object is identified as a sea mine, the district is prohibited for navigation by the Maritime Hydrographic Directorate issuing a navigator's notice, and Romanian Navy's Explosives Ordnance Disposal (EOD) divers begin neutralisation operations.

The images delivered by the side-scan sonar proved to help roughly identify the type of seabed on the surveyed areas, as seen in Figure 10(a). Figure 10(b) shows a bottom sample that was taken during the oceanographic stations, to ground truth the side-scan image of the seafloor.

Seabed composition data is of strategic importance to calculate the burial percentage of objects on impact according to their size and weight and a subsequent estimate of the burial rate per year.

As seen in Figure 11, during this survey mission, the positions of some known wrecks were reconfirmed, but also new wrecks or wreck debris were also discovered.

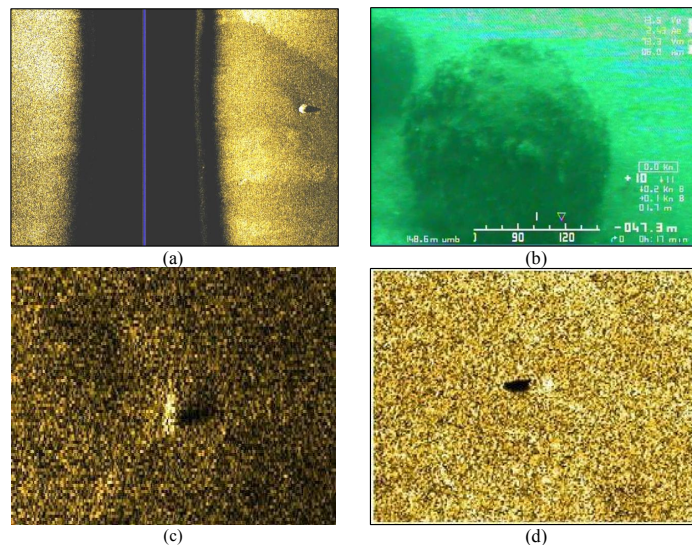


Figure 9. (a) UMA mine SSS image, (b) Remoted Operated Vehicle naval mine image, (c) explosive buoy SSS image and (d) EMF mine SSS image

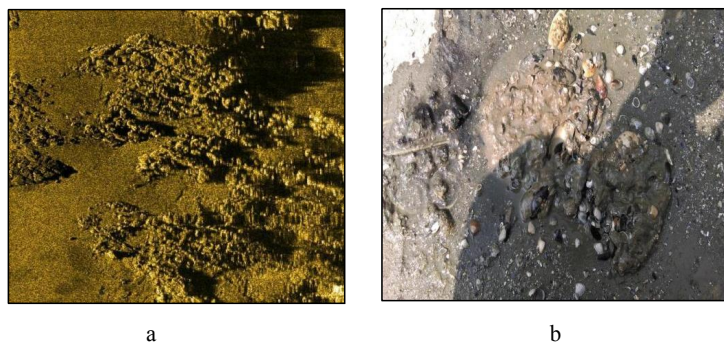


Figure 10. (a) Rocky seabed SSS image, (b)-bottom sample-muddy-sand with parts of shells

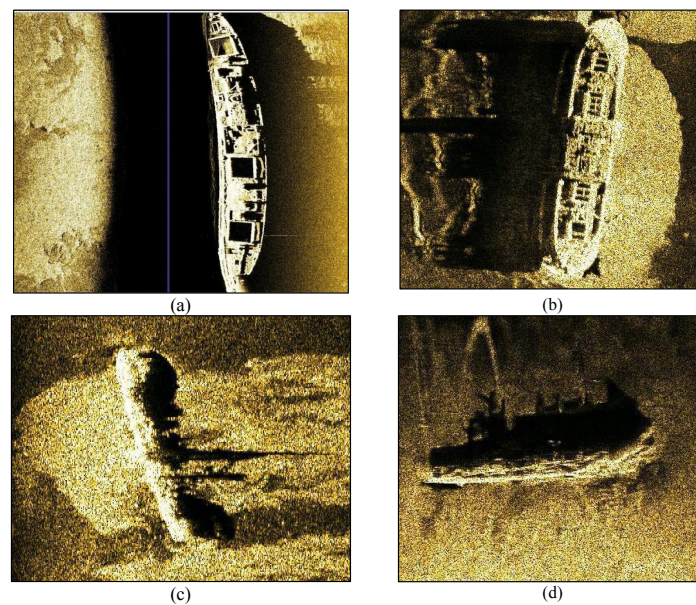


Figure 11. Wrecks discovered during the side-scan survey: (a) unknown wreck, (b) Arcadia wreck, (c) Sciuka class soviet submarine wreck, (d) Russian destroyer Moskva wreck

5. Discussion

The side-scan sonar is a valuable tool in Naval Mine Warfare to discover and classify mine-like contacts, wrecks, and underwater debris. It offers a high-quality image of the contacts lying on the seabed with good knowledge about their position and dimensions.

The North-Western part of the Black Sea has many particularities that impact any survey activities using sound energy: different types of seabed features, distinctive water column structure, and rapidly changing surface water parameters.

The unique water column characteristics of the North-Western Black Sea area (the low salinity and the low presence of Oxygen (anoxic layer) ^[23,48,49] preserved the metallic contacts in an excellent shape. The contacts have been found to be in good state, considering the marine environmental conditions in the area, considering the time elapsed since their launch in the water, due to the specific oceanographic conditions of the Black Sea ^[49].

The topography and nature of the seabed create false echoes/contacts, considerably increasing the detection and classification time of objects; a seabed with rock formations can easily hide metallic objects in their shadow. Moreover, the type of seabed act differently from the acoustic impulse sent by the side-scan sonar: higher-frequency sound and rocky seabed reflect more efficiently, while lower-frequency and fine silt and clay absorb more sound. However, it was observed that some muddy with embedded shells areas reflected more sound energy than sandy regions. The type of seabed significantly influences the process of marking targets and classifying them by the operator, especially in the case of small and partially buried contacts.

Comparison of the images using two different frequencies of the sonar showed advantages and disadvantages of each frequency: the low frequency can provide a broader range, in deeper waters and faster surveys, while the higher frequency provides more resolution on shallower areas with less area coverage.

As a recommendation, the initial survey can be conducted using the low frequency of the side-scan sonar, and after that, a high detail survey can be performed on contacts of interest (wrecks, mine-like contacts, etc.)

6. Conclusions

This research paper presents the outputs of the first UXO survey project performed on the Romanian Black Sea coast, after World War II. The raw and processed data is stored in the Maritime Hydrographic Directorate database. The database is constantly updated with the infor-

mation and knowledge from the Romanian EOD Divers or other Institutes or civilian companies that are conducting similar surveys in this area.

The in-situ survey period of the project was conducted between 2015-2018. A thorough work was carried out before the survey, for planning purposes, and data processing and analysis, after the survey. The comprehensive archival work done by the Romanian Mine Warfare Data Center contributed to the success of this project.

Marine Industry development is strongly related to the UXO assessment on the areas of interest. Offshore wind farms are constantly growing around the globe and various studies in the Western Black Sea area demonstrated significant wave energy resources ^[50]. A rigorous UXO assessment and clearance must be conducted to install future offshore wind farms or submarine cables and pipelines in the studied area.

A significant number of underwater contacts, laying on the seafloor were discovered using side-scan sonar technology: naval mine anchors, metallic fragments of naval mines, wrecks and debris, Unexploded Ordnance.

With the increase in knowledge about the potential UXO impacts, an urge to address the challenge has been created strategically. Historical UXO still represent a threat to navigation due to their explosive charge. However, the case of a naval incident caused by hitting a UXO is improbable to take place. The war wrecks and UXO identified during this survey can pose an environmental threat if chemical substances leak from the munitions. More research is required, such as an extensive biochemical sampling campaign and a solid policy framework needs to be developed.

As a result, following the study, the next direction on target classification is to identify based on intrinsic physical features of the objects rather than external features such as location and orientation of the source object. Also, library matching techniques to determine the similarity between the existing database and unknown sources will become a powerful tool in classifying UXO vs. non-hazardous objects and, in some instances, identifying the UXO type. The project is still undergoing, to carry out all the mine-hunting stages, a considerable number of underwater contacts still need to be identified with the help of divers, ROV (Remotely Operated Vehicle) or AUV (Autonomous Underwater Vehicle), and those identified as real sea mines to be neutralised by the Romanian Navy EOD divers.

Acknowledgements

We thank **Navy Captain(ret) Sorin GRECU**, former head of the Romanian Mine Warfare Center and **Lieu-**

tenant Commander Radian TRUFAȘU, head of the Nautical Cartography branch, from Romanian Maritime Hydrographic Directorate, for their great effort to gather information from the National Military Archive, regarding the Mine Warfare actions on the Romanian Black Sea coast, during and after World War II.

We thank **Lieutenant Commander Valentin DE-MENTE**, **Lieutenant Nina Camelia SANDU**, **Lieutenant Fabian CIUBOTARIU**, **Lieutenant Leonard JIANU** and **Petty Officer Marian SIMION** for their great contribution to collect and process the side-scan sonar and oceanographic data.

We thank **Captain(ret) Rogers CASIAN**, former Commanding Officer of the Romanian Hydrographic Ship “Commander Alexandru CĂTUNEANU” and all the crew that was present for the long days of survey.

This work was carried out in the framework of the research project DREAM (Dynamics of the Resources and technological Advance in harvesting Marine renewable energy), supported by the Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding-UEFISCDI, grant number PN-III-P4-ID-PCE-2020-0008.

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EDITORIAL

Biological Invasions in Marine Ecosystems: Amphipods (Crustacea: Amphipoda) as a Model Group

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ARTICLE INFO

Article history

Received: 28 March 2022

Revised: 8 April 2022

Accepted: 24 April 2022

Published Online: 30 April 2022

The introduction of non-indigenous species (NIS), deliberately or unintentionally, by means of human action, is considered one of the major threats to biodiversity and ecosystem functioning worldwide ^[1]. Some of these species successfully establish, spread rapidly into new locations, and become invasive, altering ecosystem services and causing both significant ecological and socio-economic impacts ^[1,2].

In the marine environment, the number of NIS has increased dramatically in the last decades ^[3] driven particularly by the intensification of shipping (both commercial and recreational), aquaculture activities, aquarium and life seafood trade, and the construction and formation of new transportation corridors ^[1,4]. Consequently, regulations and

policies (e.g., the Marine Strategy Framework Directive, the GloBallast Programme, the EU Biodiversity Strategy, the Invasive Alien Species Regulation (EC 1143/2014)) have been adopted to ensure the prevention and early detection of these species, which have been recognized as the only viable and cost-effective strategies for their control and management ^[5,6].

Crustaceans are among the most successful aquatic invaders around the world ^[7,8], mainly due to their ability to colonize and easily adapt to different substrata, their high plasticity in trophic strategies, and their broad tolerance of a wide range of environmental conditions ^[8]. Among marine crustaceans, one of the taxa most frequently recorded outside of their native ranges is amphipods ^[8], small in-

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DOI: <https://doi.org/10.30564/jms.v4i2.4564>

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vertebrates that form an important trophic link between primary producers and higher trophic levels^[9]. Amphipods live mainly as epibionts of a wide variety of natural substrata (e.g., macroalgae, ascidians, hydrozoans, sponges, etc.)^[10,11], but are also very successful colonizers of artificial ones (e.g., buoys, ropes, wheels, vessel hulls, and pontoons), being frequently associated with fouling communities of ports and marinas, where they can reach high densities under optimal environmental conditions^[12,13]. Like other peracarid crustaceans, amphipods have direct development, i.e., they lack a pelagic planktonic larval stage, and have also limited swimming capabilities^[12]. However, despite this, they can be dispersed over long distances by rafting on floating substrata^[12] or by anthropogenic vectors (such as ballast water and vessel hull fouling)^[14,15], favoured for their small body size and morphology, which is well adapted to strongly cling to these types of substrata. In addition, these marine invertebrates are characterized by high fecundity and growth rates, have broad environmental and trophic plasticity, and some species show aggressive intra- and interspecific behaviour^[16-19]. All these biological traits seem to facilitate the colonisation of new areas and competition with native species, therefore, making amphipods a good model group to understand marine invasions.

In the last two decades, introduced amphipods have been reported with increasing frequency around the world^[6,20-22]. However, the number of introduced species is still underestimated due to the presence of cryptogenic species (those that cannot be demonstrably classified as native or non-native in a region) and because these marine organisms are easily overlooked due to their small size and complex identification^[20]. An accurate morphological identification of amphipod species requires examination of numerous characters, some of which are difficult to observe and generally show a considerable amount of intraspecific variation (e.g., ontogenetic variation and sexual dimorphism)^[23,24]. Furthermore, amphipods are easily mistakenly identified due to the morphological uniformity between some closely related species^[6,20], but also due to the existence of cryptic species (those that are genetically distinct but lack morphological differentiation), which has been widely reported for these organisms^[23,25-27]. Consequently, the identification of NIS amphipods using only morphological approaches presents significant challenges to ensure an early detection of these species and, thus, to control their establishment and further spread. For this reason, the use of an integrative approach, i.e., combining morphological and molecular methods (e.g., DNA barcoding and (e)metabarcoding), has been suggested as the most reliable and cost-effective approach to managing bi-

ological invasions^[28]. In this context, these analyses have allowed the recognition of cryptic species and NIS present at low abundances^[23,27,29,30], but also have helped to unravel the likely origin and introduction pathways of these marine species^[22,26,29].

Despite the research advances, knowledge on amphipod invasions is far from being complete. Further studies involving scientific collaboration among experts from different disciplines (taxonomists, molecular scientists, and invasion ecologists) are needed to fill the existent gaps and, therefore, guarantee the proper identification and management of these important marine crustaceans.

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