MARELITT Baltic

Interreg Baltic Sea Region

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Practical guidance

on DFG pre-processing

Marek Press, Keep the Estonian Sea Tidy
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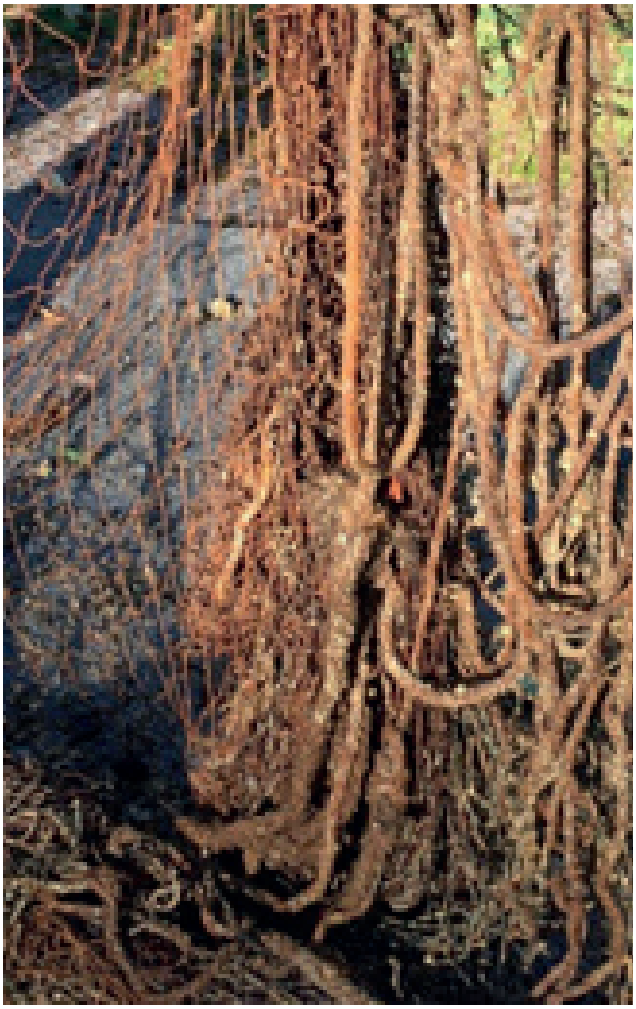

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Cover photo: Marek Press

Abstract

In the context of activity 4.4 of the MARELITT Baltic project, KEST has been involved in DFG (derelict fishing gear) sampling and pre-processing activities in selected ports in Sweden and Estonia.

The objective of the activity was to test practical DFG sorting, cleaning and preparation for re-use in a specific port environment.

To do so, KEST collected DFG material both in the course of activity 2.5 of the project (retrieval of DFG by dragging and collection of nets from shipwrecks with the aid of divers), and collected and pre-processed smaller quantities of abandoned fishing nets found in the course of coastal monitoring. KEST also accepted end-of-life fishing gear that were culled out by fishermen and removed from use.

Practical workshops were held at fishing ports in Sweden and in Estonia with the participation of Swedish, Estonian and German specialists.

The purpose of this brief report is to describe practical experimental work that was performed at ports in relation to DFG, and the techniques, work environment (work facilities and storage lots suitable for DFG collection) tools, assistive equipment and accessories necessary for cleaning DFG and preparing DFG for recycling.

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1. Background

DFG is waste that is generated in the tens of thousands of tonnes each year. Part of the DFG material is retrieved and deposited in landfills. A smaller part of the material is sent to incineration with energy recovery. Still, a very large percentage of DFG ends up despoiling the world's oceans and inland bodies of water. According to EUNOMIA, a consultancy, the total accumulated stock of debris in the EEA may be in the order of 130,000 to 550,000 tonnes from the fishing industry and 95,000 to 655,000 tonnes from aquaculture. *EUNOMIA (2016) Study to support the development of measures to combat a range of marine litter sources, pp.162-164.*

To this point, there are no cost-effective and environmentally friendly recycling streams and paths for DFG. What makes the large-scale recovery of DFG complicated is the fact that DFG is not homogenous – it consists of different materials such as various types of plastics/polymers, rubber, steel and cellular plastic. DFG is often soiled and slime-covered, contaminated with organic waste and mud, sediments and rock. In some cases, the material may be contaminated with heavy metal compounds.

At present, industrial cleaning and pre-sorting of DFG is hardly existing at all. DFG collection is mainly project-based, thus it is not possible to guarantee a regular influx of raw DFG into a dedicated waste management stream. Without a regular influx and sufficiently high material quantities, it would not be economically expedient for a business to invest in expensive DFG treatment equipment. It is also hard to market raw polymers made from DFG and cleaned and converted to plastic pellets because "virgin" plastics made from petroleum are more competitive in terms of price and purity than DFG-sourced material. Market regulators and legislators should change the situation by imposing taxes and additional obligations – forgoing recycling of plastics and continuing the exploitation of petroleum resources is not a reasonable sustainable approach from the standpoint of climate and environmental conservation.

To create additional interest in the large-scale separate collection and industrial recycling of DFG, it will be necessary to develop cost-effective pre-processing and sorting methods. These will inevitably also involve practical manual operations at ports or waste collection and processing centres.

2. Results

2.1 Planning

The first step is to plan the work and coordinate the planned activities with related parties. Think carefully about what type of material you need to clean and sort, in what quantities and what times? Where will you do this and what employees do you need to find for this purpose? What kind of work conditions and tools and equipment do you need for performing practical work? Do you have the (potential) necessary approval from facility owners and neighbours for use of tools, work facilities and outdoor lots? The planned work may result in noise, odour, mud, dust and spray. Incorrect storage methods may cause odour, putrefaction and fermentation of organic materials, which could attract vermin.

What are the potential threats and risks that could arise in the work process, and what are the necessary precautionary measures to minimize these risks? Will it be necessary to procure safety and protection equipment and first aid supplies? What will be done with the dirt, mud, organic and mineral waste generated in the course of the work, which could make its way into pipes and sewerage systems or natural bodies of water unless separately collected? Do you have the knowledge and skills for documenting the work? How and where will cleaned and sorted material grades be stored so that they do not become intermingled again?

2.2 Work environment and guidance provided to employees

The second important step before practical work can be launched is the preparation of the work facility. Consideration should be given to whether the work facilities have sufficient utilities (are they in working order, what are their technical specifications) – power and water connections, sewerage system, ventilation and lighting. Find out where clothing can be changed and soiled clothing later washed and dried. Do you have the option of taking a hot shower after work? If there are no suitable dressing, washing, toilet and break rooms in the location where the work is performed, it may prove necessary to lease them as mobile shelters.

If you wish to document the course of the work using an online database, make sure you have an internet connection.

What is the rating of the main circuit breaker? Is there a three-phase electrical connection that allows a 400V “industrial” mains power to be used. Is the electrical panel built with RCBO and is the installation properly earthed? *RCBO stands for "Residual current operated Circuit Breaker with*

Overcurrent protection". Remember that stationary electrical installations such as additional power sockets and cables may only be performed by an electrician with the relevant professional certificate. This is particularly important because the work is carried out with wet materials and pressure washers, increasing health risk through electricity.

Do you need extension cords to supply current to powered devices? What type of electrical sockets and plugs do you have? Do you need adapters for establishing an electrical connection? The power and extension cords for removable electrical devices must be made of mechanically durable rubber material. The extension cord must be spray-proof and waterproof and be earthed, and its electrical sockets and plug must have the corresponding IP rating. The extension cord and especially the electrical socket must not be located in a place where water may pool.

If it is necessary to run an extension cord and/or hose over a forklift truck or crane loader crossing, the cord and the hose must be properly protected to keep it from being damaged by the weight of the vehicle.

Be sure to find out what protection class (IP code, sometimes also interpreted as Ingress Protection Rating code) of electrical equipment and electric-powered tools are permitted to be used in outdoor conditions and/or in an environment with high pressure water and dust. If you lack the necessary knowledge, consult a professional electrician.

Is the water pressure sufficient to supply the pressure washer? Do you need hose extensions and if so, what diameter and what connectors should they have? Are the floors and walls washable so that they can be cleaned of dirt and spray after the work is finished?

Does the room or outdoor work area have a sewerage catchpit that can be cleaned? Was the sewerage system built with a grease/sand/oil interceptor? Can entry of microplastic fibres into the marine environment be avoided?

Where can containers be installed for separate collection of waste and for collection of cleaned and sorted material grades? Where does the weighing and measurement of DFG take place?

Photograph (left): cutting work at indoors work area

Photograph (right): containers for storage of cleaned and sorted material

Can the loader/crane access the work areas directly, are the gates and doorways wide enough? Is the load bearing capacity of the floors enough so that a loader-crane can be manoeuvred in work areas?

If you are not familiar with the work areas and environment from before, it may take several hours or even days to check all of the above and get the equipment in working order. Thus, it is a good idea for the employers and employee(s) who are responsible for the work environment and work equipment to check all of this ahead of time before the start of cleaning and sorting operations. Then changes can be made in the work schedule or additional equipment procured or hired.
DFG often contains sharp and lacerating objects made of metal, glass, plastic or ceramic material. Thus, be sure that your footwear is suitable for performing such work. One should not be in a room or lot meant for cleaning DFG without protective footwear. Make sure no unauthorized persons or visitors find their way to the work facilities. Use safety markings and barriers if needed. *Photograph below: Wear rugged work boots when entering the work area.*

Photographs above: DFG often contains heavy and sharp objects made of metal.

In general, it would be a good idea for the work facility or outdoor lot where the work will be performed to be divided into zones for different

purposes already before starting work (such as holding area for uncleaned DFG, zone for working with pressurized water and/or air, zone for cutting and sorting cleaned DFG, and zone for temporary storage of cleaned and sorted material). The relevant zones and storage containers for the materials should be marked with spray-proof (plastic-laminated) signs or information displays printed on to PVC.

Don't forget that the initiators of the work are responsible for the organization of the work process including the machinery and tools and the safety and security measures arising from the nature of the work.

The precautionary measures necessary for compliance with the occupational healthcare requirements have to be adequately explained to the volunteers and professional workers before they start work. Already in the work planning phase, learn about the occupational health and safety requirements and prepare your employees and the work location so that the requirements in the regulations are complied with.

2.3 Documentation

Planning the work process, providing guidance and training to employees, and the work process itself must be documented based on the nature of the work and the quantities and composition of materials. This assumes that the relevant documentation forms/templates are prepared in advance.

At an early stage, think through what is the nature of your work, and how you will perform it and with whom you will perform it. It may determine whether you prefer to document your work in hard copy, on computer or in an online database. Not all ports and waste processing centres have a power socket and WiFi in suitable places, and one should also take into consideration dust, spray and precipitation that may damage your computer. If reports are filled in hard copy, forms have to be printed out in sufficient quantity before work is started. If the documentation is drawn up immediately in the computer program or online database, make sure that the computer is protected from spray and dust and that it has the power supply and, if needed, internet connection.

When documenting the work process, at least the following data should be provided:

1. Quantities and composition of DFG material. Describe the DFG material received, its mass, length and other indicators you have at hand. What items does the DFG consist of (such as gillnets, trawls, longlines, trap-nets, trap-boxes).

2. What methodology and techniques were used (brief description of what was done)?

3. The result achieved (amount of pre-processed material by various grades and categories of material).

4. Potential deviations or other comments and findings about the work process.

5. The amount of waste generated and what was done with it.

6. What were the resources used for the work (number of hours worked, cost of workforce, cost of equipment and facility hire, cost of fuel and utilities etc.)

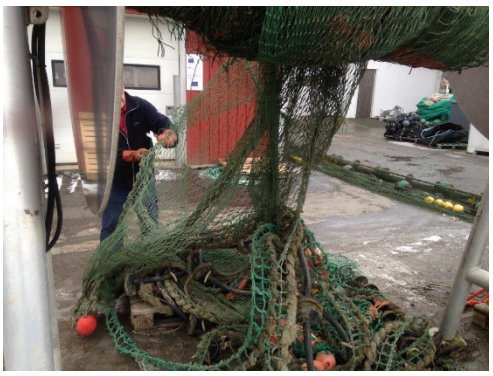
2.4 Practical work

Transport and logistics – transporting DFG from temporary storage location in a port or waste handling centre to the place where the pre-processing work will be performed.

Think it through – if DFG has been collected into large hooklift container or standard ISO containers or approx. 1 m³ big-bags, you will probably need a hooklift truck, crane loader or forklift to transport the containers along with the DFG to the work location, as they may weigh hundreds of kilograms or even several tonnes.

Photographs above: At the workshop in the Port of Sandhamn (Karlskrona), the project team was aided by the harbourmaster's forklift that was used to transport big-bags full of DFG from the temporary storage location to the work area.

The next step is removal of the material from the collection container or bag. Here a forklift can also come in handy as a tangled mass of DFG can be quite hard to untangle by hand. The work is made difficult by the presence of the metal objects such as anchors or cable/wire in the DFG.



Photographs above: During the workshop at the Port of Smögen (FF Norden), the project team used an electric net roller for raising the DFG material to a suitable work height.

As the material is often heavy and it will take the employees/volunteers several hours to clean the nets, it is in the interest of the health of the employees and volunteers and the efficiency of the work to keep the techniques and movements as comfortable and ergonomic as possible. For this purpose, the material must be anchored at one end and raised to a comfortable height for the worker.

Photograph 3. At the Port of Sandhamn, a forklift lifted the DFG material out of the big-bags.

During the FF Norden workshop at the port of Smögen and at the port of Miiduranna, it was additionally possible to use an electrical compressor to clean the nets with pressurized air. The best technique for cleaning depends on the specific material being cleaned. Use of a compressor requires a power connection, while the pressure washer requires both power connection and a water supply.

Photograph (above): Electrical compressor

Photographs above: As work was performed at the Port of Sandhamn and the Port of Miiduranna, the project team used a water pressure washer to clean the DFG.

If there is no electrical connection or water supply in the work location, trampling on the nets (wearing protective footwear) on a hard-surfaced floor may also be useful for cleaning dry nets. The dried mud, sand and other encrustations and shells will also crumble off in this manner. It should be kept in mind that one must wear rugged work boots with unyielding soles so as not to injure one's feet and achieve the best cleaning effect.

Photographs above: If there is no electrical connection or water supply, trampling on this type of nets on a hard-surfaced floor may also remove dried mud, sand and other encrustations.

2.4.1 Cutting DFG to separate it into different material categories

Various types of cutting tools will be used depending on the DFG material: knives, pincers, scissors and guillotine.

In the case of lighter monofilament fishing gear, cutting work may prove successful using small, light and sharp knives. The best result comes from use of knives with slightly serrated blades (sometimes referred to as tomato cutting knives).

However, DFG can consist of heavy trawls, which in turn consist of thick steel cables, rope mainly made of synthetics (reinforced with steel wire), floats and rockhoppers, roller gear, chains and other types of sweeps used on the footropes of trawls.

An industrial-quality guillotine cutter or mechanical pincers may be required to separate such items and pieces from each other or to break down into pieces a trawl 20 or more metres long.

At the workshops carried out, the project team experimented with different knives and scissors for cutting DFG. The photographs below show some of the tools used for cutting. It can be said that there is no universal tool equally well suited for cutting all materials and for use by all workers. One worker will see the best performance in cutting material using one tool or a combination of tools, while another worker might excel with a different set of tools and different techniques. The best solutions are achieved by way of trial and error, testing and experimentation. And please remember, always use proper protective gear based on the nature of the job, such as protective goggles, protective gloves, ruggedized boots, dust masks etc.

Photograph above: A set of tools used for cleaning, cutting and documentation.

Photograph above: A hooked blade cutter works well for the initial dismantling of some types of entangled DFG

Based on the project team's experience to this point, a relatively short ca 8 cm long, narrow (11 mm) serrated or wavy edge blade with a polypropylene (PP) handle (paring and tomato knife) can be recommended.

Photograph above. A knife with a serrated blade (sometimes referred to as tomato cutting knife).

Photograph above: A diver´s knife with the serrated blade.

A wavy edge (serrated blade) diver's knife can also yield good results in cutting DFG but in general such knives have a longer, wider and thicker blade that restricts handling, mobility and cutting speed. The advantage is that such a knife allows greater force to be applied.

One must consider that knives are blunted quickly when cutting DFG and must be sharpened frequently, otherwise cutting speed and the efficiency of the whole work will decline. That is why a relatively cheap "tomato knife" with a small narrow blade is a better choice than a pricier broad-bladed diver's knife.

It is easier to control and direct a tomato knife and it can be poked into smaller holes, tangles and connections. The knife blade we used was made of quality stainless steel and the knife stayed sharp and retained its cutting quality for a relatively long time, although it should be considered that without sharpening the knife it will have to be swapped off for a shaper blade a couple times during a day of work. That is why one should consider that every employee who is engaged in cutting should have 2-3 new or sharpened knives in reserve.

2.4.2 Sorting of cleaned and excised material into different categories and grades of material

Cleaned and excised material is sorted based on the future purpose of use of the material into different categories and grades of material. Containers and/or bags for different materials should definitely be marked properly to simplify their later storage and handling and forwarding to the correct destination (recycling or processing facility).

At the least, the marking should include the following information:

- type of material,
- dimensions (length, diameter),
- quantity (kg, number of pieces),
- storage start date,

- storage instructions and instructions on further routing.

To facilitate the marking work and later recognition, different colour codes and/or alphanumeric combinations with a specific meaning could be used.

Photograph above: Light polypropylene woven bags and a digital crane scale were used for weighing of cleaned and sorted material.

2.4.3 Coordinating the work process, interaction and cooperation with waste companies and recycling plants

Regional coordination of cooperation with fishing harbours and neighbouring local government units as well as the regional coordination of the DFG collection processes helps to overcome the problems and concerns related to funding for such actions.

The experience in organizing DFG pre-processing to this point shows that the cost of transporting and the cost of manual cutting and sorting are the biggest expenses and that they cause problems in establishing an economically sustainable recycling system and keeping it running (as the material processing might not yield major revenue even after extensive sorting of waste fractions). As a rule, external financing sources will have to be found to cover transport and manual cutting and sorting expenses. The new EU guidelines call for adoption of extended producer responsibility or other ways of raising the funds necessary for handling DFG. This requires regional and nationwide cooperation and harmonization and updating of legislation.

3. Conclusions

3.1 Planning and coordination

3.1.1 Lessons learned

DFG collection actions may not necessarily always yield the desired outcome. Even with good planning, retrieval in a hot spot area may not have the desired result (DFG is not found or is found in only very small quantity). There may be many reasons for this: Perhaps the wrong coordinates were obtained from fishermen or waves and currents have swept the DFG from the identified and mapped on a nautical chart area. Equipment may prove insufficient, DFG material may break/fall apart and it is not possible to raise the DFG from the sea on to the ship. Weather conditions at sea may change quickly and prove unsuitable for performing retrieval work. Equipment may be a point of failure (malfunctions, downtime), people may face obstacles preventing them from participating in the retrieval work (urgent activities, illness) etc. That means that even with very good, long-range and thorough planning, it is not known when, in what quantities and what type of DFG will be found, removed from the sea and transported to port.

Conclusion: These sorts of undefined properties make it more difficult to find suitable work areas, equipment and employees and complicates planning of the pre-processing work.

Recommendation: Always reserve sufficient time (a so-called buffer time) between retrieval and pre-processing so that you could possess enough information about the quantities and other properties of the material to be pre-processed. This information is important to adequately prepare the necessary work areas, equipment and tools and workers needed for the work.

3.1.2 Lessons learned

DFG material is not homogenous, and can contain any type of marine litter, organic waste, sharp and cutting objects, heavy metals, rocks and mud.

Conclusion: P*re-processing of DFG requires the initiators and employees to be well trained and have sufficient foreknowledge of potential hazards related to cleaning of DFG and the further handling of the material. The hazards may be direct (e.g. cutting objects, toxic substances) or indirect, such as potential hazards that are related to the equipment and tools used.*

Recommendation: It is advisable to conduct, after the first examination of the DFG material and prior to commencing practical pre-processing, a hazard and risk analysis to identify potential risks. This type of risk analysis assists in training

employees, designing and establishing a suitable work environment, procuring necessary tools and equipment, optimizing the work process, suitable storage of waste and much else.

3.2 Work environment, tools, safety, training of employees

3.2.1 Lessons learned

Damp or wet raw DFG has a high mass (it is heavy). Often DFG contains stones, sand and metal objects. The DFG may be knotted and matted.

Conclusion: If you have amassed a large quantity of DFG for pre-processing and it is stored in big bags or waste containers, it is highly likely that you will need equipment to move and lift the DFG such as forklifts and/or cranes.

Recommendation: Do not try to move heavy DFG containers/receptacles and retrieve the DFG from within without the necessary technical equipment. Find suitable forklift and cranes and employees with the relevant training who know how to operate the machinery for facilitating the work and ensuring the safety requirements.

3.2.2 Lessons learned

DFG often contains sharp, lacerating objects that may be made of metal, glass, plastic, ceramic material or the like. DFG also contains sand, stones and organic waste, removal of which may require a pressure washer or compressor (pressurized air). Use of the latter may dislodge dirt in the form of flying particles and spray.

Conclusion: Removal of sharp, lacerating objects from the bulk of the DFG generally requires a significant amount of manual work. Without proper protective gear, employees run the risk of injuring themselves. If a pressure washer or compressor (pressurized air) is used for cleaning the dirt may dislodge in the form of flying particles and spray, which can injure the eyes and airways.

Recommendation: Always use proper protective gear based on the nature of the job, such as protective goggles, protective gloves, ruggedized boots, dust masks etc. One should not be present in rooms or lots meant for pre-processing of DFG unless wearing protective footwear. Make sure unauthorized people or visitors do not wander into the work areas. Use safety markings and barriers as well if needed. It should be determined during the risk assessment what sort of gear you need precisely

3.2.3 Lessons learned

Pre-processing of DFG includes several work operations of varying natures. During the work, the material needs to be cleaned and sorted by categories of material.

Conclusion: Cleaning, sorting and temporary storage of DFG cannot be performed on a small enclosed territory or small enclosed room, because otherwise the already cleaned material will become soiled again from the unprocessed material. Materials that have already been separated/sorted may become mixed up again.

Recommendation: Prior to commencing work, divide the work area or outdoor lot into work zones with different functions. Mark the respective zones and material storage containers with splash-proof signs or information boards printed on to PVC. Make sure unauthorized people or visitors are not present in the work areas. Use safety markings and barriers as well if needed.

3.3 Re-use

3.3.1 Lessons learned

In some cases, DFG contains items and components of fishing gear that can be re-used and which it is easy for fishermen (performing the retrieval work) to separate from the rest of the DFG aboard ship or immediately after landing of DFG in the port (such as anchors, buoys, floats, chains, cables and sinklines). Fishermen have the best knowledge of the structure of their fishing gear and can evaluate which items suitable for re-use can be separated from other DFG.

Conclusion: Separation of items suitable for re-use from DFG aboard ship or immediately after transport to port contributes to re-use of waste items (which is in a high position in the waste hierarchy) and reduces significantly the expenditures on subsequent storage, transport and pre-processing of DFG.

Recommendation: Reach agreement with fishermen performing DFG retrieval to ensure that they will separate objects for re-use from other DFG on board ship or immediately after it reaches port.

Photographs above: Examples of high-quality re-use of DFG items. Floats and float-lines were separated from other DFG during the workshop at the Port of Sandhamn.

3.4 Cutting

3.4.1 Lessons learned

The experience gained during practical workshops show that the most time-consuming pre-processing operation is cutting of DFG using different equipment and tools.

Conclusion: Although possessing prior experience is of great value for performing efficient cutting work, the most effective combination of employees, technique and tools becomes evident in the course of testing and experimentation.

Recommendation: Don't be afraid of experimenting. The trial and error method may be the only suitable approach for determining a truly effective cutting method.

3.5 Evaluation

3.5.1 Lessons learned

Cleaning and pre-processing of DFG requires practical manual work on which much time and man-hours have to be spent. Renting and furnishing work areas, procuring necessary tools, training of employees and compliance with work safety requirements all involve significant costs.

Conclusion: Your expenditures on pre-processing of DFG may prove greater than you had originally planned.

Recommendation: To remain within the approved budget, perform budgetary compliance regularly. Evaluate and analyse your rolling expenses related to DFG pre-processing and adjust your budget and the planned work based on your possibilities and needs. Budgetary analysis is of aid in detailed planning and budgeting of future pre-processing operations.

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Derelict fishing gear (DFG) is addressed worldwide as a source of marine litter with extensive hazardous effects on the marine ecosystem. From 5.500 to 10.000 gillnets and trawl nets are lost every year and despite intense media focus – the problem is poorly known in the fisheries industry and among politicians.

The MARELITT Baltic project is one of the first transnational initiatives in the world to provide an operation oriented all-in-one solution for how to approach DFG. It will turn a diffuse problem into a clear and apprehensible topic that can contribute to an enhanced international readiness to act.

The project is divided into five work packages (WP), where package 2, 3 and 4 are the major parts concerning the cleaning, prevention and recycling of lost fishing gear.

Cleaning the sea and planning future action at sea
The aim of WP 2 is to plan and execute DFG retrievals in Sweden, Estonia, Poland and Germany both on the seafloor and wrecks. The activities will be based on methodologies and techniques tested in earlier national projects. These experiences will contribute to a common methodology which is crucial given the extreme hydrographic and morphological variation in the Baltic Sea. The new operation platform will make cleaning operations both transparent and demonstrate if the task is physically possible.

Responsible fisheries prevention scheme
The aim of WP 3 is to develop an overall approach to mitigate the problem of lost fishing gear in the future. It can roughly be divided into three types of actions. Firstly, the project will increase knowledge on fishing technological and strategic changes over time and how these changes have influenced the evolution of gear loss. In the second step, the project will focus on the potential causes to why fishing gears are lost. The third category of action includes development of preventive methods such as gear marking technologies helping to track irresponsible fishermen or assisting responsible fishermen to locate lost gears.

Marine litter reception facilities and recycling
The aim of WP 4 is to identify the options for a safe and fully sustainable handling and recycling of the lost fishing gear in a circular approach. Within this work package the phase from reaching the harbour through cleaning, sorting, transport until processing of recycling of the nets will be dealt with. The work encloses a variety of approaches such as creating a knowledge baseline about the transnational status and capacities of harbours, waste handling systems and industries in the Baltic Sea countries.

Project partners

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