Scientific Journals
of the Maritime University of Szczecin

Zeszyty Naukowe
Akademii Morskiej w Szczecinie

2020, 62 (134), 51–57
ISSN 1733-8670 (Printed)
ISSN 2392-0378 (Online)
DOI: 10.17402/419

Received: 29.11.2019
Accepted: 02.06.2020
Published: 29.06.2020

A systematic solution for mitigating the problem of derelict fishing gear

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Key words: MARELITT, ghost nets, derelict fishing gear, Baltic Sea, ecology, fishery

Abstract

In this article, a systematic solution for mitigating the DFG (Derelict Fishing Gear) problem has been presented using an example of a DFG wreck operation. The planning process has been described in detail and the influence of ghost net recovery on the marine environment has been shown. The research was performed on selected wrecks found in the Polish economic zone and the method consisted of scanning the sea bottom using 2D sonar. Based on the information obtained by the sonar, the ghost nets were later retrieved using a creeper (in cases where the ghost nets were lying on the sea bottom) or with the help of divers (in cases where the nets were sitting on the wrecks). The results have shown that, taking into consideration the research area of the Baltic Sea, the presented method will be satisfactory in most cases.

Introduction

Worldwide, ghost nets are considered to be a source of marine litter which has comprehensive and dangerous impacts on the marine ecosystem. Every year, between 5,500 and 10,000 gillnets and trawl nets are lost over board. As a reaction to the ghost net issue, the MARELITT Baltic project was launched in 2016. It is an EU-funded transnational initiative involving Sweden, Estonia, Poland and Germany. The project's team has worked over the past few years to discover a sustainable strategy for recovering derelict fishing gear in the Baltic Sea (MARELITT Baltic, 2019). The MARELITT Baltic project aims to reduce the effect of marine litter in the Baltic Sea, such as derelict fishing gear, especially nets. The project was split into five work packages, with packages 2, 3 and 4 being the main components of the recovery, avoidance and recycling of DFG.

The goal was to create cost-effective, secure and environmentally friendly recovery techniques for derelict fishing gear which could be identified through demonstrations for the sampled targets (soft seabed / wrecks / rocky bottoms) including an environmentally sensitive area impact assessment analysis. As a result, a DFG retrieval methodology handbook was produced which consists of an evaluation of dragging operations and documentation of the lessons learned. MARELITT Baltic has become the basis for future recovery policies while producing an overview of Baltic Sea host fields in the form of a map; the project will also advise on post-project activities. MARELITT Baltic also seeks to boost responsible fishery while creating a code of behavior for the industry. Other goals include improving fishing gear for responsible fishing and minimizing the issue of DFG while improving DFG recovery by providing an overview of techniques designed to decrease equipment loss.

The initiative collected regulatory suggestions for prevention in the form of both a domestic and EU-level recommendation document. This should have a long-term effect on the distinct spatial levels of changing fishing policies and legislation.

Scope and objectives

The Maritime University of Szczecin has investigated the alternatives for the ecologically sound recovery of derelict fishing gear from the Baltic Sea as part of the MARELITT Baltic project. The ecological effects of various recovery methods on the marine environment have been analyzed in order to identify environmentally sound recovery techniques.

The main result of this research is an Environmental Impact Assessment (EIA) of recovery methods for hard-substrate seafloor conditions, soft sediment environments and wrecks. The EIA findings have also been discussed in terms of the effects induced by the commercial bottom trawling techniques that are used in the Baltic Sea, as a contrast (Figure 1).

Figure 1. Sea bottom DFG creeper (Kasperek & Prędki, 2011)

The EIA's ultimate objective is to encourage a decision on the techniques for DFG recovery in relation to the anticipated marine environmental effects and locations for future recovery activities. The following methods were adopted to achieve this goal:

1. Review and classification of the various recovery methods in use (echo sounding, trawling, and diving recovery).
2. Assessment of the physical and environmental impacts of the recovery methods on distinct kinds of sea bottom (soft bottom, tough bottom, wrecks).
3. Assessment of the environmental value and the sensitivity of the receiving environment on the basis of the main habitats that are recognized in the Baltic Sea.
4. Impact assessment of the recovery techniques, based on the physical effect on the surroundings as well as the ecological sensitivity, for the distinct types and habitats.
5. Recommendations for good environmental practices in connection with DFG recovery.

Impacts of DFG

Since fishing began, fishing gear has been lost. The causes of the loss of gear differ between the distinct fishing fields and the types of ships that are used within them. Such losses can be accidental as well as deliberate. Accidental gear loss is more common in more challenging fishing conditions such as bad weather, bottom fishing with complex structures, or fishing with very long nets and several sets of gear that cannot be moved frequently (Kasperek & Prędki, 2011). Another prevalent cause of accidental loss is fishing in fields where there is both gillnet fishing and trawling, which can result, for example, in trawlers passing through gillnets that will later become disconnected from their anchors. Areas where fishing gear is likely to be lost include ports or regions with dense ship traffic, or regions with significant tourism (i.e. water sports, such as yachting and recreational fishing) (MacMullen, 2004). Abandoned fishing equipment is described as equipment that is used for fishing and then deliberately left at sea (Gillman et al., 2016). For instance, fishermen who operate illegally may abandon fishing equipment when there is a danger of detection. Alternatively, bad weather may result in abandonment of gear, as well as accidental loss of equipment.

Fishing gear is regarded as waste once the fishing gear is lost and not retrieved. If the DFG is made up of synthetic fibers, plastic waste will also be considered. Due to the slow degradation of this material, plastic waste is a growing environmental issue. The slow degradation results in big fractions, small fractions and microplastics being present in the environment for a very long time. An estimate by Jambeck et al. (Jambeck et al., 2015) showed that the contribution from land-based plastic waste in the ocean from 192 coastal countries is in the range of 4.8–12.7 million tons per year. DFG is an extra and non-negligible source of plastic waste, consisting of nets, lines, traps and other recreational or commercial fishing gear that is lost, abandoned or otherwise discarded by various fishing operations (Sheavly, 2007). This is both a local and a global issue as DFG pollutes marine environments all over the globe. Over the past 50 years, the magnitude and impact of the problem of DFG has risen considerably with enhanced fishing efforts in relic regions and the enhanced durability of fishing equipment (Macfadyen, Huntington & Cappell, 2009). By damaging delicate habitats (Arthuret al., 2014) and generating navigational risks (Johnson, 2000), many studies have shown how ALDFG affects the environment. According to one research study carried out in the Swedish Baltic Sea (Tschernij & Larsson, 2003), DFG continues to fish with an effectiveness of up to 20 percent in the first three months after its "loss" at sea and 5–6 percent after this. In that research study, the entire duration of the observed fishing effectiveness of the DFG was 27 months. Smaller drifting nets in the water column (50–100 m) continued to fish for 1 day while longer net fragments (2 km) could continue to fish effectively for at least 3 months. DFG recovery is not only beneficial to the habitat, but it can also boost the yields of commercial fishing.

MARELITT Baltic retrieval operations

The first aspects of a recovery procedure are planning and the aim to determine the region in which the recovery operation will be performed, the so-called "host region". The choice of host region can be based on fishermen's data, such as the place where gear was lost or known sea bottom barriers where fishing gear could easily be lost. The selection of host areas may also be based on information provided by the coastguard authorities that may have revealed potential locations of DFG. Recreational diver associations are yet another source of information about the presence of DFG in the marine environment. Another approach in identifying high-density DFG areas is to base the selection of host areas on maps that combine fishing intensity information with information on seafloor structures / obstacles. Which type of boat and what type of equipment will be used for DFG operations will also be decided during the planning phase. Equipment selection depends on the type of sea bottom (hard bottom, soft bottom, complex bottom) or the presence of a wreck. In many cases, it is only the vessel's availability that determines which equipment to use during the operation. In some cases, it is preferable to choose an easy-to-maneuver vessel that allows turns, zigzag patterns and quick stops when tension is noticed on the line during the search phase. During the research on the Polish coast, the m/s Navigator XXI was used, which is owned by the Maritime University of Szczecin. The equipment installed on this ship predestined it to perform this research. Polish researchers were responsible, inter alia, for investigating sunken wrecks in the context of the fishing nets that exist on them. During the planning phase, six wrecks were chosen for the investigation (Figure 2, Table 1).

They were:

- m/s Memel,
- m/s Planeta,
- Kanonierka – the proper name is unknown,
- m/s Sycylia,
- Siarkowiec – the vessel which carried Sulphur, name unknown,
- m/s Rugen.

Figure 2. Wrecks that were chosen for the project (Description: Szymczak Marcin)

Table 1. Coordinates of the wrecks which were chosen for the project

Name	Latitude	Longitude	Depth (m)	Performed action
MEMEL	54° 09.45' N	014° 20.50' E	12	Removal of fishing nets
PLANETA	54° 08.00' N	014° 30.76' E	10	No fishing nets
KANONIERKA	54° 16.20' N	015° 33.72' E	8	Removal of fishing nets
SYCYLIA	54° 17.90' N	015° 44.57' E	18	Removal of fishing nets
SIARKOWIEC	54° 22.70' N	016° 14.28' E	16	No fishing nets
RUGEN	54° 23.45' N	015° 52.00' E	30	Sonar research

Knowledge of the local laws regarding the cultural importance of wrecks is very crucial before any cleaning procedure for a wreck is launched. DFG should only be retrieved from wrecks if the cleaning is not potentially detrimental to the wreck's heritage value. The cultural heritage officials must approve any DFG wreck activities in both Poland and Germany before they can take place; however, this is not the case in Sweden.

The purpose of the research was to find out what fishing nets were on the wrecks and take sonar images (2D sonar) of selected wrecks in order to check the identification method for detecting ghost nets. A sonar study, a remotely operated vehicle (ROV) and divers were the techniques that were used to perform this inspection; additionally, divers were equipped with GoPro head cameras. Firstly, a sonar study was performed; the sonar measurements were taken with the Deep Vision DE3468D side sonar that operates at two frequencies, 340 kHz and 680 kHz (Figure 3).

The pictures taken by the 2D sonar were compared with the images recorded by the divers in order to estimate the accuracy of the sonar and its future use for other spots. The wreck of m/s Sycylia has been shown in Figure 4, the images were taken by the Deep Vision sonar mentioned above; the remnants were found at a depth of 75 meters. In this case, the sonar was working at the 680 kHz frequency. In the picture, three characteristic details have been marked with numbers. Circle No. 1 shows boards measuring 1.5 to 2 meters each, circle No. 2 shows the engine room's boilers, and circle No. 3 shows a fishing net hooked on a hull fragment.

Figure 5 shows an image taken by the divers of a fishing net hanging on the part of the wreck corresponding to circle 3 in Figure 4.

Deep Vision		Working frequencies
Model	**DE3468D**	340/680 kHz

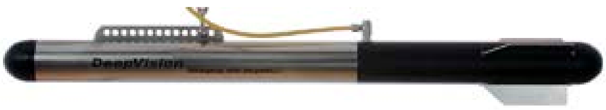

Figure 3. Deep Vision DE3468D side sonar (DeepVision, 2018)

Figure 5. A fishing net hanging on the wreck of m/s Sycylia, taken by divers (Photo: Adamowicz Adrian)

Figure 4. Wreck of m/s Sycylia – image taken by 2D sonar (Photo: Szymczak Marcin)

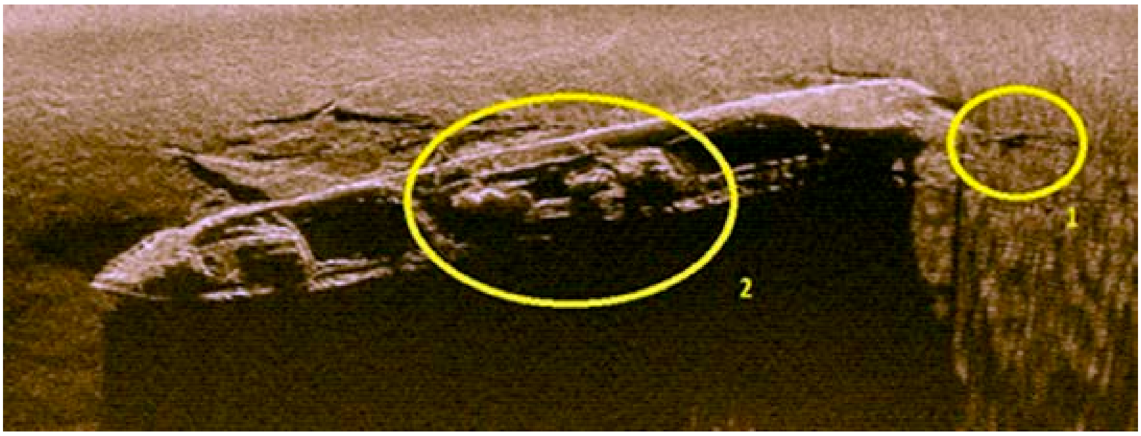

Figure 6. Wreck of m/s Rugen – image taken by 2D sonar (Photo: Szymczak Marcin)

Another site was also investigated, where the m/s Rugen wreck was situated. Due to it lying at the same depth (75 meters) the sonar worked at the same frequency.

In the sonar image taken from above (Figure 6) the nets attached to the hull (point No. 1) and amidships (point No. 2) can be seen. Figure 7 shows the same places but the pictures were taken by divers. From analyzing all of the above materials from the 2D side sonar, and in comparison, with the pictures provided by the divers, it can be concluded that the 2D side sonar method is sufficient to verify the presence of ghost nets hooked onto the wrecks. A similar comparison was done in all of the above-mentioned locations of wrecks. The sonar images that were taken during the research (at a frequency of 680 kHz) show significant detail in the image. They show characteristic places such as masts or steam boilers where the nets are hooked. With a sufficiently close scan (here the depth was 75 m) and a higher sonar frequency, such pictures will be even more accurate and identification of the ghost nets could be even easier. It should also be added that sonar measurements must be taken in very good weather. Measurements for the MARELITT BALTIC project were made with a wind force of 1–2 B. To sum up the accuracy of the sonar, its usefulness has been clearly proven for such research. The quality of the images taken by the sonar was good enough to indicate DFG lying on the wreck. This finding was confirmed by the divers and the pictures taken in situ. The resolution of the sonar itself depends on the frequency used (340/680 kHz) and is in the range between 0.5 cm and 1.5 cm and has been proven to be suitable for detecting DFG. A Navigator XXI ship of such size is perfect for this type of work. The research of the Maritime University of Szczecin has stated that the method of verifying "ghost nets" that are invading

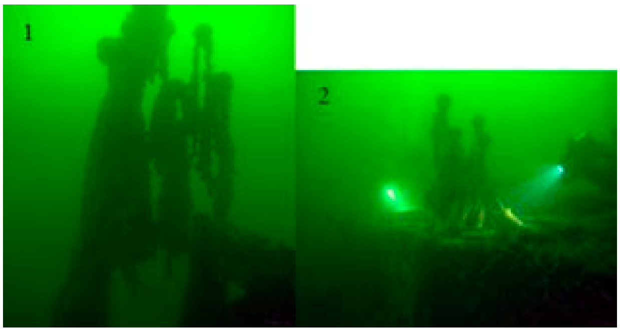

Figure 7. A fishing net hanging from the m/s Rugen wreck, taken by divers (Photo: Adamowicz Adrian)

wrecks and underwater objects using 2D sonar is effective and, when refining the details of sonar frequency, can be one of the most reliable methods in the world for this problem.

Retrieving DFG

The retrieval phase, when the DFG is retrieved, will follow the search phase. Recovery can either be carried out at a location where DFG has been found on the sea bottom or on a wreck. Since the recovery techniques vary between these two types of locations, they have been defined individually below. DFG recovery can either be carried out by the fishermen themselves or during organized recovery operations such as the MARELITT Baltic project.

When the ghost nets are lying on the sea bottom, most MARELITT Baltic partners use a creeper (Figure 1) to pull the DFG on board, either manually or with a winch. However, when using a winch, the creeper that was used during the search can be damaged and thus another device, such as an anchor or a hook, will be used instead. Polish fishermen use a gentle recovery method for MARELITT Baltic to avoid any possible damage to the DFG.

With a creeper or an anchor, the fishermen perform the retrieval and load the nets manually. Through this method, they can control the recovery method and the power of the recovery method to minimize damage to the fishing gear. The fishing gear is very expensive, which is why they want to minimize the damage to the nets.

When DFG is recovered from a wreck, a professional diving team performs the recovery manually. To minimize the risks of damaging the wreck, the DFG is carefully disentangled using a knife or saw. Once parts of the DFG are loose, airbags of various sizes are connected to lift the DFG from the wreck and up to the surface. When all of the DFG has been detached from the wreck, the DFG floats to the surface and can be picked up by the vessel's staff (Figure 8).

Figure 8. Retrieving ghost nets (Photo: Pawłowski Patryk)

Conclusions

In this article, a systematic solution for mitigating the problem of DFG has been presented using an example of a DFG wreck operation. The necessity of preparing a comprehensive plan has been clearly indicated. First, the proper recovery method should be chosen, taking into consideration the type of sea bottom as well as the available equipment and well skilled staff. It is also necessary to consider the impact of the operations being carried out on the natural environment. The impact evaluation shows that the effect of non-recovery of DFG is high for all of the evaluated habitats. Leaving the DFG where it is, entails both the introduction of marine litter into the marine environment and the potential impact of species extraction (ghost fishing). This means that, generally speaking, the advantages of recovering DFG on the sea bottom using MARELITT Baltic techniques outweigh the adverse effects of recovery activities for most of the assessed habitats. In other words, the activities of MARELITT Baltic DFG create net advantages for the marine environment.

The methods that are used for detecting DFG, consisting of sonar scanning and divers participating in confirming the existence of and recovering fishing gear, have some limitations. The main limitation is the depth to which the DFG was dropped. The resolution of the sonar decreases with increasing depth, also divers cannot dive to a depth greater than 70 meters with satisfactory efficiency and it is also not so safe for them to do so. However, taking into consideration the research area of the Baltic Sea, which is relatively shallow, the presented method will be satisfactory in most cases.

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