Prevent Ghost Fishing · Extraction program (2)

Protocol for the detection and extraction of Derelict Fishing Gear in the Mediterranean

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Title: **Protocol for the detection and extraction of derelict fishing gear in the Mediterranean**

Direcció General de Política Marítima i Pesca Sostenible
Web: http://agricultura.gencat.cat

1st edition: November 2017
2nd edition: August 2020
3rd edition: November 2021

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If making total or partial use of this document, cite as:

> Hereu, B., Ortega, J. & Ylla, J., 2021. Protocol for the detection and extraction of derelict fishing gear in the Mediterranean. Direcció General de Política Marítima i Pesca Sostenible, Generalitat de Catalunya i Universitat de Barcelona. 38 pp.

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Protocol for the detection and extraction of derelict fishing gear in the Mediterranean

1. Introduction

Derelict fishing gear (DFG) has become a growing problem affecting the conservation and sustainable use of marine ecosystems (Macfadyen et al., 2009). Globally, it is estimated that DFG accounts for approximately 10% of marine litter in volume (Macfadyen et al, 2009), and it is the main type of submerged marine debris (NOAA Marine Debris Program, 2015).

The recent use of synthetic materials, increased fishing, and the possibility of access to more distant or deeper areas as a consequence of technological development, as well as the use of gear in inappropriate areas due to declining catches, have all contributed to a significant increase in the amount of DFG and therefore its effects on marine ecosystems (Gilardi et al., 2010; Barbosa et al., 2020; Gilman et al., 2020).

DFG has substantial effects on marine species and habitats, as well as social impacts in terms of marine area use and management. Once it has been abandoned, DFG can continue to capture fish for a long time, very efficiently, without control, and without yielding any benefit from catches, a phenomenon is known as "ghost fishing" (Butler et al., 2018; Link et al., 2019). DFG can also have a significant erosive effect on benthic species and habitats, which are very sensitive to physical disturbances (Beneli et al., 2020; Donohue et al., 2001; FAO, 2010). In addition, it can alter the seabed as a consequence of removing structural species, exert a drowning effect on the bottom, and generate an accumulation of sediment that can cause anoxia (Hall et al., 2000; Levin et al., 2009). Furthermore, due to its composition, DFG represents a source of pollution and introduction of synthetic material into the food web, a problem that has become increasingly evident in recent years (Arthur et al., 2009; Hammer, Kraak, and Parsons, 2012; Gilman et al., 2020).

Another important effect of DFG, especially on the Mediterranean coast where significant use is made of the marine environment for recreational activities, is the risk it poses to navigation or aquatic activities, as well as constituting a visual impact —as submarine waste— on recreational activities (Macfadyen et al., 2009; FAO, 2010).

DFG is abandoned for a variety of reasons generally related to fishing method, operational or economic pressures, space constraints, or environmental conditions (Barbosa et al., 2020; Macfadyen et al., 2009). These reasons apply to all types of fishing, both recreational and professional:

- **Deliberate abandonment or non-retrieval.** The abandonment of fishing gear or rigging is associated with incorrect fishing practices. Illegal, unreported, or unregulated fishing is one cause, as the use of non-regulatory gear can lead fishermen to abandon it in an attempt to evade discovery. Another cause is the abandonment of gear or rigging when fishermen lack sufficient time to retrieve all the gear employed, or when recovery is very difficult, such as when the gear has become snagged to the bottom (Mac- Mullen et al., 2003; Santos et al. al., 2003).

- **Deliberate disposal of equipment at sea.** Deliberate disposal may be motivated by the excessive amount of gear displayed, potentially leading to its abandonment by fishermen for operational or economic reasons. In addition, the removal of old or damaged gear may entail added economic or logistical costs that might encourage fishermen to deliberately dispose of it at sea (Macfadyen et al., 2009; Masonpour et al., 2018).

- **Accidental loss.** There are several reasons for accidental loss of fishing gear, such as becoming entangled with other fishing gear (Santos et al., 2003; Antonelis, 2013), inadequate rigging or gear markers, especially on irregular or rocky bottoms (Macfadyen et al., 009), or extreme weather conditions or currents, which can detach the gear or drag it to rocky areas where it becomes snagged (Cho, 2009; Ayaz et al., 2010; FAO, 2010). Accidental loss is not desired by Fishermen, as this entails an economic loss corresponding to the value of the gear and work invested in its preparation and retrieval, in addition to the issue of leaving waste that can damage the ecosystems which provide their livelihood.

In the last decade, concern about the effects of DFG has increased considerably, and several international initiatives have addressed this issue (Macfadyen et al., 2009; Kuemlangan et al., 2011).

Since 2004, the United Nations General Assembly (UNGA) has explicitly recognized the problem of DFG and has issued a number of resolutions that have been adopted by a large number of international organizations, including the International Maritime Organization (IMO), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Program (UNEP), and regional fisheries management organizations (RFMOs). These guidelines include recommendations for Member States to identify, quantify, and reduce the impacts of ghost fishing mortality by including prevention as a goal in fisheries management plans, improving scientific information on the magnitude and causes of this source of mortality, and developing technology and programs for assessment and mitigation (e.g., Macfadyen et al., 2009; Gilman et al., 2016).

Other non-governmental organizations, such as the International Union for Conservation of Nature (IUCN), have also identified DFG as a global problem, and in recent years, various groups and associations have carried out DFG removal actions in various regions worldwide (Lively and Good, 2019; Richardson et al. 2019, Richardson et al., 2019).

At European level, several research projects funded by the European Union have focused on the study of this phenomenon, seeking tools to mitigate and extract DFG in deep-sea fisheries, or promoting specific measures to preserve and improve the ecological status of coastal rocky habitats (FANTARED II, 2001; Da Ros et al., 2016).

Thus, given all the negative effects of DFG and its socio-economic consequences, there is a need to take steps to reduce the loss or abandonment of fishing gear, to reduce its impact through removal campaigns, and to obtain information on its effects on marine ecosystems (Lively and Good, 2019; Richardson et al., 2019; Sullivan et al., 2019).

In the Mediterranean, DFG has been recognized as a problem of great concern. Despite the lack of information, this issue has been incorporated into the Barcelona Convention with specific measures to address it within the Regional Plan for the Management of Marine Garbage in the Mediterranean (UNEP / MAP IG.21 / 9).

It is estimated that professional fishing generates the largest amount of DFG, with loss rates of less than 1%; however, due to the lack of information it is not possible to accurately assess the relative importance of this threat (UNEP / MAP, 2015). Small-scale fisheries are very common throughout the Mediterranean basin, accounting for more than 20,000 vessels (http://firms.fao.org/firms/fishery/761/en). This type of fishing is concentrated in the most littoral and shallowest areas, often on rocky shores, where many fishing gear losses occur. Despite the abundance of DFG in coastal areas, there is very little information on its incidence or effects on marine species and habitats.

Most fishermen, skippers, and sailors are well aware of the damage and environmental impacts of DFG and are very cooperative in efforts to minimize these problems (MIO-ESCDE, 2015).

There are several management options for addressing the issue of DFG, including prevention, information, and good practice (Macfayden et al., 2009). However, once DFG is present on the seabed, removal programs are necessary.

At a theoretical level, several key aspects have been identified that must be taken into account in DFG removal programs: (i) information on the precise location of the DFG, (ii) the small area that can be covered in campaigns, (iii) the low efficiency of recovery, (iv) the time that DFG remains at sea, and (v) the cost (UNEP /

MAP, 2015). The experience gained over the years in the Prevent Ghost Fishing Project (2017-2021) indicates that these aspects are key to the viability and success of extraction programs.

The aim of the present document is to establish a protocol for the removal of DFG on the Catalan coast, through the coordination and participation of all parties involved (fishermen, public authorities, stakeholders, and users) in the different phases of detection, information collection, removal, and recycling.

Due to the high diversity of activities and uses of the Mediterranean coast, extraction programs must be designed as collaborative projects with the participation of all the sectors involved during the different phases.

The main objectives of this document are to:

- Adapt the DFG Extraction Program protocol for the Catalonian coast, based on the best available information and the experience of more than 5 years of extractions since the first edition.
- Reduce the amount and incidence of DFG on the Catalonian seabed.
- Guarantee the collection of structured information on the incidence, type, and amount of DFG in order to create a database to facilitate classification and analysis of the information obtained from extraction actions, as well as determination and quantification of the effects of DFG on marine species and benthic habitats.
- Contribute to establishing the bases for a DFG extraction protocol for the Mediterranean.
- Raise awareness about this problem in the diverse sectors involved through this and other, parallel projects.

The collection and analysis of information will serve to detect the main causes and effects of DFG, and will facilitate the design of possible management tools to minimize this phenomenon and its effects on marine ecosystems.

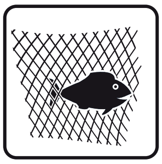
This program will not only allow us to reduce the amount of DFG on the Catalonian seabed, but will also enable us to avoid future impacts through rapid removal as soon as it appears and the design of possible mitigation measures derived from an analysis of the information obtained.

2. Impacts of derelict fishing gear on marine ecosystems

DFG not only has direct effects via ghost fishing, but can also have significant physical impacts on the species that make up benthic habitats. Furthermore, it exerts negative effects on socio-economic activities that take place at sea, because of the risks it poses to human activities and the loss of ecosystem quality and services that the sea provides.

2.1. Direct effects on fishing

Continuous capture of commercial and non-commercial species



Ghost fishing affects commercial and non-commercial species alike (Adey et al., 2008; Uhlmann and Broadhurst, 2013), wasting fishery resources and thus reducing the sustainability of fishing and economic opportunities in the fisheries sector. Ghost fishing especially affects long-lived species with low fertility, which present low resilience and are particularly sensitive to anthropogenic disturbances. These include seabirds (Good et al., 2009), turtles (Meager and Limpus, 2012; Gilman et al., 2016), marine mammals (Meager et al., 2012; Gilman et al., 2016), and long-lived fish including elasmobranchs, some of which are endangered, threatened, or protected species (Laist, 1997; Donohue et al., 2001; Filmalter et al., 2013).

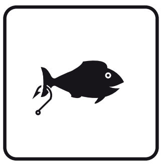
Ghost fishing is especially problematic when it involves gear such as gill nets, traps, pots, and other passive fishing gear, where the catch is based on the movement of the fish toward the fishing gear. This is the most commonly used type of gear in coastal and shallow areas, and it primarily targets species associated with rocky bottoms.

Snagged and abandoned gear, especially trammel nets, can continue to capture fish for many months, and does so very efficiently, as the trapped fish act as bait for other fish, which are in turn trapped, creating a feedback mechanism that persists for a long time and only ceases when the net eventually collapses to the bottom (FAO, 2010; Gilman et al., 2013; Link et al., 2019).

In addition, the structure of DFG itself attracts some species, increasing the concentration of organisms and consequently the efficiency of ghost fishing (Mac-Mullen et al., 2003).

Although no specific data are available due to the difficulty of quantifying this, overall, total catches as a result of ghost fishing are likely to be low compared to those of controlled fishing (Brown et al., 2007), but it has been estimated that ghost fishing may be responsible for a high percentage of bycatch worldwide (Gilman et al., 2016). Some studies have estimated that about 90% of the species caught in DFG are of commercial value (Al-Masroori et al., 2004), and that this can cause significant economic loss to fishermen. Others have estimated the loss of commercial species fishing in different areas as being between 1.5% and 5% (Sancho et al., 2003; Tschernij and Larsson, 2003) and up to 20% and 30% (Humborstad et al., 2003).

Injuries and sublethal effects on organisms



When interacting with DFG, some organisms may suffer sublethal effects, such as reduced mobility, which may compromise their ability to feed or escape from predators, or cause injuries with subsequent infections, which together or synergistically can eventually lead to death (Suuronen and Erickson, 2010; Gilman et al., 2013; Uhlmann and Broadhurst, 2013).

2.2. Physical impacts on the seabed

Erosive effects

Nets are usually snagged on rocky bottoms or are dragged to the coast where they collide with rocky bottoms. Once snagged, the movement of water caused by storms and currents drags them along the bottom, where they may catch on and uproot sessile organisms that live on the seabed (Donohue et al., 2001; Dieter et al., 2003; FAO, 2010; Capdevila et al., 2016). Seabed habitats (usually coralline, at the boundary between the rocky substrate and the sedimentary platform) host a large number of slow-growing organisms with a very fragile structure, such as calcareous algae, gorgonians, bryozoans, or arborescent algae, which are very sensitive to any physical disturbance and present very slow recovery times (Ballesteros et al., 2018; Beneli et al., 2020).

This effect is caused by passive fishing gear (e.g., nets, longlines, traps, and pots), but also and especially by active fishing gear, such as trawls or purse seine nets. Sport fishing gear, such lines and hooks, can also cause serious damage to benthic habitats, as they can become entangled with sessile organisms such as gorgonians, corals, algae, or others, causing them to suffocate or break (Beneli et al., 2020; Ballesteros et al., 2018).

Drowning

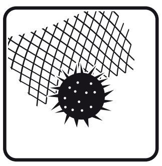
Large gear can bury habitats and / or species, crushing the species affected in the place where gear has been lost or abandoned (Hall et al., 2000; Macfadyen et al., 2009).

Moreover, the presence of DFG on the seafloor can change the microhabitat of benthic organisms, altering the hydrodynamic regime and increasing sediment accumulation, which can lead to hypoxia and may prevent buried species and / or habitats from performing the biological activities or physicochemical exchanges necessary for their survival (Levin et al., 2009).

2.3. Indirect effects on ecosystems

The side effects of fishing, and especially the indirect effects of DFG, are difficult to quantify due to the difficulty of identifying the most important factors responsible for mortality in organisms.

Habitat modification

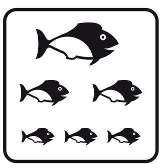


DFG may be deposited or can accumulate in critical or essential habitats, and this can affect the dynamics and survival of species and their populations. One or several phases of their life cycle may be affected as a result of disturbances to nursery or breeding areas, feeding areas, or migration routes (Gilman et al., 2021).

Accumulated DFG may also cause changes in food availability, either by reducing it or by providing unnatural food resources via the organisms trapped in or associated with DFG (Gilman et al., 2021).

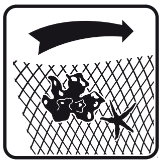
In the case of DFG that is floating adrift, this can lead to species aggregation in adjacent areas, thus altering their behavior, spatial distribution, diet, and ultimately their ability to survive (Gilman, 2011; Dagorn et al., 2013).

Pollution and bioaccumulation



It is estimated that DFG materials may persist in the marine environment for up to 600 years, depending on water conditions, the penetration of ultraviolet light, and the level of physical abrasion (Macfadyen et al., 2009). In addition, although the effect of fragments derived from the disintegration of DFG is unknown, the synthetic materials from which they are made include microplastics, toxins derived from fishing gear materials, and heavy metals such as lead used for sinkers. These all constitute a source of pollution and introduce synthetic materials into the marine ecosystem that can subsequently accumulate in the food web (Arthur et al., 2009; Hammer, Kraak, and Parsons, 2012; Gilman et al., 2016, Gilman et al., 2021).

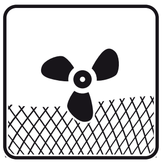
Vector for invasive species



DFG that has not sunk and remains floating adrift for a long time can accumulate a large number of organisms living on its structure, thus becoming a source of dispersal of invasive species that can have significant negative effects on marine ecosystems (FAO, 2010; Gilman et al., 2021).

2.4. Economic and social impacts

Effects on human safety



Because much leisure and tourism activity in coastal areas is related to the seabed, DFG can have a real or potential impact on safety in navigation and nautical and tourist activities in coastal areas and on the open sea. Floating DFG can become entangled with ships' propellors, causing damage and posing a risk to navigation and safety (FAO, 2010: Gilman et al., 2021). In addition, DFG on the seabed poses a potential risk to the safety of bathers and divers, who may interact with this debris.

Loss of quality and enjoyment of coastal areas

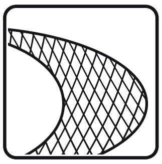
DFG also has social or other effects on activities such as tourism, either due to its negative effects on species and ecosystems or due to the visual effects of waste DFG. The enjoyment of nature, especially in coastal areas, is very highly valued by much of the population, and is a source of wealth via tourism. The presence of DFG can have a very negative impact on these activities, as users' perceptions of nature can be negatively affected by the presence of DFG (Gilman et al., 2021).

3. Types of fishing gear and their potential impact

Fishing gear comes in many distinct forms, is made from a variety of materials, and is used for different types of fishing. Consequently, DFG can interact differently with species and habitats and may have different impacts. In addition, the extraction technique for each type of gear will also be different depending on its particular characteristics. The most common types of fishing gear used in Mediterranean coastal areas are described below.

3.1. Nets

Trawling nets



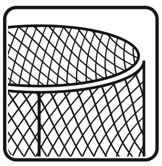
Trawling nets are shaped like a conical sack which ends with a narrow area where the trapped fish accumulate. Mesh size is variable, being larger on the side of the body and smaller on the side of the cod end. This net is dragged by a boat with two wires connecting each side of the net that, by means of two steel plate devices called doors, maintain the mouth of the net open while dragging on the bottom, thus trapping all the specimens in its path.

Dragging gear consists of the following devices, which can appear on the seabed: net, synthetic fiber ropes, steel cables, sinkers, steel chains, steel doors, steel shackles, and floats. Due to the high economic value of the gear, fishermen will usually make concerted efforts to retrieve it if it is lost.

The synthetic multifilament yarn used for trawls is larger in diameter than that used for passive and encircling fishing gear and can be detected by fish, which reduces the potential impact of ghost fishing. However, the major effect of this gear is erosion when snagged on a rocky seabed or carried by currents to coastal areas.

Impacts on marine ecosystems: *capture, injuries, erosion, drowning, habitat modification, bioaccumulation, dispersion, safety, enjoyment*.

Purse seine nets



Purse seine nets are made of thick wire with maximum dimensions of 300 meters in length and 80 meters in height, and are fitted with floats at the top and lead sinkers at the bottom. Purse seine fishing is usually performed at night and consists of detecting fish schools using sonar-type electronic equipment and then using the intense light of an auxiliary vessel —the light boat— to entice them to form a dense mass.

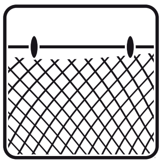
Once the fish have been attracted, the main boat wraps a net around them, which is then closed at the bottom, trapping the fish between the surface and the net. This system is used to catch oily fish and other commercial pelagic species.

Purse seine gear consists of the following devices that can appear on the seabed: net, synthetic fiber ropes, sinkers (cylindrical or conical) or a steel chain, steel rings or shackles, buoys or floats.

The nets are very heavy, made of thin thread but with very dense meshes, and when lost or abandoned they remain on the seafloor causing a significant impact due to erosion or drowning on rocky bottoms. Because of the fishing system involved and the high cost of the gear, it is not common to find it abandoned on the seafloor. However, if it has accidentally snagged on the bottom, fishermen will usually make a concerted effort to retrieve it, sometimes generating fragments which are left behind.

Impacts on marine ecosystems: *erosion, drowning, habitat modification, bioaccumulation, safety, enjoyment*.

Artisanal fishing nets



Unlike trawling and purse seine gear, where the fish are actively caught with a net, artisanal fishing gear is called passive gear because it is deposited in a fixed position on the seafloor for the fish to swim into and become trapped.

The gear consists of net sections with floats at the top and weights at the bottom, so that it is positioned perpendicular to the bottom. The size of smaller nets can vary, but they can be up to 5000 meters long and are usually up to 4 meters high, although exceptionally they can reach up to 30 meters in height. The size of the mesh also varies depending on the species to be caught or its size, but is always greater than 4 cm.

Gill nets consist of a single net which traps the fish by the gills, thus selecting the size and species of the catch via the size of the mesh.

Trammel nets consist of three layers of nylon netting mounted in the same section. The central net has a smaller mesh, while the outer ones have a much larger mesh, so that when the fish hit the central net they become trapped in the pockets of netting that form with the outer meshes. Trammel nets are usually shorter and narrower than gill nets.

Other fishing nets can be a cross between a gill and a trammel net. They are usually positioned so that the current lowers the top slightly; thus, fish swimming against the current are directed toward the net where they are caught or trapped by the gills.

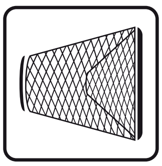
This gear consist of the following parts, which may appear on the seabed: nylon monofilament net, or synthetic multifilament fiber with various layers, synthetic fiber ropes, sinkers, weights or anchor to hold the net to the bottom, buoys or floats.

These types of fishing gear are normally used in shallow coastal areas, preferably near rocky areas. Consequently, they form one of the most commonly lost types of gear because they become snagged on the rock formations at the bottom.

Impacts on marine ecosystems: *capture, injuries, erosion, drowning, habitat modification, bioaccumulation, dispersion, safety, enjoyment*.

3.2. Shellfish gear

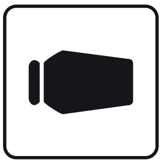
Traps



Traps are an example of passive fishing gear and, as in the case of smaller nets, they often become snagged on the bottom or lost due to adverse weather conditions. This gear consists of a rigid metal structure covered with plastic mesh. Shapes vary, but include one or more funnel-shaped entrances that make it very difficult for the prey to escape once it has entered attracted by bait. There are many types, sizes, and variants of traps, each adapted for the target species (e.g., fish, cuttlefish, shrimp, velvet crab, lobster, Norway lobster, and octopus). Traps basically include the following parts, which can appear on the seabed: synthetic fiber ropes, iron or wooden structures, lead, steel, or concrete ballasts, and plastic mesh of varying thicknesses and diameters. If lost or abandoned, these types of fishing gear can affect various commercial species, such as fish, crustaceans, or cephalopods (Butler et al., 2018; Lively & Good, 2019).

Impacts on marine ecosystems: *capture, injuries, erosion, drowning, bioaccumulation, safety, enjoyment*.

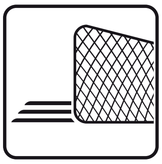
Pots



Pots are another type of passive fishing gear, and are mainly used to trap octopus. They consist of vase-shaped containers measuring about 40 cm long and 12 cm in diameter, and can be made of ceramic, plastic, or PVC. The traps are set in long lines of many units, which are deposited on the seabed. Octopuses seek refuge inside, refusing to leave even when the line is pulled out and onto the ship.

Impacts on marine ecosystems: erosion, bioaccumulation, safety, enjoyment.

Other shellfish gear



Shellfish cages. This technique involves dragging cages along sandy, shallow bottoms at very low speeds (a few meters per minute). Cages consisting of a metal structure with spikes and depressions underneath that create resistance against the sandy bottom are towed by a cable attached to an anchored boat, causing them to drag over the seabed and extract the bivalves buried in the substrate.

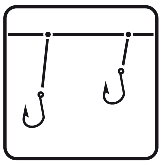
Chain rake. This gear is specifically used to catch spiny dye-murex, and consists of a net bag with a metal frame to open it. The bottom of the bag has a series of chains that hit the bottom and lift the spiny dye-murex by inserting it into the bag. This is a highly regulated type of fishing that is practiced in specific areas. In Catalonia it is currently only used in the Ebro delta area.

Impacts on marine ecosystems: *capture, injuries, erosion, drowning, bioaccumulation, safety, enjoyment*.

3.3. Angling gear

Used in both sport and professional fishing, angling gear uses natural or artificial bait to catch various species of fish when they bite the bait and become caught on the hook. There are many variants, including a single-line and hook device or several lines and hooks attached to a main mother line. Fishing lines have been observed to be especially harmful to branched species such as coral, as they easily become entangled (Beneli et al., 2020; Ballesteros et al., 2018; Yoshikawa et al., 2004).

Longlines



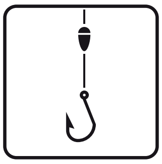
This is a form of professional passive fishing where a very long line called a “mother” is cast out, from which hang thinner lines up to 1.5 to 3 meters long at equal distances with a hook of the appropriate size for the species of fish to be caught.

There are several types of longline depending on the particular environment and target species. With bottom longlines, the mother and hooks are distributed along the bottom and are used to catch hake and other demersal species. There are also smaller bottom longlines that are generally used near the coast. In another type, weights and floats are distributed along the mother line, thus creating a vertical zigzag effect, and the hooks can catch various species of fish corresponding to a different range of depths.

In surface longlines, the mother and hooks are distributed on the sea surface and catch large species of pelagic fish that swim there during their migrations.

Impacts on marine ecosystems: *capture, injuries, erosion, bioaccumulation, safety, enjoyment*.

Recreational fishing

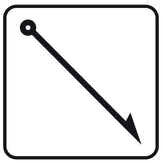


Recreational fishing gear consists mainly of a nylon filament with one or more hooks at one end baited with natural or artificial bait, and usually with a lead sinker that serves to maintain the hooks underwater. The hook can be held on or near the bottom, on the surface by a small float, oscillating vertically or horizontally in the water column, or can be dragged from a boat. There are a variety of filaments, hooks, baits, and sinkers. These techniques can be used to catch many species of fish, usually very selectively depending on the size of the hook and the type of bait.

The different types of recreational fishing gear basically consist of the following devices, which can appear on the seabed: nylon, plastic, or steel lines, sinkers or ballasts, rods, and hooks of very diverse thicknesses and lengths.

Impacts on marine ecosystems: *capture, injuries, erosion, bioaccumulation, safety, enjoyment*.

Other fishing techniques



Harpoon. The harpoon is a tool with a metal-tipped wooden, aluminum, or fiberglass shaft. The end may have a single metal tip, either straight or curved, or may be trident-shaped. These are used to catch species —usually cephalopods— either on foot along the coastline or when freediving without breathing equipment. Harpoons may also be used in addition to other fishing gear to bring caught fish to the boat and lift them on board.

Spear. Spearguns are used for recreational / sport fishing and are designed to easily catch the target species, mainly fish. Some are similar in appearance to a shotgun or rifle, and their operation is based on the projection of a harpoon or spear that passes through the prey, propelled by tensioned rubber bands or compressed air. The tip of the harpoon is equipped with beards or spikes that hold the prey when harpooned. Spearguns are usually made of aluminum, carbon fiber, and wood, while the harpoons are made of steel.

Both the harpoon and the materials used for firing and collection can become detached (accidentally or intentionally) and remain on the seabed.

Impacts on marine ecosystems: *erosion, bioaccumulation, safety, enjoyment*.

4. Detection and extraction of derelict fishing gear

As mentioned earlier, the aim of this document is to provide a protocol for the detection and extraction of derelict fishing gear (DFG), defined, in accordance with section 3 of this document, as all fishing gear used in sport or commercial fishing which, for whatever reason, is abandoned in the marine environment (see section 3).

The main purpose of this scientific-technical document is to reduce negative impacts on marine ecosystems and minimize the effects of fishing activity in the Mediterranean Sea. A further goal is to collect information to help assess the scope of the problem. Thus, in addition to specifying DFG removal procedures that cause least impact on the ecosystem, this document also outlines a procedure for reporting DFG and collecting information. The knowledge thus acquired will prove extremely useful for better, faster removal of DFG.

The protocol is also intended to ensure the involvement of all actors who interact with marine ecosystems and raise awareness about the problem of DFG as a means to reduce its negative effects.

To achieve these goals, DFG detection and removal must involve the participation of a range of actors:

- **Public authorities:** In Catalonia, the public authority responsible in matters of fishing and recreational maritime activities is the General Directorate of Maritime Policy and Sustainable Fisheries, a division of the Department of Climate Action, Food and Rural Agenda of the Generalitat de Catalunya (DGPMPS). This body is responsible for analyzing the advisability of extraction in consultation with the scientific community, and, where appropriate, for programming and participating in extraction in conjunction with underwater support teams.

In some instances, other local public authorities may also be involved, such as managers of Marine Protected Areas, councils, and others, as these can also contribute in all phases of this protocol.

- **Scientific community:** In Catalonia, researchers working on the project *Evitem la Pesca Fantasma* with the DGPMPS will be responsible for designing and updating this protocol, designing the methodology for collecting and storing information on detected DFG, and analyzing the advisability or not of removal.

The scientific community will also be responsible for diagnosing each removal action, including a description of the impacts on the affected habitats and species.

- **Fishing sector:** The participation of the professional fishing sector is a basic requirement for the long-term success of this initiative. First and foremost, this is necessary to prevent the loss of fishing gear or, in the event that it occurs, to ensure its rapid removal. Thus, reporting the loss of gear and its location will enable speedy recovery and minimization of damage. The sector's collaboration in extraction tasks will also contribute to the success of removal actions, thanks to its knowledge, logistical support, and awareness. The success of long-term collaboration of the sector is guaranteed by the fact that it does not imply any economic impact on fishermen.

- **Recreative divers, diving centers, non-profit organizations, and civil society in general:** The participation of people, entities, and companies in this project, by helping locate DFG, providing logistical support in extraction, and disseminating and raising awareness of the problem, is also essential in the fight against this problem and the conservation of marine ecosystems.

- **Public or private extraction teams:** Firefighters, underwater units of the security forces, rural agents, and underwater services companies, etc., will be responsible for carrying out underwater removal tasks. Such personnel must have sufficient training to safely carry out re-floating in an underwater environment, and the safety and equipment protocols established by current regulations must be followed. In addition, the specific tasks to be performed will be determined according to the criteria established by scientists and the public authorities.

In general terms, priority should be given to actions to remove abandoned fishing nets, given their potential impact on marine ecosystems, fisheries, and human safety. However, this protocol offers a series of recommendations for the extraction of any type of abandoned fishing gear in the marine ecosystem and provides information collection sheets so that any action carried out beyond the scope of those undertaken by the public authorities can contribute to improving knowledge on this issue.

Below, a description is given of the steps to take in extraction actions, from DFG detection to removal. Figure 1 below gives a summary of the actions of detection, information collection, analysis of the situation, action to minimize the impact of the DFG, and, where appropriate, correct waste management . These actions may be complemented by actions of inspection, impact assessment, and / or habitat restoration after completion of the actions.

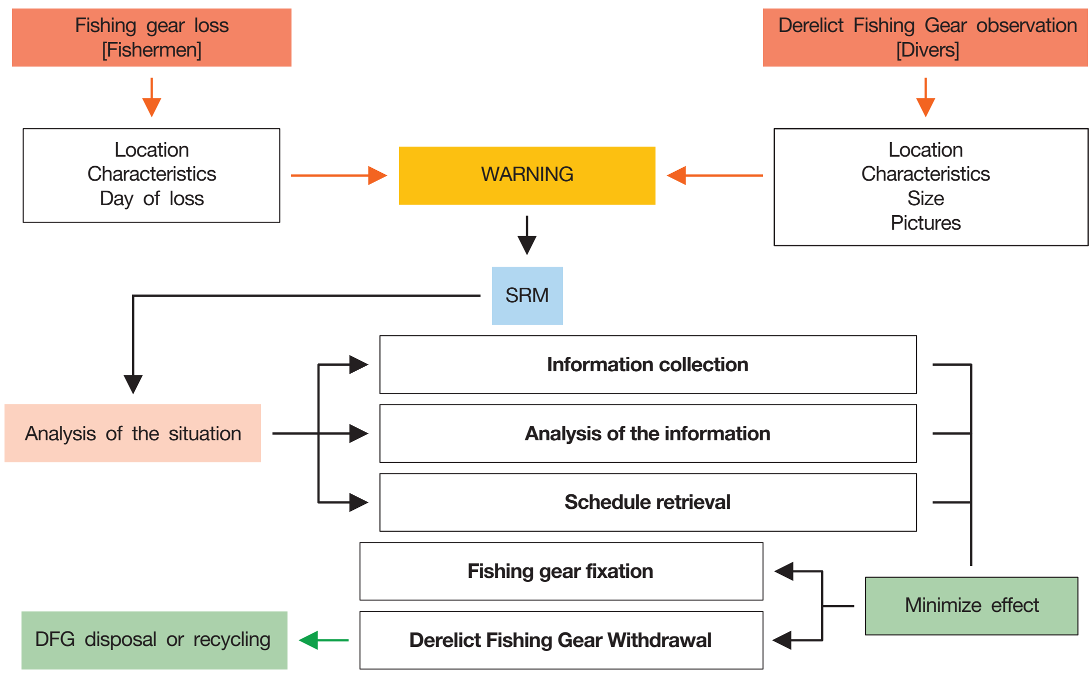


Figure 1. Summary of the protocol for detection and extraction of abandoned fishing gear.

4.1. Types of extraction action

Depending on the type of DFG, its condition, potential threat to species, habitats, and human safety, or other factors, different priorities may be established when carrying out DFG extraction actions. The urgency or not of these actions determines two strategies that can be applied as appropriate:

- **Periodic campaigns.** The most efficient way to use resources for effective DFG extraction is to conduct annual campaigns lasting several days, in which all DFG that has been sighted and located over a given period of time is extracted. This procedure yields better extraction efficiency because the DFG location is known in advance, enabling concentrated mobilization of resources and logistics and rapid removal of a large amount of DFG in a short period of time.

This procedure also minimizes the economic cost of extraction, but carries the risk that during the time elapsed between the first report and extraction, the DFG may have moved due to currents or weather conditions, rendering it difficult to pinpoint location. Furthermore, the impacts of DFG, such as ghost fishing, may accumulate over time until the DFG is removed.

- **Rapid response action.** Once a report of DFG has been received, extraction may be scheduled as soon as possible. Although this procedure is less cost-efficient, because only the located DFG is removed, the probability of finding it at the coordinates provided is greater and its negative effects are minimized because it remains less time on the seabed.

4.2. Observation and information collection

The first step in activating the DFG extraction protocol is a report of its loss by fishermen and / or detection by volunteer observers, especially divers. In both cases, it is necessary to gather all possible information about the DFG in order to properly assess how to proceed.

Useful information about the location and characteristics of the DFG, and the types of seabed on which it is located, as well as photographic material, is specified below. A form for collecting information on DFG location and characteristics is given in Annex 1. To activate the protocol, all this information must be sent to the project coordinators.

- **Name of the observer**

- **Observer contact**

- **Date of observation or loss**

- **Place of sighting:**

  ◦ Town / Area
  ◦ Coordinates: longitude and latitude

- **Depth**

- **Gear size:** Length, width, mesh size (maximum distance between knots and knots with the mesh stretched).

- **Type of DFG:**

Trammel net

Trawling net

Purse seine net

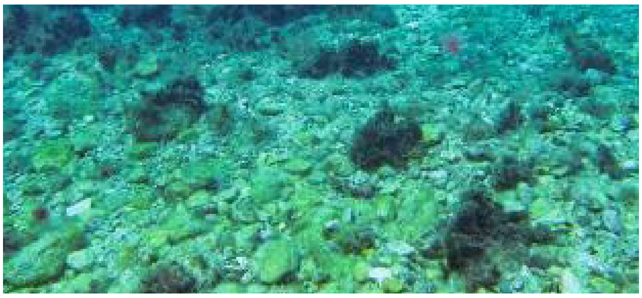
Trap


Hook and sinkers


Monofilament fishing lines

- Type of seabed on which the DFG is located (can be more than one):


Sand


Maerl or Rhodolith beds


Seagrass bed


Rocky


Coralligenous habitat

- Position on the seabed:

Loose on the bottom

Entangled at localized points

Very tangled at the bottom

Buried

- Other associated material:

- Sinkers
- Ropes
- Buoys
- Plastics
- Metallic elements
- Cement or rock

- **Risk:** Identify and specify any possible risk, whether posed by the DFG itself (in bathing or sailing areas, totally or partially afloat, etc.), or by its extraction (area of low visibility, currents, depth, etc.)

- **Trapped species:** If possible, determine if there are any trapped organisms (living or dead) and if identifiable, specify which species. If alive, specify them.

- Fish
- Lobsters or other crustaceans
- Hard or soft corals, *Gorgonia*
- Bryozoa
- Algae
- Other

- Coating by organisms:

Little or no coating

Coated by organisms

Coated by organisms and merged with the seabed

- **Photographic material:** Photographic material is very helpful as it enables a first diagnosis and facilitates DFG extraction planning. For optimal visualization, it is recommended to film or photograph the entire length of the gear in order to give information on size, position on the seabed, and degree of coating, as well as to identify the points where the DFG is attached to the bottom. A series of photographs or videos can also provide information on the aspects that will present most problems for DFG extraction.

- **Observations:** Any other information that may be of interest for DFG identification and extraction.

4.3. Analysis of intervention advisability, and possible contingencies

The scientists responsible, together with the public authorities, will examine the information received about DFG in order to determine the advisability and feasibility of its extraction. If the information received is insufficient to determine this, further information may be sought. To this end, the coordinators may contact the person who submitted the report and / or schedule an on-site inspection of the DFG. In the case of direct inspection, this will have the following objectives:

- To detect, identify, and document the DFG by means of photography and video.

- To evaluate its condition, degree of attachment, and fusion with the seabed, and design a procedure for its extraction.

- To ensure that disposal does not pose a risk to humans or the ecosystem.

Where appropriate, one of the researchers in the Avoid Ghost Fishing project will assist the extraction team in order to contribute to a detailed assessment of any protected or particularly interesting habitat or species.

The visual and written information collected will be used to conduct an analysis of the advisability of DFG extraction. Such extraction will only be carried out if the environmental benefits outweigh the inevitable damage caused to benthic habitats by extraction work and if extraction will not pose a threat to human safety. Certain considerations must be taken into account when assessing the advisability of extraction (Figure 2):

- Diver safety. Even in the best environmental conditions, DFG removal can be a very long and complicated operation for divers, especially if the DFG is large and entangled on the seabed. Protecting divers' health is always a priority, so DFG can only be removed if safety requirements are met. Therefore, in conditions of rough seas, strong currents (surface or bottom), or poor visibility, extraction will not be carried out.

- Extraction activities shall not compromise the conservation of marine organisms and habitats. If DFG extraction poses a risk to seabed organisms and habitats, and extraction might be more harmful than the effects of the DFG itself, it is recommended to leave it on the seabed.

To determine whether it is ecologically advisable to extract the DFG, the degree of coating by organisms and the degree of attachment to the seabed will be taken into account:

- Degree of attachment to the bottom. The DFG may be firmly attached to rocky bottoms or rigid structures. In these cases, given the difficulties posed by its extraction, consideration should be given to not extracting the DFG, or only partially extracting it. If the DFG (especially nets) has different sections, some of which are firmly attached to or snagged on the bottom while others are not, it is recommended to extract only the loosest sections by cutting the gear into pieces.

- Degree of coating by organisms. If the DFG is heavily coated by organisms (especially calcareous organisms), extraction may cause erosion, generating a serious, counterproductive impact on the bottom. In this case, it is recommended to leave the DFG on the bottom.

Depending on these parameters, the different characteristics of abandoned nets are as follows:

- DFG with little or no coating: Recently lost or abandoned nets on the seabed, in which the first species are beginning to appear but which are not attached to the substrate and are still loose. Filamentous or fast-growing algae, or hydrozoans are present on the DFG.

In these cases, total extraction of the DFG is recommended, where possible releasing the living organisms trapped in situ. Colonies of bryozoans or gorgonians that have been uprooted can be carefully removed for later transplantation following restoration protocols (Montero-Serra et al., 2018; Pagès-Escolà et al., 2020; Montseny et al., 2020).

- DFG coated by organisms: When nets or other DFG have been on the seabed for a long time, animals such as bryozoans, sponges, or mollusks, among others, begin to settle on the structure, using it as a substrate. Coating by erect or calcareous algae also increases. In these cases, it is recommended to totally or partially extract the DFG, where possible releasing the living organisms trapped in situ. Again, colonies of bryozoans or gorgonians that have been uprooted can be carefully removed for later transplantation following restoration protocols (Montero-Serra et al., 2018; Pagès-Escolà et al., 2020; Montseny et al., 2020).

- DFG heavily coated by organisms and fused to the bottom: When the DFG has been on the seabed for a very long time, it is colonized by animal species and calcareous algae such as *Mesophyllum expansum*, *Mesophyllum lichenoides*, or *Mesophyllum alternans*, which are characteristic of structurally complex communities, especially in coralligenous habitats (Linares et al., 2012). These are low-growing species, and with the passage of time they coat the DFG with solid calcified layers, which eventually fuse the DFG with the substrate. Consequently, their removal would involve habitat destruction. In these cases, it is recommended to cut the net in order to separate the fused parts from the loose parts.

It is also recommended not to forcibly separate the parts of the net that are coated with calcareous algae, as this is likely to damage the habitat. Therefore, only loose parts of the net that are not fused to the substrate should be removed so as not to damage the habitat.

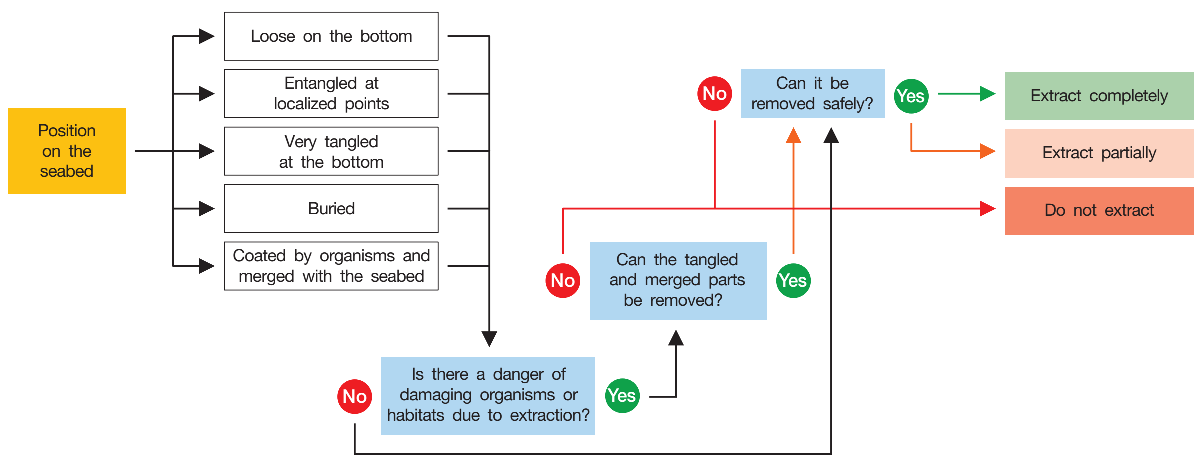


Figure 2. DFG extraction decision tree, according to degree of coating, fusion with the seabed, and extraction safety. Modified from Da Ros et al., 2016.

4.4. Removal of derelict fishing gear

Once the DFG has been characterized and extraction has been analyzed and deemed scientifically advisable and technically feasible, its negative impacts on the marine ecosystem shall be minimized by total or partial removal.

Under no circumstances should DFG be removed without a prior analysis of the situation and a finding that the benefits of removal outweigh the possible negative effects of the action.

4.4.1. Preliminary considerations

If the decision is made to remove the DFG, the procedure will vary depending on the type of fishing gear. However, it is necessary to bear in mind some preliminary considerations regarding removal actions:

- **Necessary training:** The removal of DFG consisting of nets may pose a risk to the people carrying out extraction operations. This task must only be carried out by divers with the necessary training and full logistics equipment.

- **Depth of operations:** The greater the depth, the lower the effective time of underwater work and, therefore, the higher the cost of the removal operation. In addition, the greater the depth of action, the greater the risk posed to divers.

- **Composition of underwater team:** The number of divers for each operation will depend on the characteristics of the DFG, and will be determined based on the information obtained previously. Note that an excessive number of divers is less efficient and can often lead to more risky situations.

Where the DFG to be extracted is large or difficult to remove, two or more teams of divers should be available to work in consecutive turns.

- **Composition of surface support team:** The surface support equipment for DFG extraction operations shall consist of at least one boat large enough to transport divers and the extracted material. Professional fishing vessels equipped with devices for the extraction of large, heavy nets may also be used. Experience has shown that the support of remotely operated vehicles (ROVs) during extraction and removal tasks greatly optimizes the operation, both in terms of determining the exact location of the DFG and facilitating an on-site diagnosis of the situation.

4.4.2. DFG removal procedure

1. **Prior inspection.** Once a report has been received, a first visual on-site inspection shall be carried out to pinpoint the exact location of the DFG and to collect the information necessary for safe extraction, such as DFG characteristics and size, minimum and maximum depths, position on the bottom, possible critical points where the DFG is anchored or buried, water transparency, currents, and other data that may be relevant to the extraction operation. It is important that this preliminary inspection is performed by the same people who will carry out the extraction.

At this stage, an ROV may be very useful since it will facilitate a survey of the working area to determine the exact location of the DFG by the all members of the extraction team. Thus, the use of an ROV can save on diving time, which is critical for the efficiency of extraction operations.

2. **Briefing.** Once the necessary information has been gathered in the preliminary inspection, a meeting shall be held with all members of the diving and scientific team to determine the extraction procedure. The plan for the extraction operation shall include aspects such as depth, extraction strategy, and contingency and safety plans, and tasks will be assigned to each team member.

3. **Extraction.** Depending on the type of DFG and its characteristics, different techniques must be used to release it from the bottom and bring it to the surface. These techniques are described below:

Traps and other small DFG

- The first step will be to determine if there are any fish, crustaceans, or other mobile animals trapped in the DFG, and release them. Checks shall also be made for sessile animals attached to the DFG or associated elements (ropes, cords, plastic mesh, etc.), and these should be disentangled with the help of scissors and a knife.

- All released species shall be recorded and added to a list of affected species for each DFG (Appendix 2).

- The DFG shall be released from the bottom and the remains of rope and other elements usually associated with traps and other small DFG shall be collected to form a compact bundle. The whole should then be detached from the bottom as carefully as possible to avoid damaging benthic organisms. This operation may require cutting parts of the traps or associated items with a knife or scissors.

- At this time, and if necessary, the trap and all associated elements should be tied together with short ropes so that the whole bundle is compact.

- The DFG should be extracted using air lift bags. The use of air lift bags requires some experience, and should be carried out with additional air equipment (not physically attached to the diver). First, it must be ensured that no person or vessel is near the extraction operation. The air lift bag should be securely fastened to the trap and associated elements so that it is as compact as possible. It should then be slowly inflated using the auxiliary regulator until the bundle attains a neutral weight. Once this has been achieved, the air lift bag should be further inflated slightly until it attains a negative weight and begins to float. At this point, the divers must retreat and let the air lift bag and trap rise to the surface. Note that due to the decrease in pressure, the air in the air lift bag will expand and the speed of rising will increase. It is also very important to make sure that the DFG or associated elements are not attached to the bottom, as otherwise these could detach suddenly, damaging the bottom or posing a threat to divers.

Line fishing remains

- Nylon fishing lines and hooks shall be removed manually, carefully disentangling lines so as to minimize erosion or breakage of affected elements.

- All released species shall be recorded on board and subsequently included in a list of affected species (Appendix 2).

- Line removal shall preferably be performed with the help of scissors, as these enable divers to cut the line without applying pressure or stretching (cutting a line with a knife will tauten it in one direction, which could damage entangled organisms). Knives should only be used when it is necessary to cut a thick rope or when the use of scissors is not feasible.

- The disentangled line shall be brought to the surface, together with hooks, sinkers, cables, and any other associated elements.

Fishing nets

Derelict fishing nets are usually attached to seabed organisms which may be damaged if the nets are removed simply by pulling on them. Consequently, these nets should be extracted in a controlled manner so as to minimize any impact on the seabed, in addition to recovering and restoring as many trapped or damaged species as possible.

- Living trapped organisms should be removed and released. The filaments of the nets to which the organisms are attached should be cut with scissors, since these allow divers to cut the line without applying pressure or stretching it (cutting a line with a knife will tauten it in one direction, which could damage entangled organisms).

- All released species shall be recorded on board and subsequently included in a list of affected species (Appendix 2).

- Dead organisms or uprooted sessile organisms should be left in the net and taken to the surface.

- If some sections of the fishing net are very entangled at the bottom, impeding removal, these should be cut. First, the thicker supporting ropes should be cut with a knife, and then the mesh should be cut with scissors. The sections of the net that are entangled should be left at the bottom, ensuring that these are as small as possible and will not lead to ghost fishing or move and damage the seabed.

- Fishing net extraction requires the use of air lift bags, which in turn requires some experience and should be performed with additional air equipment (not physically attached to the diver).

Various techniques can be used for fishing net extraction, depending on net characteristics and position on the seabed.

Compaction. The fishing net should be disentangled, freeing non-uprooted sessile organisms. To do this, the net shall be removed manually, using scissors to cut sections of net or thread that may be attached to organisms such as gorgonians, coral, bryozoans, or algae. Knives should only be used when a thick rope must be cut or when the use of scissors is not feasible.

- In the case of large nets, once all live organisms have been released and the net has been disentangled from the seabed, the DFG should be compacted by tying it transversely with short ropes, zip-ties, or ribbons at regular intervals determined by the size and length of the net.

- The air lift bags should then be positioned in place. The number and size of these will depend on the size and length of the net. For small and/or lightweight nets, one air lift bag should be placed at one end, whereas for large and/or heavy nets, several air lift bags should be placed at regular intervals to keep the net afloat.

- The air lift bags should be slowly inflated until attaining a neutral weight, and then further inflated slightly at one end until they attain a slightly positive weight and begin to float, pulling the net to the surface. At this point, divers must retreat and let the air lift bags and net rise to the surface.

- It is important to make sure that the net and any associated elements are not entangled on the seabed, as otherwise the net could detach suddenly, which could damage the seabed or pose a threat to divers.

- If a section of the net is attached to the seabed and prevents the bundle from rising to the surface, it should be disentangled manually or with the help of scissors and a knife to cut the necessary elements.

Disentangling. If part of a net is free in the water column and another is attached to a rock, one air lift bag should be attached near the first anchoring point. This air lift bag should be inflated slowly until it exerts a gentle force on the anchored part of the net. The diver should then unhook and release the net from the bottom using scissors or a knife, taking care not to uproot trapped sessile species. As the net is released, further air lift bags must be added to compensate for the weight of the released net. To facilitate this task, sections of released net that have reached the surface can be cut.

4. **Lifting on board.** Once at the surface, the fishing net can be hoisted on board. If the net is small, this operation can be performed manually. Alternatively, if the net is large and heavy, the support of a vessel with machinery for hoisting nets will be required, such as a professional fishing boat.

5. **Final Briefing.** Once the extraction operation has been completed, all team members should participate in a final meeting to pool and review extraction information, including diving time, depth, amount of DFG extracted, possible unforeseen problems, currents, environmental conditions, and visibility, as well as information on the species trapped and released, habitats, and seabed characteristics, or any other relevant information. All this information can be used for future extractions.

4.4.3. Main dangers of DFG extraction

The safety of divers and personnel involved in DFG extraction actions must be a priority. Some of the problems that can arise during extraction operations are listed below. In the event of any incident, the work should be stopped and the divers should return to the surface.

Entanglement

Whether extracting traps, lines, nets, or other materials, the main risk of an intervention is to become trapped by an element, which could be the DFG itself, the associated ropes or lines, or the materials used for extraction. Such elements may become attached to the diver's body or to an element of their equipment (e.g., manometer, regulator, or bottle tap).

- All the elements on the seabed must be monitored and located at all times, maintaining an appropriate safety distance (especially in conditions of poor visibility).
- Each diver must have a sharp implement that can be used with one hand and is accessible to both hands (scissors, knife, etc.).
- Carrying hanging objects (e.g., regulators or manometer) should be avoided and possible points of attachment should be limited as much as possible.
- One diver responsible for safety who is not involved in extraction should always be on hand.
- If a diver becomes entangled:
    - Make visual signals to other divers to warn of the situation. Communicate the situation to the surface team.
    - If a diver is trapped at one or two points and can be easily released, the safety diver must release him or her with the utmost caution.
- If a diver is severely entangled:
    - A third diver must go to the surface and ask the surface safety diver for help and an extra air tank.
    - Do not disentangle the diver at the bottom: All the elements with which he or she has become entangled must be cut and the diver must be raised to the surface respecting speed and decompression stops.

Running out of air

The concentration required during extraction operations can make us lose track of time, potentially giving rise to problems with air availability, especially at greater depths, where there is a risk of decompression.

- Diving time, decompression stop time, and air tank pressure must be constantly monitored.
- Bring extra air equipment for balloon inflation operations for extraction. This additional air equipment must be independent and under no circumstances physically tied to the divers.

Being quickly dragged to the surface

The use of air lift bags implies that at some point, the DFG will make an uncontrolled, rapid ascent to the surface, with the risk to divers of becoming entangled and being dragged to the surface.

- Never inflate an air lift bag without making sure that all divers are at a safe distance from the DFG and that everyone has understood the operation before performing it.

- Make sure that the diver who inflates the air lift bag is not attached to the DFG or to the balloon itself.

- Before inflating an air lift bag, make sure that the DFG is completely free of the seabed or any element that could anchor it.

- Air lift bag inflation should never be sudden. Because the volume of air will increase as the balloon rises to the surface, if an air lift bag is fully inflated at the bottom, the ascent will be very violent. First, it should be very gradually inflated until attaining minimum buoyancy with the air lift bag in an upright position but without lifting the DFG. Once stabilized, the air lift bag should then be further inflated gradually until the DFG begins to move upward. Once it starts to move, stop inflating and quickly move away from the DFG to avoid becoming entangled and dragged to the surface.

4.5. Disposal

Following removal from the marine environment, derelict fishing gear must be disposed of properly, or preferably recycled. Disposal or recycling arrangements must be made before the removal operation and must be detailed in any DFG extraction plan. Arrangements will be necessary for transport and final disposal of the DFG in a timely manner.

Every effort should be made to dispose of or recycle the DFG in a timely manner, since any trapped organic material can cause an odor or even a public health issue the longer the gear is exposed out of water.

In most cases, the DFG will have significant growth of algae and other marine organisms and will very likely be difficult to recycle. Clean gill nets, purse seine nets, ropes, lines, and monofilament lines can be recycled at several commercial fishing ports.

The DFG can be modified to assist with its disposal. For example, DFG removed from beaches can be cut into manageable pieces and secured in plastic trash bags for easier handling and containment of organic matter. Larger nets can be tightly bundled together to decrease the volume of the material, promote ease of handling, and prevent entanglement of birds and other terrestrial animals prior to being covered in a landfill.

4.6. Documentation

In order to assess the effects of DFG on marine species and habitats, it is necessary to collect information on all DFG extraction actions carried out.

Thus, once the DFG has been retrieved, it should be unloaded at the nearest port in order to undertake a detailed inspection of the type of gear, length, weight, etc. In addition, all species and organisms that may be trapped, whether dead or alive, should be identified and counted. To perform this task with nets, these must be spread out on the ground so that their length and width can be measured, and the trapped species released using scissors.

The information collection form for extracted DFG (Annex 2) indicates all the information necessary to document DFG extractions. This is complementary to the information previously described in the form regarding DFG location and characteristics.

To complete the written information, it is recommended to take photographs or film a video of the DFG before, during, and after extraction, and of the seabed after DFG extraction.

All the information collected will be entered in a database recording all DFG extractions. This database will be used to describe the effect of DFG, update extraction protocols, and design new management measures to reduce the impact.

4.7. Habitat restoration

When sessile species such as gorgonians, red coral, or bryozoans have been uprooted from the seabed, they have no chance of surviving once released because they have lost their vertical position on the bottom and cannot perform their vital functions.

Consequently, if the DFG has uprooted a large number of animals and colonies of sessile species, these should be brought to the surface together with the net, and then released at the surface carefully so as not to break or kill them. Ensuring that they are submerged at all times, they should be kept in containers as large as possible with fresh seawater that will need to be oxygenated or replaced periodically.

There are currently several scientifically tested marine habitat restoration techniques that ensure the recovery of these uprooted species (e.g., Montero-Serra et al., 2018; Pagès-Escolà et al., 2020; Montseny et al., 2020). Therefore, if the scientific community is given access to these uprooted organisms, they can be re-planted in their original habitats, aiding restoration. To this end, giving advance warning of DFG extraction actions can facilitate the organization of restoration actions.

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Annex 1

Prevent Ghost Fishing

Form for collecting information on Derelict Fishing Gear (DFG) location and characteristics

Name ....

Phone number .... E-mail ....

Date of observation .... Town ....

Area ....

Latitude .... Longitude .... Depth ....

Type of DFG
- ◯ Trammel net
- ◯ Trawling net
- ◯ Purse seine net
- ◯ Trap
- ◯ Hook and sinkers
- ◯ Monofilament fishing lines

Type of seabed on which the DFG is located (can be more than one)
- ◯ Sand
- ◯ Seagrass bed
- ◯ Rocky
- ◯ Maerl or Rhodolith beds
- ◯ Coralligenous habitat
- ◯ Others ....

Other associated material
- ◯ Sinkers
- ◯ Ropes
- ◯ Buoys
- ◯ Plastics
- ◯ Metallic elements
- ◯ Cement or rock

Approximate size Length .... Width ....

Position on the seabed
- ◯ Loose on the bottom
- ◯ Entangled at localized points
- ◯ Very tangled at the bottom
- ◯ Buried

Coating by organisms
- ◯ Little or no coating
- ◯ Coated by organisms
- ◯ Coated by organisms and partially merged with the seabed
- ◯ Merged with the seabed

Entrangled species
- ◯ Fish
- ◯ Lobsters or other crustaceans
- ◯ Coral, gorgonians or other sessile invertebrates
- ◯ Other ....

Possible human risk situations
- ◯ Navigation
- ◯ Entangling
- ◯ Other ....

Photography or video available ◯ Yes ◯ No

Comments ....

....

....

....

....

....

Please send this form to: **protecciomarina@gencat.cat**

Annex 2 (1 of 2)

Prevent Ghost Fishing

Derelict Fishing Gear Withdrawal Information Collection Form

Day .... Hour .... Site of extraction ....

Latitude .... Longitude .... Depth ....

Size, Length .... Width ....

Type of fishing gear ....

Other remarcable elements ....

People in charge of the extraction ....

Entangled species	Number	Abundance* 1	2	3	Number released alife	Comments
Algae						
Cystoseira mediterranea						
Cystoseira zosteroides						
Cystoseira spp.						
Sphaerococcus coronopifolius						
Peyssonnelia spp.						
Mesophyllum alternans						
Sponges						
Axinella verrucosa						
Axinella damicornis						
Spongia officinalis						
Ircinia fasciculata						
Petrosia ficiformis						
Cnidaria						
Eunicella singularis						
Paramuricea clavata						
Leptogorgia sarmentosa						
Corallium rubrum						
Cladocora caespitosa						
Alcyonium acaule						
Bryozoa						
Pentapora fascialis						
Myriapora truncata						
Reteporella grimaldii						
Adeonella calveti						
Turbicellepora avicularis						

* 1=present, 2=abundant, 3=very abundant

Please send this form to: **protecciomarina@gencat.cat**

Annex 2 (2 of 2)

Entangled species	Number	Abundance* 1 2 3	Number released alife	Comments
Echinoderms				
Paracentrotus lividus		○ ○ ○		
Arbacia lixula		○ ○ ○		
Sphaerechinus granularis		○ ○ ○		
Holothuria tubulosa		○ ○ ○		
Holothuria forskalii		○ ○ ○		
Astrospartus mediterraneus		○ ○ ○		
Echinaster sepositus		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
Tunicate				
Phallusia mammillata		○ ○ ○		
Halocynthia papillosa		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
Mollusca				
Bolinus brandaris		○ ○ ○		
Hexaplex trunculus		○ ○ ○		
Ceratostoma erinaceum		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
Polychaeta				
Poliquets tubicoles		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
Crustacean				
Scyllarides latus		○ ○ ○		
Palinurus elephas		○ ○ ○		
Pagurus sp.		○ ○ ○		
Pisa sp.		○ ○ ○		
Percnon gibbesi		○ ○ ○		
Dromia personata		○ ○ ○		
Maja squinado		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
Fish				
Unidentified remains		○ ○ ○		
Dentex dentex		○ ○ ○		
Epinephelus marginatus		○ ○ ○		
Symphodus mediterraneus		○ ○ ○		
Scorpaena porcus		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		
		○ ○ ○		

* 1=present, 2=abundant, 3=very abundant

Please send this form to: **protecciomarina@gencat.cat**

Stop Ghost Fishing

For more information:

www.pescafantasma.cat