CleanAtlantic

Tackling Marine Litter in the Atlantic Area

Material flows of recreational coastal fishing equipment in the Autonomous Region of Madeira

WP 7: Monitoring and data management
WP 7.3: Reducing abandoned lost and otherwise discarded fishing gears (ALDFG).

Região Autónoma da Madeira
Governo Regional

Secretaria Regional
de Ambiente, Recursos Naturais e Alterações Climáticas
Direção Regional do Ambiente e Alterações Climáticas

Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION
Clean Atlantic

WP	7
ACTION	7.3
LAST UPDATED	10/05/2023
VERSION	1
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DISCLAIMER

ÍNDICE

INTRODUCTION

MARINE WASTE

More than 80% of marine waste in Europe consists of plastics of different types and it is estimated that 27% (11,000 tonnes) originates from fishing gear (e.g., buoys, nets, lines, traps) [1]. Sources include commercial and recreational fishing activities and aquaculture and mariculture facilities.

Directive 2019/904/EU of the European Parliament and the European Council of 5 June 2019 on reducing the impact of certain plastic products on the environment sets out measures to prevent and reduce the impact of certain plastic products on the environment (particularly on the aquatic environment and human health), and to promote the transition to a circular economy with innovative and sustainable business models, products, and materials.

Recognising that plastic components of fishing gear have a high recycling potential, the Directive provides that Member States will have to establish extended producer responsibility (EPR) by 31 December 2024 for fishing gear and components of fishing gear containing plastic. The objective is to ensure the selective collection of this waste in the expectation that that sound management, including recycling, can be financed with this system: producers of fishing gear containing plastic must contribute to cover the costs of collection and their transport and subsequent treatment. Typically, this type of scheme also places on producers the responsibility to invest or cover awareness costs.

The Directive recognises, however, that there should be exceptions as " all marine litter containing plastic poses a risk to the environment and to human health and should be tackled, proportionality considerations should also be taken into account. Therefore, the fishermen themselves and artisanal makers of fishing gear containing plastic should not be considered as producers and should not be held responsible for fulfilling the obligations of the producer related to the extended producer responsibility."

The directive also provides that the Commission shall request the European Standardisation Organisation to develop harmonised standards for circular design of fishing gears.

Currently, in Portugal, as in most Member States, there are no specific policies for fishing gear waste. The closest instruments to cover this type of waste are PERSU 2020 and PNGR (both under review as of the date of this report), and the Circular Economy Action Plan. However, none of them specifically refers to fishing gear.

Although the main motivation behind legislation on fishing gear waste is to reduce marine pollution by plastics, lead waste, particularly from recreational fishing, is also coming under the spotlight because of its potential impact on the marine ecosystem and human health.

According to estimates released by ECHA (European Chemicals Agency) every year around 44,000 tonnes of lead are dispersed into the EU environment in ammunition for sport shooting and hunting and in fishing gear in the proportion of 57 % for sport shooting, 32 % for hunting and 11 % for fishing. In other words, **every year around 5000 tonnes of lead are released into the EU's marine environment through recreational fishing** [2] .

[1] https://webgate.ec.europa.eu/fpfis/cms/farnet2/sites/farnet/files/publication/en_farnetguide17.pdf
[2] https://echa.europa.eu/hot-topics/lead-in-shot-bullets-and-fishing-weights

Based on this diagnosis, this entity proposed, in 2021, that the European Commission adopt the following restrictions:

- ban on the sale and use of lead weights and lead lure (with transition periods depending on weight: ≤ 50 g three years; > 50 g five years)
- immediate ban on the sale and use of lead wire for fishing
- immediate ban on the use of lead sinkers when the sinker is deliberately released (lead 'drop off' techniques)[3].

In May 2021, Commission Implementing Decision (EU) 2021/958 was published, setting out templates for reporting data and information on fishing gear placed on the market and waste fishing gear collected in Member States. The Decision determines the need to declare the total materials - plastics, metals, and rubber - contained in the fishing gear placed on the market and the waste fishing gear collected. The information on plastics and metals shall however be disaggregated into types of plastics and types of metals according to the typologies listed in Table 1.

According to Directive 2019/904/EU the first reference period for reporting is the calendar year 2022. The data and information must be communicated electronically within 18 months from the end of the reference year in which they were collected, which means that the deadline for the reporting of the first reference period is June 2024.

Table 1 - Typologies of plastics and metals to be reported under Implementing Decision (EU) 2021/958

Typology	Description
Plastics	Polypropylene (PP)
	Polyethylene (PE)
	Ultra-high-molecular-weight polyethylene (UHMWPE))
	Polyamide (Nylon)
	Other (PET, PVC, PEAD, EVA etc.)
	Polymer mixture
Metals	Steel
	Aluminium
	Lead
	Other metals or mixtures of metals

The data and information reported by Member States will also have to be accompanied by a quality control report to verify the accuracy, reliability and comparability between Member States reported information. This information will have to be submitted electronically within one and a half years from the end of the reference year in which it was collected. More than just a reporting element, it provides a strong support to the management of fishing gear waste.

[3] technique used by some carp anglers.

Authorities in regions such as Madeira, where there is a direct proximity or dependence on the state of marine ecosystems, play a key role in preventing marine litter, and minimize its impact on ecosystem degradation and consequent loss of biodiversity.

Accounting for product consumption and waste production makes it possible to define more efficient strategies in economic and environmental terms for their management. Knowing and accounting for the waste that is being produced today allows evaluating possible destinations that prevent landfill. Knowing and accounting for products being purchased today allows us to scale waste management systems and investigate new ways to keep materials in circulation in the economy after the end of life of the products they are part of.

OBJECTIVES AND AIM

Aware of this challenge, the Regional Directorate for Environment and Climate Change (Direção Regional de Ambiente e Ação Climática, DRAAC), promoted two studies to evaluate the material flow of fishing gear in the Autonomous Region of Madeira, identifying quantities, types, origins, and destinations of these products.

The first study, developed in 2021[4], targeted the flows of commercial fishing gear and mariculture. **Current study is dedicated to the flows of recreational, leisure and sport fishing gear, but excluding embarked and subsea fishing.**

This work is part of CleanAtlantic, a larger project aiming to protect biodiversity and ecosystem services in the Atlantic Area by increasing the capacity to monitor, prevent and eliminate marine litter.

Additionally, it aims to raise awareness and promote change among stakeholders and to improve marine litter management systems[5].

This set of studies, under the name RePesca, intends to contribute to the development of a more sustainable and circular model for fishing gear in the Autonomous Region of Madeira, together with the development of basic knowledge on this subject.

REGIONAL LEGAL FRAMEWORK

The Regional Legislative Decree n.º 19/2016/M regulates the Recreational Fishing of Plant and Animal Species[6], in the Marine Waters of the Autonomous Region of Madeira. Under this diploma, recreational fishing means the capture of marine species, without commercial or scientific purposes, in one of the following forms of exercise:

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[4] Circular, 2021. Characterization of the flows of fishing gear materials in the Autonomous Region of Madeira. Report conducted for the Regional Directorate of Environment and Climate Change of the Regional Secretariat of Environment, Natural Resources and Climate Change.

[5] http://www.cleanatlantic.eu/pt/

[6] Does not apply to the harvesting of gastropod molluscs such as limpets. This activity is regulated by its own Decree (Decreto Legislativo Regional n.º 11/2006/M).

a) Leisure fishing, for mere recreation.

b) Sport fishing, to obtain sportive marks in organized competition.

c) Tourist fishing, which is practiced under the terms of the legal regime of maritime-tourist activity.

It may include the following:

1) Manual catch, which is practised in the littoral zone, with or without the use of catching tools.

2) **On foot pole and line fishing, which is carried out in the coastal zone, from land or isolated rock formations.**

3) Embarked fishing, carried out in coastal and oceanic areas on board of a vessel registered for recreation or engaged in maritime tourism.

4) Underwater fishing, which is carried out while floating or submerged in water under apnea, including harvesting carried out manually and with the use of catch tools.

Recreational fishing is subject to licensing by the Regional Fisheries Directorate and pole fishing from land is licensed on an individual and non-transferable basis.

In the case of sport fishing, the performance of any competition requires the authorisation of the Regional Fisheries Directorate, upon the prior opinion of the following entities:

a) Sports association that tutors the sport in the Region.

b) Captaincy of the port in the area where the competition is scheduled to take place.

c) The town council of the respective area.

On foot and embarked recreational fishing are regulated by Portaria n.º 484/2016, which defines the permitted gear, constraints and licensing terms for the exercise of recreational fishing in the marine waters of the Autonomous Region of Madeira. According to this ordinance, recreational fishing may only be carried out by means of handline, fishing rod, harpoon, trolling and jigging gear. The use of support equipment is also permitted. Hooks may include other gear designed to improve their operability, such as ballast (commonly known as sinkers) and buoys.

Baits and decoys, whether artificial or natural, to be used for fishing on foot shall not consist of fish roe, prohibited species, live exotic species, or substances liable to cause environmental damage, including poisonous or toxic substances.

Recreational fishing licenses are granted for periods of 30 days or 12 months. It is an administrative offence punishable by a fine to fish without holding a license and to throw overboard objects or substances that may harm the marine environment or damage the fishing gear or vessels.

METHODOLOGY

To reach the identified objectives, the work was carried out in five phases, presented in Figure 1.

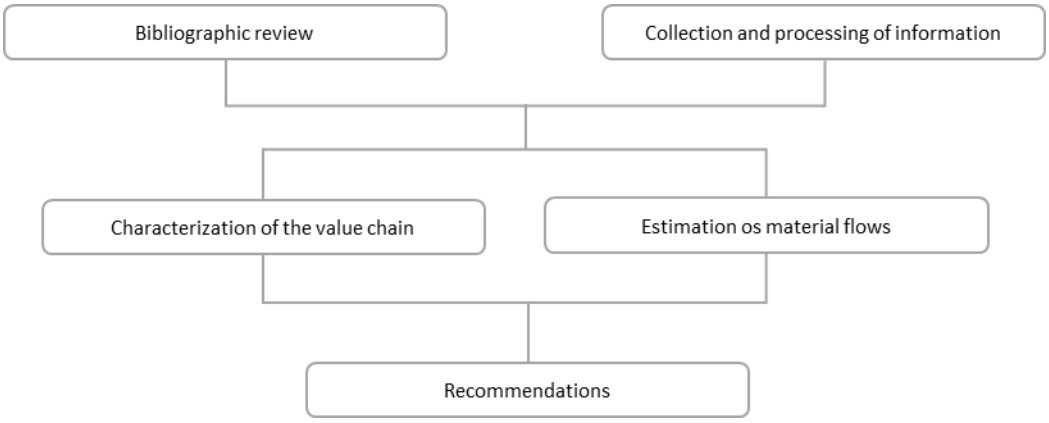


Figure 1 – Methodological approach

In the first phase, a bibliographical review was carried out on websites and information was gathered from specialists, responsible entities in the region, and shopkeepers. Based on the information collected, the value chain of recreational fishing gear was characterised, together with a qualitative characterisation of the fishing equipment and its materials. The information collected from some experts allowed, albeit with little precision, to estimate some of the quantities of equipment and materials used in the region - which are potential wastes of the activity. Finally, some recommendations are suggested for the region to monitor the quantities and prevent the impacts associated with gear flows and fishing activity, particularly the production of waste.

CHARACTERIZATION OF THE VALUE CHAIN OF FISHING GEAR

Figure 2 shows the recreational fishing gear value chain in the Autonomous Region of Madeira. Upstream are the gear manufacturers located outside the region, the suppliers (distributors/traders) that are in the territory and suppliers outside the region, namely the national and foreign online sales shops.

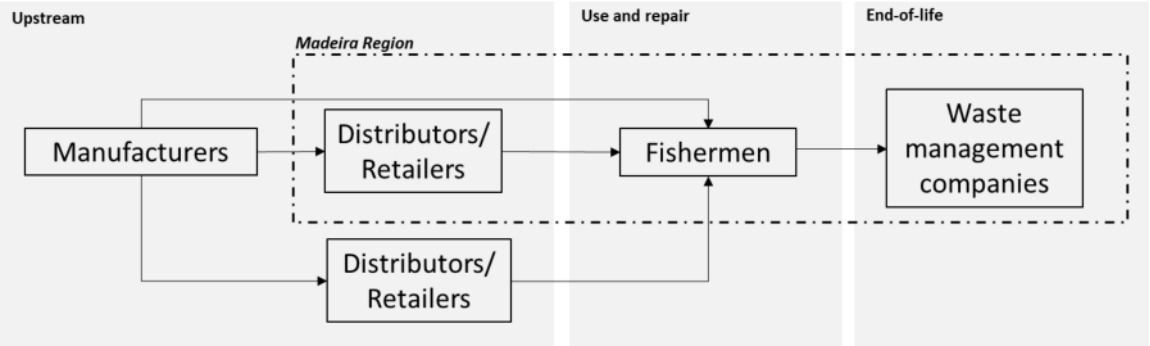


Figure 2 – Value chain of recreational fishing gear in Madeira region

The use phase involves recreational and sport fishermen, who are also the ones that usually ensure the maintenance and repair of the gear (guaranteeing the extension of its lifetime). At the end-of-life, the gear is deposited by users in waste containers and collected by waste managers, who take it to its final destination. Some unserviceable equipment may be subject to temporary storage before being repaired, used for possible recovery of components or before being sent to their final destination.

Currently fishing gear waste is landfilled, and a small fraction can integrate the waste mixture that is subject to incineration.

According to a survey carried out by DRAAC, the main suppliers of recreational fishing gear in the region are:

- ARTES & PESCA – Loja de pesca (Caniçal)
- Loja do Mar
- Madeira Pesca
- O Inglês-Pesca desportiva
- Fastprodutos
- Loja Náutica Madeira Chacon
- SaltyMar-Pesca & Acessórios
- Nautileste, Turismo Marítimo, Lda
- Livre Direto
- Porto Santo Náutica
- Rikixa Li, Lda
- FishPoint
- Supermercado Nobre (Água de Pena)

In addition to these local shops, competition anglers stock up in online shops.

A study promoted by the Regional Directorate of Fisheries (Direção Regional das Pescas, DRP) in 2017 characterized the socio-economic activity of recreational fishing in the region[7]. That year a total of 5490 licenses were issued. In subsequent years the number of licences issued lowered, with a reduction of about 20% between 2017 and 2021.

Table 2 - Number of licences issued for the on-foot fishing modality, by duration period, 2017-2021. (Source: DRP)

[7] Martínez-Escauriaza R, Hermida M, Villasante S, Gouveia L, Gouveia N, Pita P. (2020). Importance of recreational shore angling in the archipelago of Madeira, Portugal (northeast Atlantic). *Scientia Marina* 84(4):331-4. Available from: https://scientiamarina.revistas.csic.es/index.php/scientiamarina/article/view/1875

Period	2017	2018	2019	2020	2021
30 Days	230	243	228	170	279
12 Months	5260	4356	4059	4390	4096
Total	5490	4599	4287	4560	4375

For the study 734 fishermen were surveyed. Some at the DRP service counters during licence application and others during their fishing activity. According to results, line fishing is practiced throughout the year in the region, more often in the summer, and mainly on weekends, during the day. The total estimated annual catch of fish was 520t that year.

Almost half of the fishermen (40%) admitted having no income or relying on social benefits (about 30% were unemployed and 11% were retired).

According to the estimates, each fisherman spends an average of 254 euros per year in this activity, meaning a total of about 1 million euros of expenditure per year for the fishermen as a whole.

About a third of the fishermen concentrate on docks and platforms over the sea, another third prefers rocky areas and only about 6.5% use to fish on the beach.

During the survey inquirers detected some fishermen without licenses - some of them because they were minors and therefore did not need them. On the other hand, all competitive fishermen have a fishing license, because it is a regulated activity and subject to greater control, including from their peers.

The sport fishing activity in the region is managed and promoted by Associação da Pesca Desportiva da Região Autónoma da Madeira (APDRAM). This association aggregates the sport fishing clubs of the Autonomous Region of Madeira, having currently around 80 associate anglers. Currently, the fishing clubs in Madeira are the following:

- Centro Desportivo e Cultural Porto Moniz
- Clube Desportivo São Vicente
- Grupo Amadores de Pesca Desportiva da Madeira
- Clube Naval do Funchal
- Sporting Clube da Madeira
- Centro Cultural e Desportivo da CM do Funchal
- Clube Desportivo Mar e Serra
- Centro de Cultura e Desporto dos Trabalhadores dos Horários do Funchal
- Centro Cultural e Desportivo dos Trabalhadores da EEM (Eletricidade da Madeira)
- Associação Recreativa e Cultural da Ajuda
- Grupo de Campismo de Santo António
- Clube de Tiro Caça e Pesca da Madeira

DRP provided information on the schedules of tournaments which allowed to count the number of competitions between 2017 and 2021 (Table 3). The competition statistics' sheets allowed, in turn, to count the number of anglers per competition, therefore the average number of anglers per competition per year.

Table 3 - Number of sport fishing competitions in the RAM and average number of anglers, 2017-2021 (Source: DRP)

		2017	2018	2019	2020	2021
Number of competitions	Madeira	11	23	18	4	6
	Porto Santo	0	3	0	6	2
	Total	11	26	18	10	8
Number of fishermen per competition		25	24	26	28	25

The locations where the competitions take place are presented in Table 4. In the same table the type of coast is characterized according to its the submerged zone, where the bottom fishing gears will operate (see next section).

Table 4 - Sport fishing competition sites in the Autonomous Region of Madeira and type of coast (submerged area) (Source: DRP and Duarte Nóbrega)

Sport fishing competition sites	Type of coast (submerged area)
Água de Pena	rocky / sandy
Cais 8 - Funchal	sandy
Lugar de Baixo - Ponta do Sol	mixed*
Lugar de Baixo (enrroc.)	rocky
Paul do Mar	stony / rocky
Porto Moniz / C. da Fontinha - Porto de Abrigo	rocky / sandy
Porto Moniz / Penedia	stony / rocky
Seixal / Laje - Porto Moniz	mixed
Porto Santo	sandy
Praia das Palmeiras - Santa Cruz	mixed
Praia de Natal - Caniçal	stony
Praia Formosa - Funchal	sandy
São Vicente (Vila)	sandy

*mixed = sandy and stony

The type of submerged area influences the potential loss of materials from fishing gear, such as sinkers and hooks that get stuck in rocks or stones.

QUALITATIVE CHARACTERISATION OF RECREATIONAL FISHING MATERIAL FLOWS

The most used methods in recreational fishing are bottom fishing and surface fishing (or angling). Bottom fishing[8] is a method used to place bait close to the bottom. It is used all along the coast and allows catches of all coastal species. A distinction can be made between Surfcasting, a beach fishery where the aim is to reach long casting distances, and rock bottom fishing, practised in rocky areas. In surface fishing, on the other hand, buoys act as bite indicators, alerting anglers when a fish bites the hook. Another function of buoys is to suspend the bait, keeping it firmly attached to the hook, suspended in the water.

According to APDRAM's[9] regulation for sport fishing competitions, the formal definitions of the fishing modalities are the following:

- Competition fishing with float (buoy) - Fishing practiced with a rod, with or without reel, using a float duly calibrated for the signalling of the touches of the species to be captured.
- Competition bottom fishing - Fishing practiced with rod and reel, where the assembly with the hooks is submerged by a heavy object (sinker) attached to the line. The hooking of the fish is made upon the sensation of the bait attack on the line or on the tip of the rod.
- Spinning competition - modality practiced with rod and reel with artificial or natural baits, which are launched and recovered consecutively, making the hooking of the fish with the moving baits.
- Fishing competition "de sentir" - modality practiced with rod and reel, using or not a buoy. When the line is tense, allows the instantaneous hooking by the sensation in the rod or in the line of the attack to the bait.
- Surfcasting - sport practiced with rod and reel, whose objective consists of throwing a heavy object (sinker) as far as possible.
- Free competition fishing - the practice of all the modalities mentioned above

Figure 3 - Sport fishing on the beach (left) and on the rock (right) (Source: http://apdram.pt/portal/index.php)

According to Directive EU/2019/904 fishing gear refers to " any item or piece of equipment that is used in fishing or aquaculture to target, capture or rear marine biological resources or that is floating on the sea surface, and is deployed with the objective of attracting and capturing or of rearing such marine biological

[8] https://www.pesca-pt.com/pesca-fundo
[9] http://www.apdram.pt/portal/index.php/associacao/regulamento-regional-de-provas/Documentos/REGULAMENTO%20REGIONAL%20DE%20PROVAS.pdf/download

resources". In the case of recreational fishing, the main equipment, and its generic composition (Table 5), are described below. The elements described were collected from specialized fishing websites and online shop catalogues.

Table 5 - Main component materials of recreational fishing equipment

Equipment	Materials
Fishing rod	Fibreglass, carbon fibre, graphite fibre.
Reel	Metal alloys (e.g. Zamac - Zinc, Aluminium, Magnesium, Copper), metals such as aluminium or zinc, glass or carbon fibres, polymers (e.g. Polyamide)
Fishing line	Polyamide, Fluorocarbon
Hook	Steel, Iron, Carbon
Sinker	Lead, Tin, Metal alloys (with lead)
Artificial lure	ABS (Acrylonitrile Butadiene Styrene), Vinyl, Metals (Zinc Alloys, Lead)
Buoy	Balsa, Polyurethane, Polyurethane Foam, Fibreglass, Ethylene Vinyl Acetate

Fishing rods are generally made of fibreglass, carbon fibre or graphite fibre, which gives them strength and lightness. Carbon fibre rods are generally light and fibreglass rods are generally more resistant to shocks. Two important characteristics in the classification of fishing rods are: 1. the length (measured from the beginning of the handle to the tip), which is directly related to the throwing distance; 2. the throwing weight limit, which defines the maximum weight (sinker + bait) that the rod can support during throwing. For beach fishing (surfcasting), for example, a rod should be used with a casting capacity greater than 120 grams and a length greater than 4 metres. For float fishing a light-action rod (20 to 60 grams) should be used, with appropriate length for the place.

The reels are the equipment that, attached to the rod, houses the fishing line, and provide the conditions for launching and retrieving the line/hook/fish. Generally, the body is built in a strong and light material that can withstand all the pressure that is exerted inside and outside. For that reason, reels are composed of a combination of different materials in different proportions. These materials range from metal alloys and metals such as aluminium or zinc, to glass or carbon fibres and polymers such as polyamide.

The material that makes up a fishing line can vary based on numerous factors, but the main one is the size and type of fish to be caught. Nylon (polyamide) is the basic material of current fishing lines, with great resistance to breaking, abrasion and impact, and elasticity characteristics. In sport fishing it is also common to use another polymer called fluorocarbon (composed of carbon and fluorine). Fluorocarbon has two advantages over polyamide which can be useful in certain situations:

1. fluorocarbon yarn has a higher density than water and therefore sinks, whereas nylon yarn has a lower density than water, and therefore tends to float or sink little.
2. Fluorocarbon lines are almost completely transparent making them almost invisible to fish.

Hooks are mainly produced from three materials: iron, carbon, and steel. The most common are steel alloys, which can be plated in metal alloys.

Baits or samples may be natural, the most used, or artificial. The most commonly used natural baits in Madeira region are7: portions of polychaetes, molluscs (mainly squid or snails), decapods or small fish such as sardines and blue mackerel. Many fishermen use bait previously caught by themselves (such as snails, crabs or small fish) or bread.

Artificial specimens, which often have a hook attached, may be rigid or flexible. The rigid ones are made, for instance, from acrylonitrile butadiene styrene, and the flexible ones from vinyl polymer. The heads are sometimes produced from metal, such as zinc alloys or even lead.

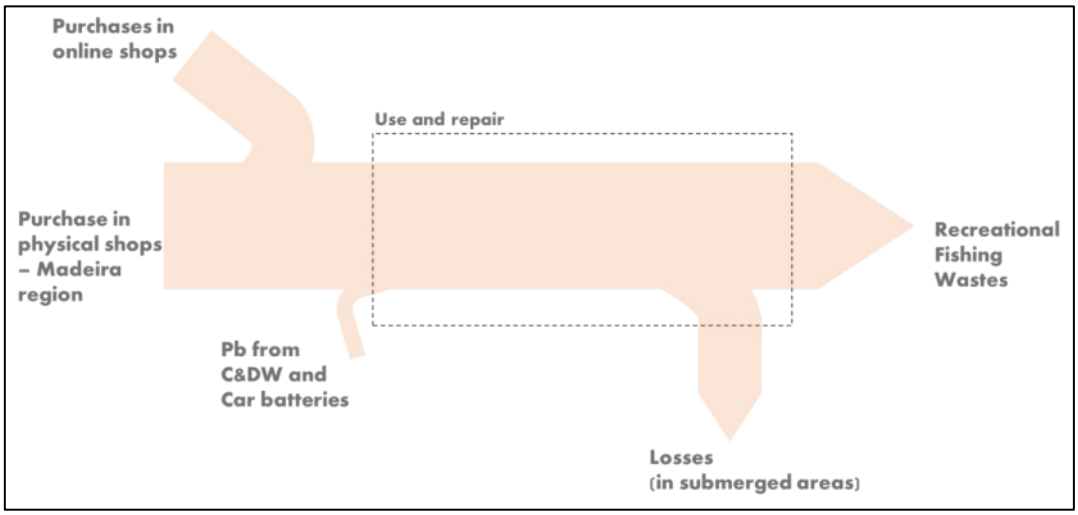
Buoys may be made of various materials that provide them buoyancy. Competitive fishing uses preferably balsa wood buoys[10]. Non-competitive recreational fishing uses buoys made of various other materials, namely Polyurethane, Polyurethane Foam, Fibreglass, Ethylene Vinyl Acetate.
Sinkers are heavy metal objects that are attached to the fishing line to prevent the live bait from swimming upwards or floating if it is injured under water. It is common for practiced fishermen to have casts to produce lead sinkers and make them from lead recovered from construction and demolition waste and car batteries. This practice may pose a health risk to fishermen who melt lead in the casts and breathe-in the vapours and particles of this heavy metal [11] .

QUANTITATIVE CHARACTERISATION OF FISHING MATERIAL FLOWS

Despite being subject to licensing, recreational fishing activity is not subject to as close control and scrutiny (institutional and public) as commercial fishing activity. On the other hand, apart from the regulated practice of sport fishing, the activity of the remaining thousands of recreational fishermen is almost completely unknown, namely regarding the type of fishing practiced or the type of equipment used. Additionally, it was not possible to obtain information from fishing shops in the region regarding the equipment purchased there. The accounting of material flows associated with this activity is therefore strongly conditioned.

The following paragraphs attempt to describe the main flows and the type of information needed to account for them. In some cases, values are estimated based on the empirical knowledge of practitioners, like the Architect Duarte Nóbrega, from the Regional Secretary of Environment and former leader of APDRAM, or Mr. Carlos Manuel Sousa, also a former leader of APDRAM.

The flow of fishing gear materials in the region of Madeira begins with the purchase of equipment by fishermen (Figure 4), either in specialty shops or in non-specialty shops, such as sports shops or others. Another means of entry of this equipment in the region are online shops.



[10]Very light wood, of South America, which combines lightness with stone and rock resistance.
[11] https://www.cdc.gov/niosh/topics/lead/exposure.html

Figure 4 - Main flows of recreational fishing gear (Pb - Lead; C&DW - Construction and Demolition Waste)

To account for the materials that enter the region and will sooner or later become waste (listed in Table 5), it is necessary to know how much equipment in the region is owned by people who fish recreationally, for sport or otherwise. In other words, it is necessary to know the number and type of rods, reels, fishing line, hooks, sinkers, artificial lures, and buoys.

As for sinkers, Duarte Nóbrega believes that currently only about 40% is acquired in fishing shops, the rest being used from C&DW and car batteries. This use of lead from waste is also associated with a parallel trade of lead shot among the fishing community.

According to data from DRP, the number of fishing licences issued in 2021 was 4375 (a decrease of about 1000 compared to the licences issued in 2017). According to Duarte Nóbrega there is some informality in the practice in the region, and, in his opinion, apart from sport fishermen[12], only about 40% of recreational fishermen may nowadays hold a license. Based on this assumption, the total number of recreational fishermen would be around 11,000, to which we may add the 80 members of APDRAM.
According to Duarte Nobrega a sports fisherman has on average about 12 fishing rods for his activity. The beginners have about 4 to 5 rods each and the professionals use about 20 to 25 rods. Thus, the number of rods associated to sport fishing will be around 1000.

Duarte Nóbrega estimates that a sport fisherman has, on average, about 12 fishing rods for his activity. The beginners will have about 4 to 5 rods each and the professionals use about 20 to 25 rods. Thus, the number of rods associated with sport fishing will be around 1000.

If each non-sport fisherman will have an average of 2 rods, the total number of active rods will be around 23,000. The number of reels will be at least the same.

As the number of hooks and sinkers per rod is variable, it is not possible to estimate their total quantity. Nor is it possible to estimate the length of line consumed given the varying capacity of the reels. The same is true for buoys and artificial samples, as the number of fishermen using buoy and those using artificial versus natural samples is not known.

Like commercial fishing, the practice of recreational fishing involves losses at sea. Whether of materials which are retained because they get stuck to rocks, such as sinkers or hooks, or materials which come loose due to the breaking of the fishing line (hooks or buoys and samples).

In Surfcasting, where the rods are stronger and where sinkers are used to submerge the wire, there may be a great loss of material (mainly sinkers) in rocky or stony immersed zones. There may be competitions where a sinker can be lost on each cast. Since fishing with a buoy is essentially surface fishing, the loss of material in each cast is scarce, with the occasional loss of a hook.

According to Duarte Nóbrega, in places like Paul do Mar or Penedia in Porto Moniz each fisherman can lose about 2kg to 3kg of sinkers, in about 100 launches per competition. In places like Porto Santo or Cais 8 in Funchal, less sinkers are lost because the activity is practiced on sandy beaches (in each competition only 2 or 3 sinkers will be lost, at most).

[12] All sport fishermen have a licence, a mandatory requirement for membership of APDRAM and for participating in sport fishing competitions.

A survey of the losses in each competition would allow to count the annual losses of materials in the submerged area of the fishing grounds, allowing to evaluate the urgency of adopting measures to reduce the losses. The number of sinkers accumulated in the submerged areas is a function of a) the number of tournaments per fishing method, b) the average amount of sinkers lost per tournament per angler and c) the average number of anglers per competition.

For demonstration purposes only, an estimate of those materials can be made for the events for which a record exists, assuming certain values of losses according to the characteristics of the fishing grounds. Table 6 lists the usual places where competitions organised by APDRAM take place and the characteristics of the immersed zone on each place. According to these characteristics, values of losses were assumed for each site [13].

Table 6 - APDRAM sport fishing competition venues, type of shore and values assumed for the loss of sinkers per Surfcasting competition, per angler

Sport fishing competition sites	Type of coast (submerged area)	Weight of sinkers lost per competition (kg)
Água de Pena	rocky / sandy	1
Cais 8 - Funchal	sandy	0,2
Lugar de Baixo - Ponta do Sol	mixed	0,5
Lugar de Baixo (Enrocamento)	rocky	2
Paul do Mar	stony / rocky	2
Porto Moniz / C. da Fontinha - Porto de Abrigo	rocky / sandy	1
Porto Moniz / Penedia	stony / rocky	2
Seixal / Laje - Porto Moniz	mixed	0,5
Porto Santo	sandy	0,2
Praia das Palmeiras - Santa Cruz	mixed	0,5
Praia de Natal - Caniçal	stony	2
Praia Formosa - Funchal	sandy	0,2
São Vicente (Vila)	sandy	0,2

As previously mentioned, DRP provided information on the competition schedules and statistics of some of the competitions held between 2017 and 2021, namely the competition venues, dates, and number of anglers in each competition (Annex). By computing the values assumed in Table 6 with the information provided by DRP, the annual number of sinkers lost per year in the Surfcasting competitions was estimated (Table 7).

Table 7 - Estimates of sinker losses in sport fishing competitions in the Autonomous Region of Madeira

Year	Weight of sinkers lost in surfcasting competitions (kg)
2017	288
2018	413
2019	350
2020	103
2021	113

[13] These are assumed values based on the values advanced by Duarte Nóbrega and the characteristics of the sites. They should not be used as a reference, as they cannot be validated, taking into account current knowledge and available information.

Annual losses of sinkers in the submerged areas of sport fishing are estimated to range from a high of around 400kg in 2018 to a low of 100kg in 2020. The considerably lower loss values in 2020 and 2021 result from the lower number of trials due to COVID-19 pandemic. Despite the necessary caution in reading these results, because of their low precision, assuming that the lost lead is not recoverable, it implies that during 2017-2021 period about one tonne of lead may have accumulated in the immersed areas of the competition sites. To this material (a heavy metal) steel or iron hooks and polyamide and fluorocarbon fishing wires must be added.

DISCUSSION AND RECOMMENDATIONS

This study is part of the CleanAtlantic project, which aims to increase the capacity to monitor, prevent and eliminate marine litter.

The study revealed that there is a great lack of information on recreational fishing activity, resulting in a great difficulty in accounting the material flows associated with this activity.

REPORTING

Ensuring a more accurate knowledge of the material flows will require taking steps to trace the annual quantities of gear sold in the region, on the one hand, and the potential waste generated, on the other.

Eventually equipment associated with recreational fishing may become, like commercial fishing gear, subject to extended producer responsibility and thus to reporting obligations along the lines of Commission implementing Decision (EU) 2021/958. Some facts, such as the use of online purchase by many fishermen, and the non-existence of a specific circuit for waste from this activity, will naturally hinder the accuracy of this reporting.

As proposed in the previous study on commercial fishing gear, Madeira region may become a pioneer in the collection and processing of this information. It will be potentially easier to identify the (local) operators in the value chain, turning information collection more agile.

The information to report will require a characterisation of the gear to quantify the different types of materials that make up the gear.

To know more accurately the dimension of the value chain of this equipment, it would be important that Madeira authorities carry out a greater scrutiny of the activity. Firstly, launching a broad survey of the activity to know the types of equipment used and the quantities. This survey could be complemented by a campaign of observation of the activity and counting of equipment in the most common places of fishermen gathering in the seasons and periods of the day identified in the socio-economic survey already conducted by DRP in 2017.

With the support of APDRAM, and shopkeepers it will be possible to define a methodology with composition factors that allow information to be processed in a more expeditious manner.

A regular record of entries of fishing gear (products put on the market) together with an analysis of the distributions of the average lifespan of the different gears allows estimating, from historical data, the annual waste production for different time horizons.

AWARENESS RAISING

A strategy to prevent marine pollution and to assure the proper management of waste resulting from recreational fishing depends entirely on fishermen's involvement. As in the case of waste in general, this type of strategy must be accompanied by a commitment to raise awareness of the actors in the value chain and, in the first instance, waste producers.

Awareness-raising actions must be accompanied by the creation, by the regional authorities, of conditions that expedite and simplify the correct separation and forwarding of waste, demonstrating to fishermen a joint effort. To this end, it would be important to assess the need to increase the number and volume of litter bins and containers in areas with a higher concentration of fishermen.

Awareness raising should include the demonstration of the consequences inherent to coastal marine litter - when possible, by using local examples to ensure a greater sense of identification. In addition, it is important that initiatives also have positive messages and incentives. This includes demonstrating possible waste destinations (e.g., products made from recycled polymers) and the value that waste may have.

Actions may include:

- Delivery of an awareness leaflet to the fisherman when purchasing the licence (either online or in person).
- Regular placement of awareness posters in the most frequent fishing spots.
- Awareness SMS sent to licensed fishermen, especially on days when fishing is most frequent.
- Develop awareness programmes with the support of shopkeepers (involving, for example, the inclusion of awareness messages on the labelling of some equipment, such as decoy buckets and others. The elements (e.g., stickers) to be added to the original labels may be developed together with DRAAC and DRP).

Initially incentives may be developed for fishermen who ensure the prevention of marine litter, including annual awards, even if symbolic, but which give visibility to those who make the most effort to ensure this goal. Also, an awareness campaign accompanied by distinctions awarded to fishing locations (e.g., "Clean recreational fishing location") may lead to peer control and discourage negligent practices.

LOSS CONTROL

The accumulation of materials (e.g., sinkers, hooks, fishing line) in the submerged and emerged areas of recreational fishing sites is a threat to marine ecosystems and may pose a danger to the public.

Accounting for losses will always be very difficult, especially for non-sport fishing. In the practice of sport fishing (that has provisions to ensure that the places where it is practiced are completely free of waste) it could be instituted that fishermen report the losses of material during the events.

In addition, it would be important to assess the possibility of setting up waste collection and recovery campaigns in the most common recreational fishing grounds, as the waste collection campaigns carried out in remote areas by DRAAC.

Notably, in this case there are technical and operational challenges for these campaigns, since most losses occur in areas usually immersed and with a difficult orography (rocky or stony areas).

When technically possible, this type of campaigns, could be an additional awareness-raising factor, demonstrating the consequences of the practice and encouraging discussion on possible changes in practices.

NEW MATERIALS AND SHARING ECONOMY

The shift towards more sustainable recreational fishing practices should include the substitution of some of the materials that can have higher environmental and health impacts and the incentive to prolong the lifetime of the equipment.

In order to reduce lead, which most likely represents the largest fraction of losses and is also the material that can pose the greatest environmental risk, there are already, according to ECHA[14], a number of alternative solutions on the market such as those made of tin, tungsten, glass, stone or various alloys. Currently, any of the alternatives are not very attractive to fishermen, since they are more expensive solutions. On the other hand, the density of lead allows the sinkers to be smaller and therefore easier to transport than the other solutions (usually with lower densities). Finally, any of these alternatives is still very scarce in the market, making their acquisition difficult even for those who are willing to spend more for a more environmentally advantageous solution [15].

The adoption of new solutions could be strongly encouraged when the EU adopts restrictions on the use of lead in fishing. However, given the relative ease of private production of lead shot (notably with lead obtained from used car batteries), if there is no strong enforcement in the early times after the restrictions come into force, it is unlikely that the change will be widespread, not least for economic reasons. The discouragement of the use of lead may eventually have to include an incentive for the use of alternatives, which may take the form of economic incentives (particularly for fishermen who are currently exempt from paying for a licence [16]). The increase in the use of alternative solutions will have the expected consequence of reducing prices, encouraging its more widespread adoption.

The reduction of the impacts of recreational fishing should also be based on decreasing material consumption, namely through the so-called sharing economy. As has been widely demonstrated, setting up systems to redistribute goods for reuse is an important part of the circular economy. To this end, in addition to the development of a widespread repair system (with experienced fishermen and tackle shops) conditions should be created to organise, re-condition and make gear available for re-use, either through sale, loan, rental or leasing systems. APDRAM could be supported to develop a platform for sharing, exchanging, or

[14] https://echa.europa.eu/hot-topics/lead-in-shot-bullets-and-fishing-weights

[15] At least in some cases, while their adoption is not widespread and therefore their accumulation in the marine environment is not considerable. Since these alternatives are disclosed by ECHA it is assumed that their potential impact on health and environment is lower than that of lead sinkers. However, it will be necessary to ensure that the potential consequences of a higher amount of some of the metals on ecosystems are analysed.

[16] The following are exempt from the payment of the fee for issuing the recreational fishing licence: a) Practitioners with a gross annual income lower than the Annual Minimum Regional Remuneration (RMRA); b) Retired practitioners; c) Practitioners with a proven degree of disability; d) Practitioners enrolled in the employment center.

selling second-hand, good condition or reconditioned materials. The Association should encourage this sharing economy especially among beginners or younger practitioners.

Shops should also be encouraged to create second-hand sales systems with guarantee, enabling the acquisition of better-quality equipment at more affordable prices.

Annex

Table 8 - Sport fishing events' schedules and statistics in Madeira region, 2017-2021 (Source: DRP)

Type of competition	Class	Day	Month	Site	Nr. of fishermen
2017					
Surfcasting	2nd Division	25	Jun.	Paul do Mar	32
Surfcasting	1st Division	25	Jun.	Paul do Mar	25
Surfcasting	2nd Division	2	Jul.	Paul do Mar	27
Surfcasting	1st Division	2	Jul.	Paul do Mar	26
Boia	Individual	9	Jul.	Água de Pena	11
Boia	Individual	23	Jul.	Água de Pena	11
Surfcasting	n.d.	29	Jul.	Seixal (Lage)	48
Surfcasting	1st Division	3	Sept.	Porto Moniz / Penedia	22
Boia	Clubs	10	Sept.	Água de Pena	25
Boia	Clubs	17	Sept.	Água de Pena	24
2018					
Surfcasting	Veterans	18	Mar.	Praia das Pal. - S. Cruz	13
Surfcasting	1st Division	25	Mar.	Paul do Mar - Calheta	32
	2nd Division	26	Apr	Paul do Mar - Calheta	25
Surfcasting	1st and 2nd Division	22	Apr.	Água de Pena G. P. das Palmeiras	31
Surfcasting	Jun. U16/U21	19	May	Porto Santo	16
Surfcasting	Arca D' Ajuda	27	May	Praia Formosa - Funchal	25
Surfcasting	Veterans	3	Jun.	Lugar de Baixo - P. de Sol	11
Surfcasting	2nd Division	10	Jun.	Paul do Mar - Calheta	19
Surfcasting	1st Division			Paul do Mar - Calheta	26
	Veterans	17	Jun.	Praia das Pal. - S. Cruz	10
Buoy	Individual	24	Jun.	P. Moniz / C. da Fontinha - P. de Ab.	19
Surfcasting	1st and 2nd Division	1	Jul.	Paul do Mar - Calheta	26
Buoy	Individual	8	Jul.	P. Moniz / C. da Fontinha - P. de Ab.	19
Misto 24h	CD Mar e Serra	14-15	Jul.	Cais 8 - Funchal	48
Buoy	Individual	22	Jul.	P. Moniz / C. da Fontinha - P. de Ab.	17
n.a.	CCD P. Moniz	28	Jul.	-	42
Buoy	Individual	2	Sept.	P. Moniz / C. da Fontinha - P. de Ab.	17
	Clubs	9	Sept.	P. Moniz / C. da Fontinha - P. de Ab.	20
Surfcasting	Clubs	16	Sept.	Paul do Mar - Calheta	29
Surfcasting	Clubs	30	Sept.	Água de Pena - Machico	30
Buoy	Clubs	7	Oct.	P. Moniz / C. da Fontinha - P. de Ab.	20
Surfcasting	Clubs	20	Oct.	Porto Santo	30
Surfcasting	Clubs	21	Oct.	Porto Santo	30
Surfcasting	1° Divisão	28	Oct.	Praia Formosa - Funchal	21
Buoy	Clubes	11	Nov.	P. Moniz / C. da Fontinha - P. de Ab	20
Surfcasting	1° Divisão	18	Nov.	Água de Pena - Machico	23
2019					

Surfcasting	2nd Division	24	Feb.	Paul do Mar - Calheta	23
Surfcasting	2nd Division	24	Feb.	Paul do Mar - Calheta	29
Surfcasting	Clubes	3	Mar.	Água de Pena - Machico	30
Surfcasting	1st Division	10	Mar.	Praia das Pal. - S. Cruz	28
Surfcasting	2nd Division	10	Mar.	Água de Pena - Machico	25
Surfcasting	Jun. U16/U21	31	Mar.	Praia das Pal. - S. Cruz	13
Surfcasting	1st Division	7	Apr.	Praia das Pal. - S. Cruz	28
Surfcasting	2nd Division	7	Apr.	Água de Pena - Machico	25
Surfcasting	Veteranos	25	May	Praia das Pal. - S. Cruz	14
Surfcasting	1st Division	2	Jun.	Paul do Mar - Calheta	26
Surfcasting	2nd Division	2	Jun.	Paul do Mar - Calheta	19
Buoy	Individual	9	Jun.	P. Moniz / C. da Fontinha - P. de Ab.	20
Surfcasting	Open Ind. - M. Ganança	16	Jun.	Praia Formosa - Funchal	20
Buoy	Individual	23	Jun	Lugar de Baixo - P. de Sol	20
Misto	24h APDRAM	29/30	Jun	Cais 8 - Funchal	42
Buoy	Individual	7	Jul.	Água de Pena - Machico	18
Misto	24h CD M. e Serra	13/14	Jul.	Cais 8 - Funchal	54
Surfcasting	Clubes	21	Jul.	Água de Pena - Machico	30
2020					
Surfcasting	Veteranos	16	Feb.	Praia das Pal. - S. Cruz	26
Surfcasting	1st Division	23	Feb.	Praia das Pal. - S. Cruz	29
Surfcasting	2nd Division	23	Feb.	Água de Pena - Machico	32
Surfcasting	Jun. U16/U21	27	Sept.	Praia das Pal. - S. Cruz	15
Surfcasting	Jun. U16/U21	10	Oct.	Porto Santo	15
Surfcasting	Jun. U16/U21	11	Oct.	Porto Santo	15
Surfcasting	1st Division	24	Oct.	Porto Santo	24
Surfcasting	1st Division	25	Oct.	Porto Santo	24
Surfcasting	T. da Madeira - Dupla	31	Oct.	Porto Santo	52
Surfcasting	T. da Madeira - Dupla	1	Nov.	Porto Santo	52
2021					
Surfcasting	Jun. U16/U21	15	May	Porto Santo	19
Surfcasting	Jun. U16/U21	16	May	Porto Santo	19
Surfcasting	2nd Division	23	May	Água de Pena - Machico	33
Buoy	Clubs	27	Jun.	Água de Pena - Machico	24
Surfcasting	2nd Division	4	Jul.	Água de Pena - Machico	34
Surfcasting	Jun. U16/U21	8	Aug.	Seixal/Laje - P. Moniz	16
Surfcasting	Clubs	12	Sept.	Água de Pena - Machico	30
Buoy	Clubs	19	Sept.	Cais 8 - Funchal	25