PLASFITO
RESEARCH PROJECT

IDENTIFICATION KEY FOR FISHING GEAR WASHED-UP ON COASTLINES OR COLLECTED IN THE OCEAN

Edgar Dusacre[1], [2], Victor Burger[1], Sabine Meneut[3], Sophie Lecomte[4], Benedicte Morin[1], Florane Le Bihanic[5], Miren Cajaraville[2] and Jérome Cachot[1]

université de BORDEAUX · EPOC · cnrs · Universidad del País Vasco · Euskal Herriko Unibertsitatea · PiE Plentziako Itsas Estazioa Estación Marina de Plentzia

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Authors:
Edgar Dusacre[1,2], Victor Burger[1], Sabine Meneut[3], Sophie Lecomte[4], Benedicte Morin[1], Florane Le Bihanic[5], Miren Cajaraville[2], and Jérome Cachot[1]

Affiliations:
[1] EPOC, University of Bordeaux, CNRS, OASU, EPHE, UMR 5805, 33600 Pessac, France
[2] CBET Research Group, Dept. Zoology and Animal Cell Biology; Faculty of Science and Technology and Research Centre for Experimental Marine Biology and Biotechnology PIE, University of the Basque Country UPV/EHU, Basque Country, Spain
[3] Glokis company, Maison des artisans et des entreprises Aix-Marseille Métropole, All. de la Garrigue,
13110 Port-de-Bouc, France
[4] CBMN, University of Bordeaux, CNRS, Bordeaux INP, UMR 5248, 33600, Pessac, France
[5] PNM Bassin d'Arcachon, OFB, 33470, Le Teich

Contact:
To get any information about this document please send an email at edgar.dusacre@u-bordeaux.fr or jerome.cachot@u-bordeaux.fr or mirenp.cajaraville@ehu.eus

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SOMMAIRE

INTRODUCTION & EXPLICATIONS

Introduction:

Through all the different types of waste collected or observed in the ocean and coastlines a substantial amount is composed of fishing gears (FG) (Macfadyen et al., 2009). However, to date standardised protocols of beach cleaning or beach litter monitoring have not fully addressed the problem of this category of waste and do not have a clear a sorting grid. Therefore, to date because of this lake of knowledge and classification we cannot really know what is the proportion of plastic wastes coming from the fishing activity and even less the proportion of waste in function of the fishing metier.

This why in the PLASFITO research project decided to create a FG identification key for the beached plastics and the other collected in aquatic environment. Our ambition is to share this identification key to a maximum odf structure that develope a plastic pollution monitoring program. In this work a summary of the main fishing metier and the fishing gears they use is made. At the end the identification key is accessible and as well as the necessary datasheet to well collect the data.

How to use this FG identification key?

This identification key can be use use with any sampling protocol from citizen science one to rigorous experimental research one. The steps to be able to use this key are:

1. Read all the document

2. Download the data sheet for the waste sorting at the end of the protocol.

3. Have a look at the open access bank of image on GitHub. It could help you to recognise the FG.

4. Sort the items you collected during you sampling protocol or beach cleaning. Use the identification key, the photo guide and the datasheet.

5. Fill the data sheet will all the information explained in it.

6. Send us the data sheet with the following name: FG_IDKey_nameof yourstructure_ date (e.g. F G_key_4P scienseas_160422). Contact: plasfito@4pscienseas.org

7. If you feel that some of your fishing gear are interesting and that they miss to our bank of images, feel free to send us the pictures; Please be careful to send images of good quality, good luminosity and with a signature.

8. You can use your data for any work or project.

9. Follow the news of the PLASFITO research project on the Website, feel free to communicate about this project and disseminate this key and our other work and publications.

FISHING NET STRUCTURE AND TERMS

What is a mesh?

A mesh of a net is an area of different possible shapes (square, rectangle, diamond) delimited by four sides and four nodes. The first indication that must be given to define a mesh is its size (Percier, 1958).

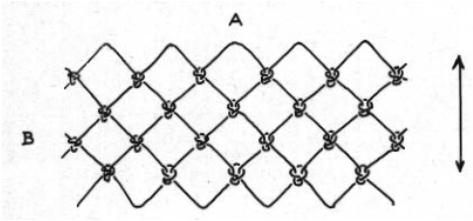


Figure 1: Scheme of various meshes that compose a part of a fishing net.

Strand structure:

We talk of a strand as long as several threads are intertwined. Therefore if there are at least two theads we talk of multi-filament (fig. 3, 4). Otherwise we speak of monofilament because the item is made of a single thread (Fig. 2).

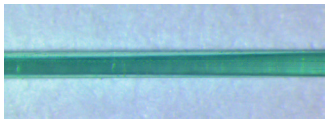


Figure 2: Monofilament

It exists two main structure to make a strand. Their is the braided strands and the laid strands also called twisted strand. (McKenna et al., 2004; Wright et al., 2021).

There two ways to differentiate them:

1. Visual differentiation
2. By exerting an opposing rotational force on the final strand with two hands. If the smallest strand that composed the final strand are loose it is a laid rope.

Braided rope:

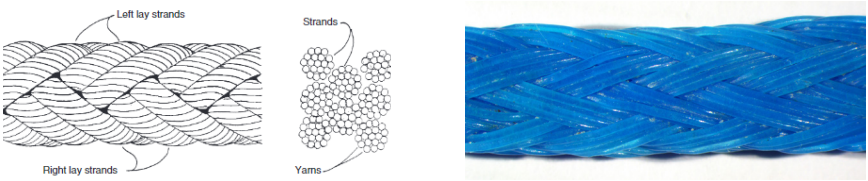


Figure 3: At the left the scheme of eight-strand braided strand made of eight laid yarns. At the right a real eight-strand braided strand made of eight wide and thin.

Laid rope:

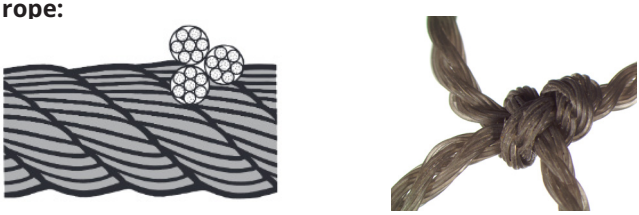


Figure 4: At the left the scheme of a three-strand laid strand made of seven laid yarns . At the right A three-strand laid strand made of seven laid yarnswith a node.

Trawl net

Trawl nets are composed of many parts. Following the trawling metier (pelagic and bottom-sea), the geographical area and the fishermen, the structure of the strand, the diameter of the strand, the size of the mesh, the polymer and the colour can change. The specificity of the bottom-sea trawl net is that the bottom part of the gear is heavily weighted thanks to metal chains, rubber leg or rock hopper (Fig. 10). Most of the time these nets are made of polyethylene for bottom trawling and polyamide for pelagic one. Four main waste come from trawl net. Big parts of nets too degradaded due to their conventional use (and still poorly managed) (Fig. 5). Piece of trawl net coming from the hanging and torn off of trawls on the seabed or on wrecks (Fig. 6). Small pieces that come from net repairs, also called «mending pieces» (Worn ends or cut and unused spool ends of «mending») (Fig. 7).

a b c

Figure 5: (a) Parts of a trawl net. (b) Parts of the trawl net's code end. (c) Protective panel going under the cod end.

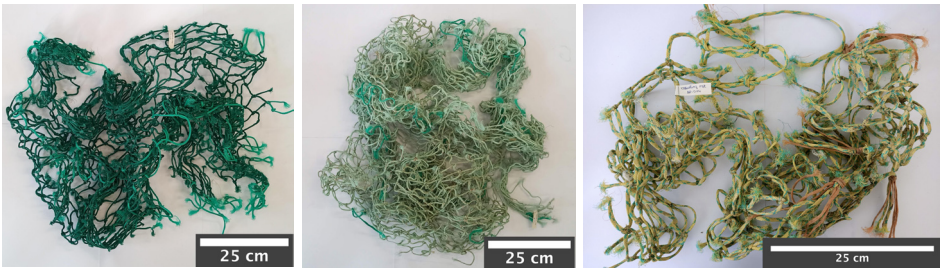


Figure 6: Unidentified part of trawl nets hanging and torn off during fishing activity and then washed up in the Aquitaine coastline (France).

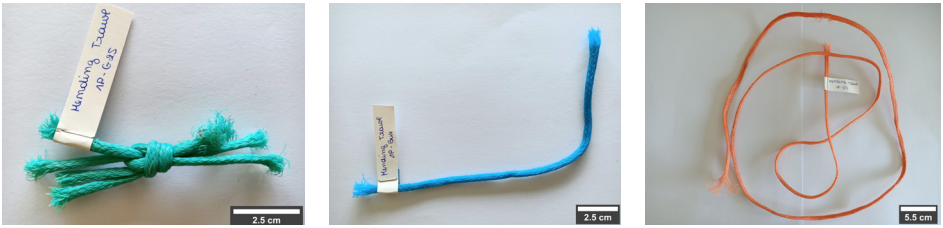


Figure 7: Three different mending pieces coming from trawl net repairs washed up in the Aquitaine coastline (France).

FISHING GEARS

Seine net

Figure 8:

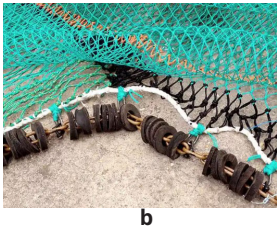
French purse seine boat. This middle scale fishing metier is called «Bolinche» in this region of the world (photo @ CDPMEM).

The seine fishing metier is composed of 3 different sub-metiers. One is pelagic and is called purse seine. The two other are bottom-sea fishing metier and are called Danish or Scottish seine. The purse seine is composed of 1 homogeneous circle net with at the top a rope with many buoys for positive buoyancy and at the bottom a weighted rope which can then be tightened to close and trap fish. There are different scale of purse seine from net of hundreds meters to nets of kilometres. The Scottish and Danish seine are a mix between trawl net and purse seine metier. As for trawl net both demersal seine nets have a weighted ground gear (Fig. 10). Scottish and Danish seines are mainly used for large scale fishing. Polymers, colours, mesh size, length, buoyancy and other parameters will depend of the fishing metier, the fishermen, the fishing geographical area and the targeted spp..

Figure 9:

Purse sein (bolinche) net used by the french fishing fleet that fish sardine (Photo @Adobstock).

a



b

c

Figure 10: Ballast methods for bottom-sea trawl nets, Scottish seine and Danish seine. Method depends mainly of the seafloor. (a) Metal chain (photo @Laurence Hartwell/Through the Gaps), (b) rubber leg (photo @Coastal Nets, 2022a), (c) rock hopper (photo @APCPIPA, 2015)

Gillnet

Gillnet is a worldwide used fishing metier. Various mounting are observed. The composition of a «gillnet» system (buoys, ropes, anchors, flagging, net meshes size, polymer) will depends of the fishermen, the targeted spp. and depending at which depth the nets are set up (surface and mid-water are called driftnets, when bottom-sea nets are called set nets). Most often a gillnet will be composed of a net with meshes, joined or maintained with mounting ropes (Fig. 11) and larger ropes at the top and the bottom to fix buoys and weigh (Fig. 12). Yarn structure can also change between monofilaments or laid multifilament (Fig. 13).

Figure 11: Monting rope for gillnet

A gillnet is at least composed of one layer (also called panel) and can have up to three layers in the case of trammel nets. The length of these nets varies following the fishing sacle and ranges from a few dozen metres to several dozen kilometres
Filament that composed The structure of the yarn can be different. It could be a mono-filament (single yarn) or a multi-filament. Most of the time these nets are made of polyamide.

Figure 12: Trammel gillnets mounted with their ropes and floats, stored on the docks of the port of Arcachon. Difference between the left and the right image is the color and the type of yarn.

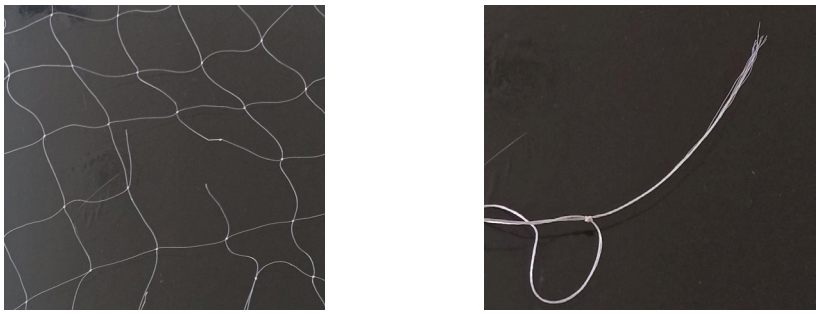


Figure 13: Two pieces of one panel of two different trammel gillnets. The right one is a monofilament (Ø 0.33 mm) with a mesh of 45 mm. The left one is a multifilament (Ø 0.15 mm) with a mesh of 200 mm.

FISHING GEARS

Longline

Figure 14: Laid central line of a longline

Figure 15: Two anti-slide knots added to the central line to keep the same interval between each leaders.

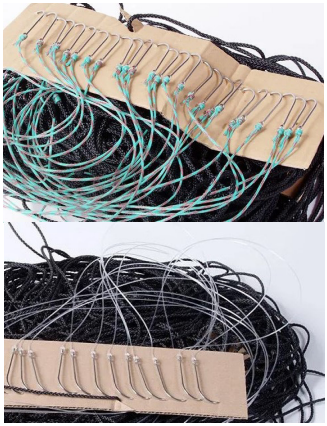


Figure 17: At the top a mono-filament leaders with hooks linked to a central rope. At the bottom a braided leaders with hooks linked to a central line.

Longlines are set-ups designed to fish with a multitude of hooks on a main line. The ”standard” model is composed of a central rope (several kilometres) with anchor and/or buoys at each side and with fishing lines with one or multiple hooks all along the central line at regular intervals. It exists two main longlines fishing metier in function of the depth: mid-water longlines and bottom longlines (Weissenberger, 2015). The length of the central rope, the number of hooks, the polymers depend mainly of the fishing depth and the targeted species. The central rope has often a diameter inferior to 1 cm and is often rigid with tightly twisted strands (Fig. 14). Central line can be a braided rope or a monofilament line (Fig. 15). The fishing lines, also called leaders are linked to the central lines using a swivel often stuck between two anti-slide knots (Fig. 16). Leaders could be thin laid rope or monofilament yarn (Fig. 17). Multiple colours of longlines exist.

Figure 16: At the top a new central line with stop-slide knots, buoys and swivels and its monofilamnet leaders with their hooks. At the bottom another central line monofilament with stop-slide knots, pearls and swivels.

FISHING GEARS

Recreational and professional

Fishing lines metiers are very diverse. It is quite complicated to do the difference between recreational fishing lines and professional ones (Fig. 18). It exists three main fishing lines metier: pole fishing with artificial (plastic) (Fig. 19) or natural lures, trolling lines using hand fishing pole or lateral boat fishing poles with several lines and finally jigging lines that consists to various lines continually jerked by hand or a jigging machine (Weissenberger, 2015). All these lines are made of monofilament polyamide with one or multiple plastic or metallic leaders. Multiple colours of line exist.

Figure 18: Pieces of monofilament line certainly used for recreational or professional line fishing. (Photo @ NOAA, 2021 and @The Broomsmen)

Figure 19: Plastic fishing lures found on different coastlines. (Photo @Junichi Sugishita, NWR)

FISHING GEARS

Rope

Ropes are common tools in the maritime sector. Every boat, whether it is a pleasure craft (motorboat or sailboat), racing boat, merchant ship or fishing boat, has a number of ropes on board to enable it to moor, to fix objects or to launch or raise gears. Ropes are therefore essential to this sector. Ropes compositions, structures, polymers, sizes, shapes, densities, strength, resistances and colours are divers and depend of the use. However, nowadays most of the ropes are made of plastic and more precisely of polyethylene and polypropylene (McKenna et al., 2004)
In the fishing activity ropes have many different uses. We can find ropes to maintain nets, lines or traps but also to set up buoys and anchors. Ropes are also used to track and raise the trawl nets and the Danish and Scotiish seine.

Figure 20: (a):(d) four different ropes found on the Aquitaine coastline (France). (e) Trawl tow rope also called ”wrap”. (f) A cluster of different ropes found on the Aquitaine coastline (France).

Trap

Traps can have several shapes, sizes and polymeric composition. Traps are often set-up linked between them thanks to a rope and maintain in the sea floor thanks to an anchor. They have all a funnel entrance that allow the aquatic organisms to easily enter but which makes it much more complex the escape. Most of them have a solid structure recover by net or metal grid (Fig. 22).
Some are pots with solid walls espacially used for octopus fishing (Weissenberger, 2015). These pots are historically made of clay but they are nowadays in plastic. It exists of course a multitude of other traps than those presented here.

Figure 21: Two different type of traps. At the left traps have a steel strcture with a braided or laid net recover. At the left all the structure is in steel. Only the rope is in plastic (photo @Mooncusser).

Figure 22: At the right a cluster of PE octupus pot with their ropes. At the left four different octopus trap used in Galicia, Spain. The one at the bottom left is in PE.

FISHING GEARS

Buoy

As ropes buoys and floats are common material in the maritime sector. The use of buoys is very divers. Here a focused has been made on the buoys and floats used during the fishing activity and are therefore directly linked to the fishing gear. Main difference between buoys and floats appears to be the structure. Buoys are considered as a complex structure made of different possible parts: float, mast, flag, flashing light, radar reflector and counter weight (Bord Iascaigh Mhara, 2007). While a float is a light object of variable shape that floats on the surface or in a liquid. In the buoys the mast is mainly hand made with bamboo. Industrial ones are made of aluminium or plastics (Bord Iascaigh Mhara, 2007). Four main families of floats exists: polyform floats (also called inflatable markers), polystyrene floats, net floats (different between gillnet, trawl net and seine) and hand made floats.
Buoys and floats compositions, structures, polymers, sizes, shapes, densities, strength, resistances and colours are divers and depend of the use and the legislation (Bord Iascaigh Mhara, 2007). Make a geographical or a fishing metier polymer classification for floats is quite hard due to the differences in usage and habits of fishermen. According to the floats producers and resellers (Coastal Nets, 2022a; Polyform AS, 2019) and the OSPAR Convention (2020) we can establish an exhaustive table to refer the polymer of the different floats families (Tab. 1)

Table 1: List of polymer in function of the floats

Floats families	Polymer of the inner layer	Polymer of the outer layer
Polyform buoys	PVC	Air, PS, PU
Polystyrene buoys	PS	
"Hard plastic" net floats	PVC, PE	
Seine floats	EVA	

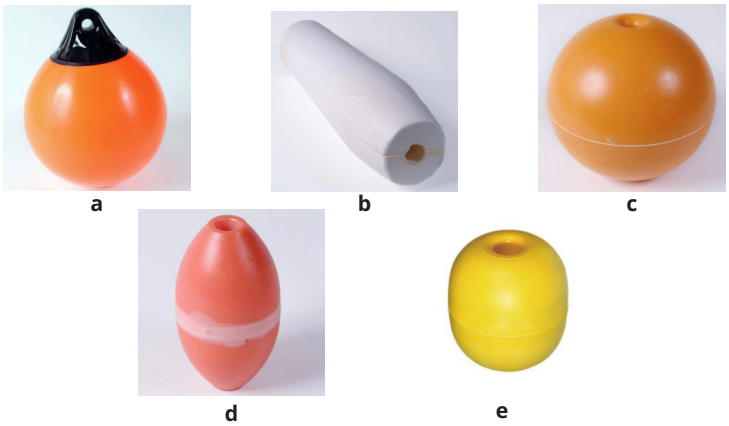


Figure 23: (a) Polyform float in PVC. (b) Polystyrene float. (c) "Hard plastic" net float essentially used for trawl nets (PE). (d) "Hard plastic" net float essentially used for gillnets and trawl nets (PE). (e) Ethylene vinyl acetate float used for seine nets.

Fish boxe

Fish boxes are often used to transport the fishes from the boat to the fishing market and then to transport them until the point of sale (fish shops, supermarkets, processing plants...). Two main fish boxes exists. The "Hard-plastic" one, mainly made of HDPE and the expanded polystyrene (EPS) ones. HDPE one are also called "fishing market boxes" because they are mainly used to stock fishes on the boat, to transfer them until the fishing market and to sale them. While polystyrene one are mainly use by fish shops and supermarkets. Fishing market boxes can be of multiple colour and size but have three main shape. The one used for fish are full without holes (Fig. 24a) or nested with small regular square holes (Fig. 24b). The third shape made for shellfish have a thinner thickness with more holes (Fig. 24c). In France for certain regions the colour of the boxes allow to know the maritime district or port where they are used. EPS boxes are practically always white, with slightly different shapes but are easily recognisable (Fig. 25).

a b c

Figure 24: (a) HDPE full fish box of 20L. (b) HDPE nested seafood box. (c) HDPE shellfish box also called "shellfis basket".

Figure 25: Polystyrene fish boxes

FISHING GEARS

Unidentified items

Some items found on beach are looking as fishing gears without being or might by misunderstanding fall into certain categories. It is the case for some type of ropes that can be found on coastlines (Fig. 26). In fact, some ropes do not appear to come from maritime sector. Therefore they will be classified has «unidentified rope».

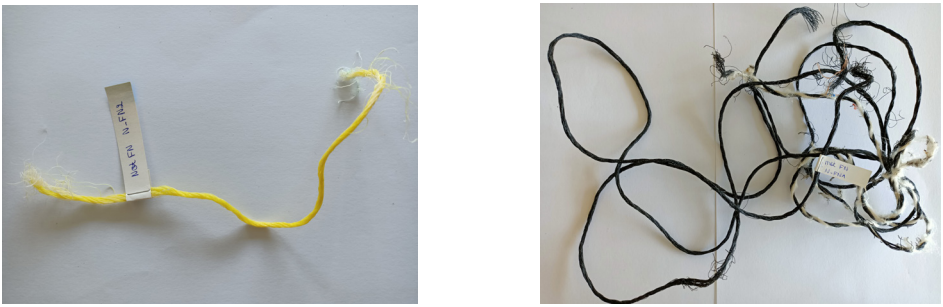


Figure 26: Ropes not coming from the maritime sector and certainly coming from a terrestrial activity.

Moreover on net could may look like a gillnet but is not one (Fig. 27). This type of net has plastic melt node to make the meshes. In any report, producing or resselling company shopbook this fishing net appears to be used. However, because we don't have any concrete information on its use we will classify them as «Unidentified net».

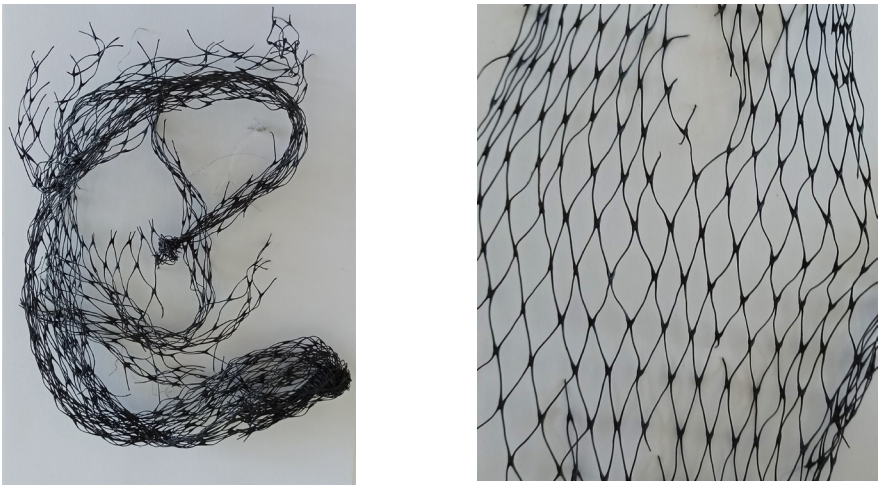


Figure 27: Unidentifiable net with melted plastic knots. The right picture is a zoom on an unidentifiable net with melted plastic knots.

WHICH POLYMER FOR WHICH FISHING GEAR?

Fishing gears are of a great diversity. Physical structures, colours, polymers, diameter, width, length, buoyancy, resistance, elongation and tensile strength will depends of numerous factors but main one are: the fishing metier, the targeted spp., the FG reseller and the fisherman will. However, following the FG it is possible to set a summary table (Tab. 2) of the different polymers for each FG.

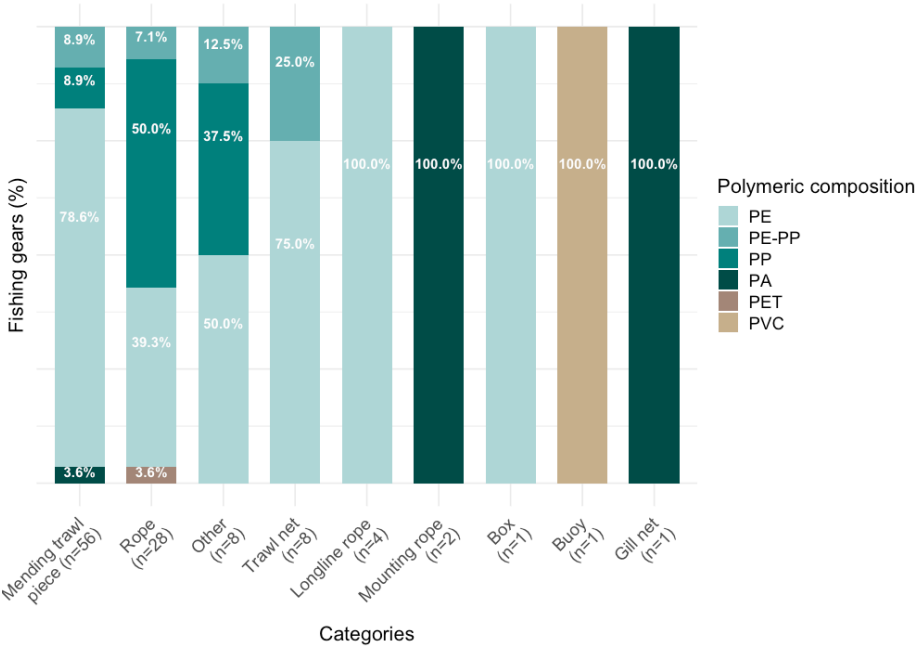


Figure 28: Percentage of fishing gear washed-up on Montalivet beach in function of what they are used for and their polymeric composition.

Sampling in Aquitaine coastline (France) allow to identify 9 different fishing gears (Fig. 25) of which 3 come from identified fishing metier: trawl, longline and gillnett fishing. Most of the mending pieces and trawl net are in PE (78,6% and 75%). 100 % of the longline rope are in PE. Trawl net could be in PE (60%) or can be made with a mix of PE and PP (40%). 50% of the ropes are in PP but other polymer are possible. 50% of the unidentifiable items are in PE but other polymeric composition are not negligible. Any other conclusion can be made with the other category due to a lack of effectif.

WHAT TO DO NOW?

In the next page you will found the «Identification Key». The goal is to select one of the FG you collected during your sampling or your cleanup. Then you will have to find which FG is it. To do it follow the question asked and answer then. When you arrived to a light green rectangle it means you found the FG. To be sure go to check the indicated page. If you want more pictures to help you, you can go to the online photo bank in the Github.

Then when you have you definitive answer add a value in the cooresponding column of datasheet. The datasheet in available on the Github or you can copy it from the last page of thi s document. Don't mix up the FG you will need it after the count to measure the mass per category.

Repeat the process for all the FG you collected.

WHICH INFORMATION WE NEED ?

By using this Identification key to classsify the FG you collected during your beach cleanup or your sampling you will participate to a participatory science project. It is the reason why we need some precise information.

Date of the mission (dd/mm/yyyy)**:**

Geographical area (in decimal degrees)**: Latitude:** **longitude:**

Country:

Beach name:

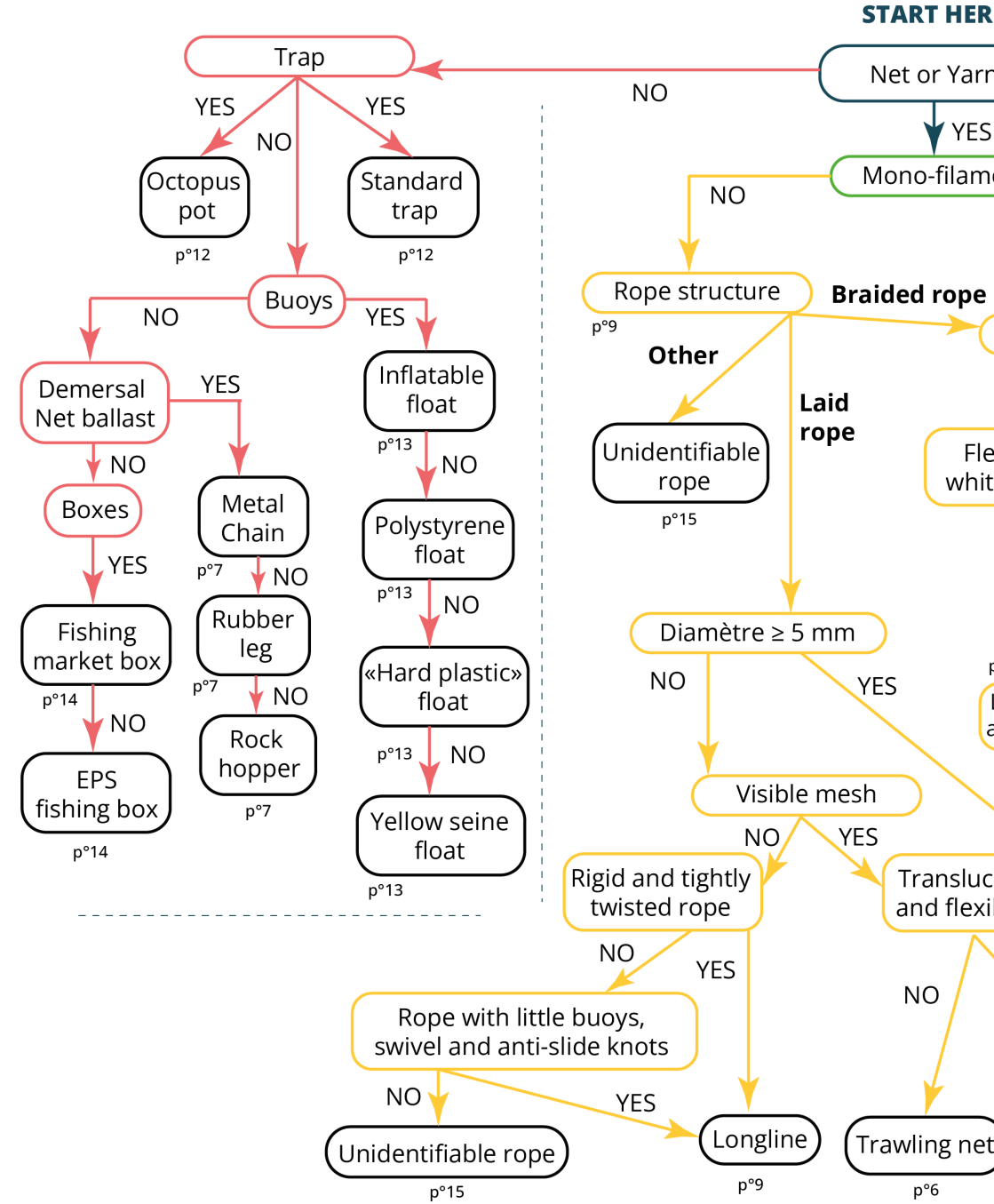
Type of beach (sandy beach, rocky beach or artificilised coast):

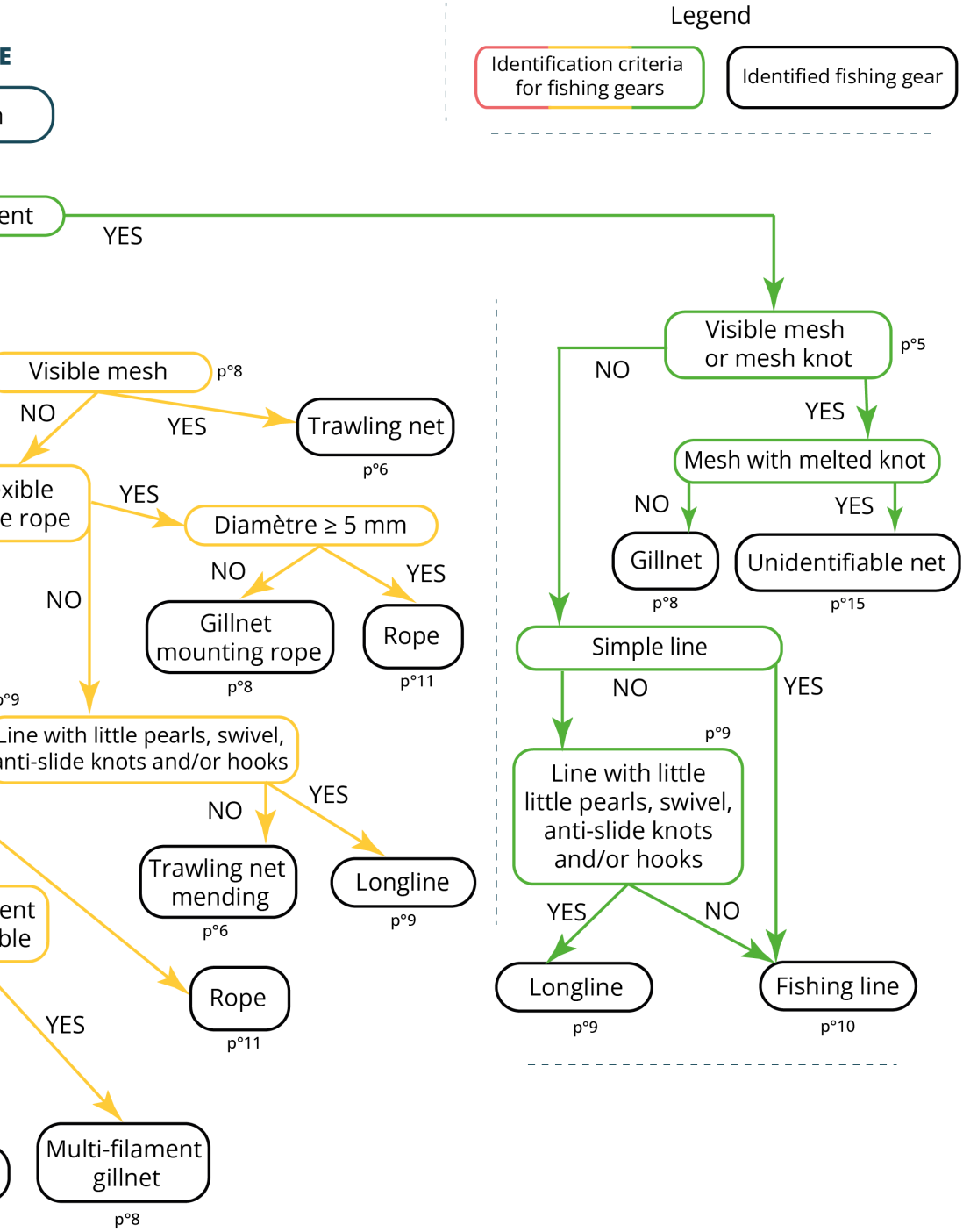
Weather (classical TV weather)**:**

Oceanographic conditions (use the Beaufort wind scale):

Tide (low, middle or high tide)**:**

Tidal range (easily available on internet):


START HER
Trap
Net or Yarn
NO
YES
YES
NO
YES
Octopus pot
p°12
Standard trap
p°12
Mono-filam
NO
Buoys
Rope structure
p°9
Braided rope
NO
YES
Other
Laid rope
Demersal Net ballast
Inflatable float
p°13
Unidentifiable rope
p°15
Fle
whit
YES
NO
NO
Boxes
Metal Chain
p°7
Polystyrene float
p°13
Diamètre ≥ 5 mm
YES
NO
NO
YES
Fishing market box
p°14
Rubber leg
p°7
«Hard plastic» float
p°13
Visible mesh
NO
NO
NO
EPS fishing box
p°14
Rock hopper
p°7
Yellow seine float
p°13
Rigid and tightly twisted rope
Transluc
and flexi
NO
YES
NO
Rope with little buoys, swivel and anti-slide knots
NO
YES
YES
Unidentifiable rope
p°15
Longline
p°9
Trawling net
p°6


Legend
Identification criteria for fishing gears
Identified fishing gear
YES
Visible mesh or mesh knot
p°5
NO
YES
Mesh with melted knot
NO
YES
Gillnet
p°8
Unidentifiable net
p°15
Simple line
NO
YES
p°9
Line with little little pearls, swivel, anti-slide knots and/or hooks
YES
NO
Longline
p°9
Fishing line
p°10
Visible mesh
p°8
NO
YES
Trawling net
p°6
YES
Diamètre ≥ 5 mm
NO
YES
Gillnet mounting rope
p°8
Rope
p°11
NO
p°9
Line with little pearls, swivel, anti-slide knots and/or hooks
NO
YES
Trawling net mending
p°6
Longline
p°9
Rope
p°11
YES
Multi-filament gillnet
p°8

Trawl net	Trawl mending	Gillnet	GMR	Unidentifiable net	Line	Longline	Ropes	Unidentified rope	

Metadata to fill the table called "Fishing gear table - Item":

You can add as many rows as you like. You can make a row for each waste writing "1" or you can have only one row with a sum (e.g. "270" or severa

Abbreviation:

GMR = Gillnet mounting rope
HP net float = Hard plastic net float
SCB = Steel chain ballast
RLB = Rubbe leg ballast
RHB = Rock hopper ballast

Trap	Inflatable float	HP net float	Yellow sein float	PS float	SCB	RLB	RHB	fish box	EPS fish box

l lines with different counts (e.g. "2, "10", "7", "23").

MASS MEASURE PER CATEGORY

Trawl net:	
Trawl mending piece:	
Gillnet:	
Gillnet mounting rope:	
Unidentifiable net:	
Line:	
Longline:	
Ropes:	
Unidentifiable ropes:	
Trap:	
Inflatable float:	
PS float:	
Hard plastic float:	
Yellow sein float:	
Metal chain ballast:	
Rubber leg ballast:	
Rock hopper ballast:	
fish box:	
EPS fish box:	

Please Write the mass as a single value.
Unite: Kilogram (Kg) and accuracy to the hundredth (e.g. «1,25» ou «0,52»)

Work carried out in the framework of the Plasfito research project.

This multi-disciplinary project aims to contribute to the improvement of scientific knowledge on the subject of microplastics, nanoplastics and marine additives from fishing gear during their life cycle.

This project is intended to be systemic. That is why the majority of stakeholders in the professional fishing sector have been met and listened to.

We hope to bring a new prism of reading to this not negligible pollution. Following the publication of the results, we also hope to be able to support fishermen and other stakeholders in the sector in the management of waste and the evolution of habits and equipment.

PLASFITO
RESEARCH PROJECT