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ALTERNATIVE SOLUTIONS FOR DRIFTNET FISHERIES

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FISHERIES

ALTERNATIVE SOLUTIONS FOR DRIFTNET FISHERIES

STUDY

This document was requested by the European Parliament's Committee on Fisheries

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Abstract

The principal environmental impact of driftnets is related to the bycatch of non-target species. In general driftnets have a high degree of size selectivity and can efficiently be regulated by mesh size. Few alternative fishing methods are available to catch the species targeted by driftnets, and the impact for some of these gears is controversial. Solutions are proposed to mitigate the environmental impact of driftnet fisheries by alternative fishing gears and improvement of selectivity.

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LIST OF ABBREVIATIONS

ACDR	Aggregated Catch Data Reporting
CFP	Common Fisheries Policy
DGMARE	Directorate General for Maritime Affairs and Fisheries. It is the Commission department responsible for CFP and IMP implementation
EC	European Commission
ERS	Electronic Recording and Reporting System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
GND	Driftnets
GNS	Set gillnets (anchored)
GSA	Geographical Sub Area
GTR	Trammel nets
IBA	Important Bird Area
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IMP	Integrated Maritime Policy
IUU	Illegal, Unregulated and Unreported (Fishing)
JNCC	Joint Nature Conservation Committee
LLD	Drifting longlines
LLS	Set longlines
LOA	Length Overall
MLS	Minimum landing size
NGO	Non-Governmental Organisation
SAC	Special Area of Conservation
SPA	Special Protection Area
SSD	Small Scale Driftnets
SSF	Small Scale Fisheries
STECF	Scientific, Technical and Economic Committee for Fisheries
TCM	Technical Conservation Measures
UN	United Nations
UNGA	United Nations General Assembly
WWF	World Wide Fund for Nature

TECHNICAL TERMS

Anadromous fishes that migrate from the sea into fresh water to spawn; or fish that stay entirely in fresh water and migrate upstream to spawn

Bycatch the catch of non-target species and undersized fish of the target species. Bycatch of commercial species may be retained or discarded along with non-commercial bycatch

Catadromous fishes that migrate from fresh water into the sea to spawn; or, ones that stay entirely in fresh water and migrate downstream to spawn

Discards any fish or other living matter caught when fishing that is not retained but returned to the sea – alive or dead

Driftnet any gillnet held on the sea surface or at a certain distance below it by floating devices, drifting with the current, either independently or with the boat to which it may be attached. It may be equipped with devices aiming to stabilise the net or to limit its drift (*Ref. Council Regulation (EC) No 809/2007*)

Endangered species, stock or population is 'endangered' if it is facing a high risk of extinction in the wild in the near future

Fish stock scientifically, a population of a species of fish that is isolated from other stocks of the same species and does not interbreed with them and can, therefore, be managed independently of other stocks. However, in EU legislation the term 'stock' is used to mean a species of fish living in a defined sea area; the two are not always synonymous

Fishing power a relative measure of the ability of a vessel or type of gear to catch fish compared to another vessel or type of gear. Thus, a motor trawler is more powerful, in terms of catching capability, than a sailing smack or steam trawler, and a purse seiner is more powerful that a driftnetter

Fixed gear any fishing gear that is anchored or attached in some other way to the seabed so that it does not drift or move while it is in fishing mode – e.g. crab pots, long-lines and bottom set gill nets

Fleet (*gang*) any number of nets joined end-to-end and operated as one gear

Float a buoyant unit used to give lift or to mark the position of a net, or both

Floatline (headline) the principal upper frame rope of a net to which floats and netting are attached

Gavel line vertical frame line at each side of the driftnet. The purpose of the gavel lines is both to increase the entangling property of the net by slack hanging to the gavel lines and to strengthen the edge of the net

Gill cover or bony flap that covers the gills, the operculum

Hanging ratio the hanging ratio (E) is commonly defined as E = L/Lo = Length of rope on which a net panel is mounted (L) / Length of stretched netting hung on the rope (Lo)

Leadline (footline) the principal lower frame rope of a net to which netting is attached

Maxilla the upper jaw, or pertaining thereto

Mesh selection the process by which fish above a certain size are unable to pass through the meshes of a fishing net but fish below that size can do so.

	It works most successfully in free-hanging nets such as driftnets and gillnets, but trawls are also regulated by minimum mesh size (MMS). The efficiency of trawl mesh selection varies enormously with mesh shape
Minimum Landing Size (MLS)	the smallest length at which it is legal to retain fish or offer it for sale. In theory, it is the minimum length at which no less than 50 % of a given species first reach sexual maturity. In practice it tends to be set at a level influenced by market acceptability, and is frequently less than the biological optimum
Minimum Mesh Size (MMS)	the smallest size of mesh that can be used legally in any given type of net. It is measured either down one side of the mesh (knot-to-knot) or across the diagonal under tension (stretched mesh). The MMS is set to allow at least 50 % of the target species at their MLS to pass through the mesh
Netting	meshed structure of indefinite shape and size composed of a yarn or of one or more interlaced or joined yarn systems, or obtained by other means, for example by stamping or cutting from sheet material or by extrusion
Non-target species	any species that form part of the bycatch but are not (one of) the principal species that the fishery is exploiting
Pelagic	living from midwater to the surface of the sea
Preopercle (preoperculum)	the bone between the cheek and the gill cover
Rigging trawl	the process of fitting the necessary ropes and accessories so as to make a net ready for fishing
Selection curve	the variation in the proportion of fish encountering a net that are retained by a given mesh (or fish-hook) size
Selectivity	a measure of a gear's ability to target and capture a species of fish while allowing juveniles and non-target species to escape
Selvedge (selvage rope)	a rope running lengthwise along the join between two pieces of netting in the direction of the axis of the trawl
Semi-driftnet	drifting gillnet anchored to the bottom at one end of the net
Set net (fixed net)	general term for any simple net when it is held in fishing trim by anchors, sinkers and/or stakes
Sinker	one of the weights spaced along the leadline of a fishing net
Static gear	any form of fishing gear that operates without being towed or moved through the water – *e.g.* crustacean pots, long-lines, set nets, traps, etc.
Technical conservation measures	fishery management measures involving primarily the fishing equipment used rather than fishing time, place, or catch, e.g. minimum mesh size (MMS), engine power, width of individual (*e.g.* scallop) dredges, and number towed by one boat
Undersize fish	any fish that is less than the legal minimum landing size (MLS)

Source*: Several of the above-listed definitions are from the Glossary of Marine Nature Conservation and Fisheries (Anon., 2001) and the Multilingual dictionary of fishing gear (Commission of the European Communities, 1992).*

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EXECUTIVE SUMMARY

Introduction

Driftnets have been used since antiquity, and small-scale driftnets (SSDs) have been used throughout the EU for many years without raising particular concern to fish small-medium pelagic species like anchovy, European pilchard, and mackerel. However, in the late 1970s and 1980s large-scale driftnets with much larger mesh sizes and greater length were introduced, resulting in significant incidental mortality of protected species including cetaceans, sharks and rays, and giving rise to environmental concern (Oceana, 2005; 2007; 2008).

The uncontrolled use of large-scale driftnets and their devastating effects on many vulnerable species have led to attempts to apply stricter legislation on driftnets (UNGA, 1991; IWG, 1990). In response to the expansion of large-scale driftnet fisheries and associated environmental concerns, in 1992 Council Regulation (EC) No 345/92 reduced the total size of driftnets that could be used in EU waters (except the Baltic Sea, the Belts and the Sound) and by EU vessels outside EU waters to 2.5 km.

However, the legislation did not halt the expansion of large-scale driftnet fisheries. A number of additional regulations have since been introduced to address the problem. The aims of the additional measures were to:

- provide a clear and unambiguous definition of a driftnet;
- protect certain groups of pelagic species including tuna, swordfish, billfish, several sharks and all cephalopods (listed in Annex VIII of EU Reg. No 894/97 as amended by Regulation (EC) No 1239/98) and prohibit landings of such species incidentally caught in driftnets;
- protect harbour porpoises in the Baltic Sea.

Current driftnet fisheries in EU waters

According to the two latest studies published by EC-DGMARE (2014a; 2014b)[1] and to the author's personal contacts with Member States, 45 active SSD fisheries operate across the main EU regions: Baltic Sea; Black Sea; Mediterranean; North Sea including the Skagerrak and Kattegat (hereinafter North Sea);and North-East Atlantic.

An SSD fishery originating from Poland was identified in the **Baltic Sea** despite the ban on driftnets. It operates inshore and primarily targets salmonids using a *semi-driftnet.* Three active driftnet fisheries - two Bulgarian and one Romanian - were identified in the **Black Sea**; one is a marine fishery targeting Atlantic bonito (*Sarda sarda*), the other two operate in rivers and estuaries and target a range of species including Pontic shad (*Alosa immaculata*). Most of their vessels are under 12 m long.

[1] EC-DGMARE, 2014a. Study in support of the review of the EU regime on the small-scale driftnet fisheries. Final project report (Ref. No. MARE/2011/01) including ten case study reports for selected Member States, published on 24/07/2014, 295 pp.
Available at: http://ec.europa.eu/fisheries/documentation/studies/small-scale-driftnet/index_en.htm
EC-DGMARE, 2014b. Identification and characterization of the small-scale driftnet fisheries in the Mediterranean (DRIFTMED). Final project report, published on 28/07/2014, 287 pp.
Available at: http://ec.europa.eu/fisheries/documentation/studies/driftmed/index_en.htm

The **Mediterranean** has eight active driftnet fisheries originating from Italy. According to the DRIFTMED study (EC-DGMARE, 2014b) they target a variety of species; primary targets include anchovy (*Engraulis encrasicolus*), European pilchard (*Sardina pilchardus*), amberjack (*Seriola dumerili*), Atlantic mackerel (*Scomber scombrus*), chub mackerel (*Scomber colias*), bogue (*Boops boops*), horse mackerel (*Trachurus trachurus*), bluefish (*Pomatomus saltatrix*) and saddled sea bream (*Oblada melanura*). Six of these fisheries operate on the western coast of Italy and two on the southern coast (Catania and Selinunte, Sicily). According to the author's contacts with the Spanish Ministry, another driftnet fishery targeting sardine is found in the EU Mediterranean, but is not included in the EC-DGMARE (2014a; 2014b). Some vessels in the area of Malaga (Spain) use a net called *"Sardinal"*, which is very similar to the *"Xeito"* driftnet originating from the north of Spain.

Seven driftnet fisheries operate in the **North Sea**, six of which originate from the United Kingdom (UK). They primarily target cod (*Gadus morhua*), Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), Atlantic herring (*Clupea harengus*), common sole (*Solea solea*) and sea bass (*Dicentrarchus labrax*). All UK driftnet fisheries but one are found in ICES division IVc; the sixth is the north-eastern salmon fishery (region IVb). The seventh fishery originates from Sweden and targets mackerel in the Skagerrak and Kattegatt. There are 25 active driftnet fisheries in the **North-East Atlantic** originating from France, the UK, Spain and Portugal. In this region they target species such as sea bass, Atlantic salmon, herring, common sole, European pilchard, mackerel, shad (Alosa spp), lamprey (Petromyzontidae) and sea bream (Sparidae). The majority of driftnet vessels are under 12 m in length and operate within 12 nm of the shore.

Aim

The aim of the present study is to analyse and review the literature to find and explore alternative solutions to a complete ban on driftnet fisheries, taking into account the scientific evidence of the damage that driftnets may cause to the environment in the different EU regions. It also looks at alternatives (EU-wide, national or regional) both in terms of shifting of fishing gear and technical solutions and of possible conversion to other activities.

The analysis draws upon the existing literature on: *i)* the main characteristics of driftnets in EU fisheries (e.g. mesh size, twine thickness, hanging ratio, etc.); *ii)* use of fishing gear (e.g. maximum distance from the coast, soaking time, fishing season, etc.); *iii)* number of vessels involved in this type of fisheries; *iv)* number of people involved in the use of driftnets both in the fisheries sector and in processing industries. After assessing the possible impacts of SSDs on the ecosystem, including both protected and non-protected species, the study provides recommendations for policymakers to base their decisions on the circumstances in which driftnet use is not acceptable. It also examines the effectiveness of a possible ban making it illegal to keep other fishing gear (e.g. longlines) on board to circumvent controls.

Evaluation methodology

The analysis is based on the latest available information from a range of sources including academic publications, studies, research projects, websites and databases of European Institutions and Members States bodies, but especially on two studies:

- *"Study in support of the review of the EU regime on the small-scale driftnet fisheries"* (EC-DGMARE, 2014a);
- *"Identification and characterization of the small-scale driftnet fisheries in the Mediterranean (DRIFTMED)"* (EC-DGMARE, 2014b).

These studies provide detailed information on driftnet gears, fishing capacity and fleet activity, composition of catches, and impacts on vulnerable species and the environment in general. In addition, data regarding three further SSD fisheries, not examined by the two studies, were included in the current report based on information obtained through the author's contacts with the Swedish and Spanish national fisheries bodies.

This analysis presents the most recent data as clear tables and figures, supplies critical information, and sets forth recommendations for consideration by the Members of the European Parliament. Its aim is to be comprehensive and comprehensible by non-specialists and to provide only data relevant to decision-making, excluding non-essential information.

Study overview

The study is divided into eight chapters. The first provides a general description of driftnet fisheries, with particular emphasis on the capture method and main technical features of SSDs. Chapter 2 describes the currently active SSD fisheries in EU according to the latest two projects funded by DGMARE (EC-DGMARE, 2014a; 2014b). The technical features of driftnets are reported in Chapter 3.

Chapter 4 assesses the impact of SSDs by evaluating which fisheries are most likely to interact with protected and Annex VIII species (EU Reg. No 1239/98). Chapter 5 discusses the EU regime on SSD fisheries and examines the four policy options proposed by DG-MARE to revise the current EU driftnet regime.

The purpose of Chapter 6 is to identify and describe alternative fishing methods to catch the same species or group of species now being exploited by SSDs, assess and discuss their environmental impact, and establish whether they could replace SSDs. Chapter 7 provides the fundamentals of the methods for measuring the selectivity of driftnets and other static gears. Chapter 8 formulates recommendations regarding alternative fishing gears and improvements in SSD selectivity, to mitigate the negative impact of driftnet fisheries on the environment, for consideration by policymakers.

1. DESCRIPTION OF DRIFTNETS AND METHOD OF CAPTURE

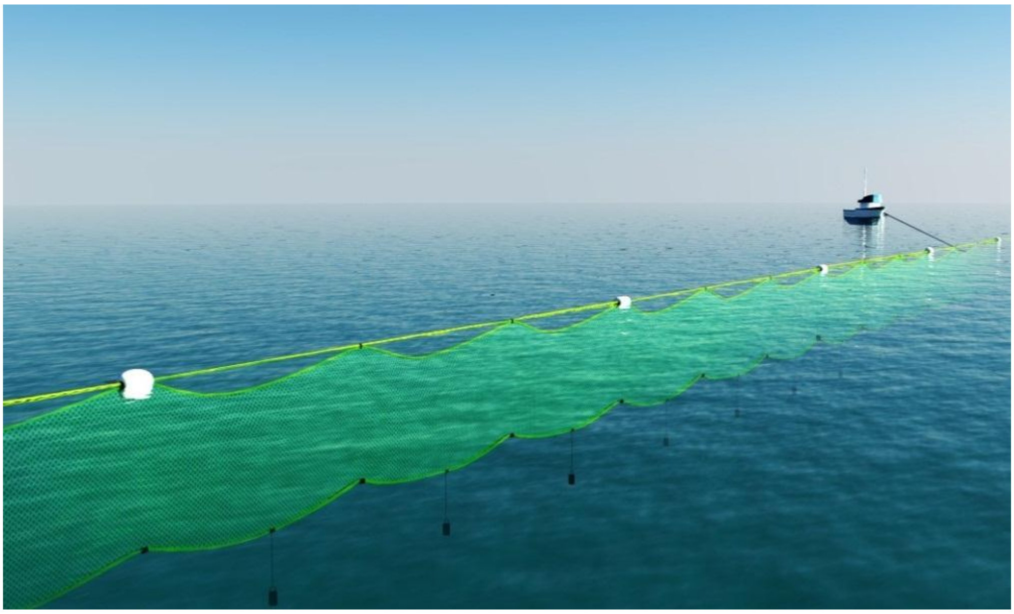
KEY FINDINGS

- Drift-netting is a very efficient fishing method, especially to catch fish near the surface and when fish are schooling, but it is also used on the bottom, in mid-water, and to catch scattered fish. Compared with stationary (set) nets, it requires the constant presence of the vessel, hence the fishermen, and is therefore more demanding and laborious than stationary set nets.
- Drift-netting is a common fishing method used to catch a variety of species all over the world. There exist a large number of gear types and variants. Driftnets vary widely in overall dimension, colour, mesh size, twine material and thickness, hanging, and rigging of weights and floats.
- Driftnets are classified according to the fish species they are designed to catch and/or how they are positioned in the water column.

Based on the general method of capture, the driftnet belongs to passive fishing gears. It is set straight out in the water, forming a vertical net wall or barrier of netting perpendicular to the migration direction of fish (Figure 1). The same nets may be used to surround or encircle the fish, which may then be herded into the netting. When used in this way the nets act rather as an active fishing gear, and are generally referred to as encircling gillnets (Karlsen and Bjarnason, 1986).

A representative picture of a driftnet is shown in Figure 2. Its main components include netting, floatline, lead line, floats, sinkers, buoys, buoy lines, and gavel lines. Construction of a driftnet is not very different from a stationary set net, and the same net is often used for both fishing methods; the differences lie in rigging arrangements and net operation. Driftnets may be set as single nets, but most often several nets are tied together into a fleet (or *gang*) of nets.

Figure 1: Small-scale surface driftnet

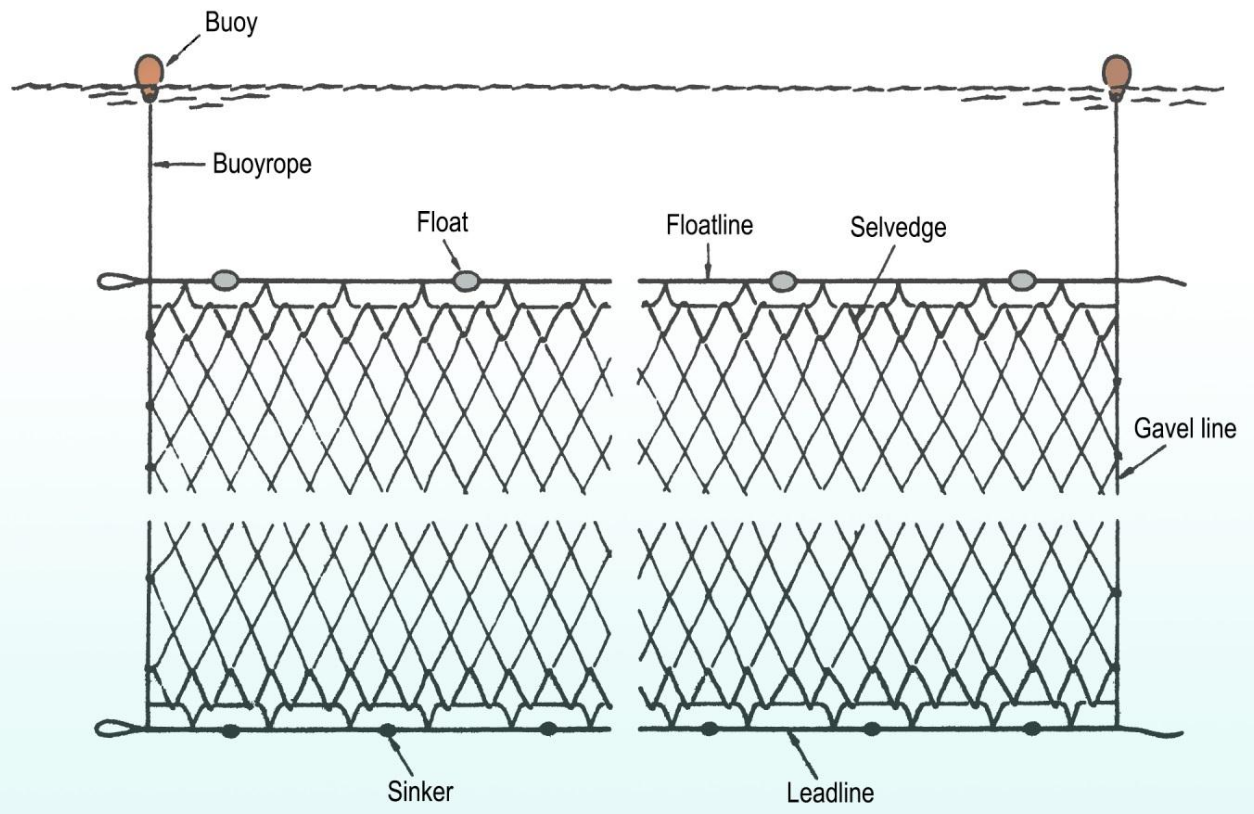


Source: FAO (2011)

Unlike fixed gillnets, driftnets are left free to drift with the water movement. In some fisheries the nets are attached to the vessel by a rope or cable at one end of the fleet, in others they are just allowed to drift alone. However, when the driftnets are set for fishing the vessel needs to be in the fishing ground, because for instance the diurnal migrations of some pelagic stocks can give rise to very heavy fishing in a short time, and even to loss of the nets if they are not closely watched, or because of possible entangling with other driftnets or other fishing gears used in the area. Since driftnets may be a navigational hindrance to passing vessels, it is essential that the nets be well marked with buoys in the daytime and with lights at night, especially in areas of intense seagoing traffic.

The way a driftnet takes fish varies by in relation to fishing conditions and to fish head and body shape. The key requirement is that the fish cannot pass through the net meshes, but when attempting to do so draws the net around itself with such force that it cannot free itself (Karlsen and Bjarnason, 1986). The fish is then held by the twine of the mesh around its head (**snagged**), behind the gill cover (**gilled**), or around the abdominal and dorsal fins (**wedged**), or simply by the teeth, opercular spines, auxiliaries or other projections, drawing adjacent meshes around itself, twisting and rolling itself in the netting (**entangled**). The main parameters affecting the catch rates of driftnets are reported in detail in Chapter *7.3. Factors affecting selectivity*.

Figure 2: Main components of a driftnet



Source: adapted from Karlsen and Bjarnason (1986)

1.1. Advantage and disadvantage of driftnets

An **advantage** of drift-netting is that it is a very simple fishing method, particularly suited for small-scale fishing. It is suitable for small fishing boats with a crew of one or two even without simple gear handling equipment. It is also very efficient, especially in catching fish near the surface and when fish are schooling, but it is also used on the bottom, in mid-water, and to catch scattered fish. Another advantage is that the gear can be set at any depth in the water column. Driftnets can be worked in stronger currents than set gillnets and are better suited for river fishing. Notably, they are less prone to be fouled by seaweed or objects drifting with the current than stationary set nets, and are not as easily seen by fish.

A **disadvantage** compared with stationary (set) nets is that driftnets require the constant presence of the vessel, hence of the fishermen. Where setting and hauling of the gear is frequent, drift-netting is more demanding and laborious than set nets. Another disadvantage is that the fishing gear is exposed to damage by passing ships.

1.2. Types and main gear parameters of driftnets

Driftnets may be classified according to the fish **species** they are designed to catch and/or by how they are **positioned** in the water column. In some fisheries, like North Atlantic salmon and herring fisheries or Mediterranean anchovy fisheries, driftnets are very specialised fishing gear, and the nets are carefully designed for the size and distribution characteristics of a single species. Because drift-netting is a common method used to catch a variety of species all over the world, there are a large number of types and variants. With respect to depth positioning driftnets may be distinguished into **surface**, **mid-water** and **bottom driftnets**. Driftnets (and gillnets) vary widely in overall dimensions, colour, mesh size, twine material and thickness, hanging, and rigging of weights and floats.

1.2.1. Types of Netting Material

The four most widely used materials for fishing gear manufacturing are shown in Table 1. Whereas all four are used to make frame ropes and hanging lines, netting is exclusively made in nylon except in the case of salmon nets, where terylene provides the physical attributes of heaviness, required by the absence of a fishing line, and stiffness, needed to prevent salmon from forcing its way through the net (Hansen and Moth-Poulsen, 1999).

Fishermen are aware of the importance of material type in relation to catch performance and physical features. The physical characteristics of the main twine are reported in Table 2. Multifilament nets are held to be the least efficient despite being the strongest. Multi-monofilament nets are considered as the most efficient, because the thin parallel threads make the net ‘softer’ than monofilament or multifilament nets.

Table 1: The four most widely used synthetic fibres to make fishing gears

Polymer name	Abbreviation	Trade name
Polyamide	PA	Nylon
Polyester	PES	Terylene
Polyethylene	PE	Nymplex
Polypropylene	PP	Danaflex

Source: Sala et al. (2013)

The different qualities of the netting materials often entail distinct use patterns. Studies comparing monofilament and multifilament nets demonstrated that differences may be species-dependent. Stewart (1987) compared the nets used in British cod fisheries and found that the multifilament net has a better catch performance than multi-monofilament and monofilament nets. Catch differences may be related to the way fish are enmeshed, since multifilament and multi-monofilament nets were seen to catch considerably more entangled fish. Furthermore, the monofilament net was hard and springy whereas the other two materials were softer (Stewart, 1987).

Table 2: Physical construction of the twine[2]

Definition	Description
Multifilament	A nylon multifilament twine twisted from 2 (210/2) up to 9 (210/9) or multiple single yarns twisted from a vast number of small filaments < 0.1 mm thick. The twine is non transparent, quite firm and inelastic
Monofilament	Consists of a single solid nylon filament. The knots are tied with double knots and the netting is mechanically stretched in depth, and often also heat-set in order to increase knot firmness
Multi-monofilament	Typically consists of 3 (1.5x3) up to 10 (1.5x10) monofilament twines loosely twisted into each other
Super-multimonofilament	Made in the same way as multi-monofilament, but with thinner monofilament twines often in a given number, typically 0.5x8 or 0.5x12; the latter therefore has 12 monofilament twines 0.12 mm in diameter. A very flexible twine, as indicated by the name "supersoft"
Mono-Twine	Usually made from 3 monofilament twines each twisted round its own axis to the left (S) and then round each other to the right (Z), to obtain a twine stiffer than multi-monofilament. Typical twines are 4x3 and 5x3
Mono-ACE	A very loosely twisted, silky net; for example the 225/6 consists of 6 twines of denier thickness 225, each consisting of loosely twisted unbroken filaments; as a result the final twine appears as a slack bunch of unbroken twines. Strong but wears easily. Mostly used in trammel net and cod net manufacturing

Source: adapted from Hansen and Moth-Poulsen (1999)

1.2.2. Colour of netting

Nettings are available in different colours. The most popular are orange, white, grey and green, but preferences vary from year to year and between landing sites. The reason for the different effect of different colours is unclear, but is related among other factors to the contrast of the netting against the sea surface and bottom. Even though fish can use other senses to detect nets, vision seems to be the most important (Parrish, 1969); in general, less visible nets catch more fish. Clear monofilament nets, nearly invisible to humans in the

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[2] See *Annex 3*, for details on textile measurement (i.e. den and tex) and manufacturing process of sewing thread (i.e. S- or Z-twist).

water, are usually the most efficient (Jester, 1973). Since visibility depends on how net colour and tone contrast with background, it may be affected by the time of day and by seasonal changes in water clarity or colour. As a rule, Andreev (1955) recommended darker nets in good light or clear water, and lighter nets in turbid water.

Fish can see colours, and nets of different colours may result in several-fold differences in catches. The effect of colour can vary with species due to differences in behaviour or colour sensitivity; for instance, colour and visibility may be irrelevant to species that are active at night. Wardle et al. (1991) discussed the visibility of monofilament nets from a physical standpoint and showed interesting patterns in relation to object orientation in water as well as to differences in air and water reflection.

Although much remains to be done in assessing the importance of colour in driftnets and other gillnets, considerable gains in catchability can be obtained by choosing an appropriate colour when targeting definite species. The results reported by Jester (1973) and Tweddle and Bordington (1988) indicate that catch rate differences between the most and least efficient colours may exceed a factor of two (Hovgård and Lassen, 2000).

1.2.3. Twine thickness

Fishermen and net manufacturers are aware that nets constructed of thinner twine catch considerably more fish than those made of coarser materials (Hovgård and Lassen, 2000). Fishermen usually attribute the higher fishing power of finer nets to their being ‘softer’. The dimension of the netting material implies a trade-off between fishing power and net durability, since nets made of fine materials are more easily damaged. In commercial fisheries, durability and ease of handling are often the main factors steering the choice towards relatively coarse netting materials.

1.2.4. Net hanging ratio

The hanging ratio, E, is defined as the length of the frame lines relative to the stretched length of the netting; details are found below in *Annex 3 (General specifications of the main gear metrics)*. Nets meant for catching fish by snagging, gilling or wedging should be hung tighter (i.e., more stretched out) with a high hanging coefficient than typical entangling nets. In practice, the hanging ratio for entangling nets is generally in the range of *E=0.5* or less, whereas the hanging ratio for driftnets generally ranges from *E=0.5 to 0.8*.

It is not uncommon for netting to be hung unequally to the floatline and the lead line, in which case a higher hanging coefficient is usually applied on the lead line. The advantage of a longer lead line (higher hanging coefficient) is that jellyfish, seaweed or other flotsam get tangled in the net less easily during fishing and/or fall out more easily during hauling. It has been claimed that larger fish get entangled more easily in nets with increased hanging ratio at either frame line (Karlsen and Bjarnason, 1986; Hovgård and Lassen, 2000).

1.2.5. Mesh configuration

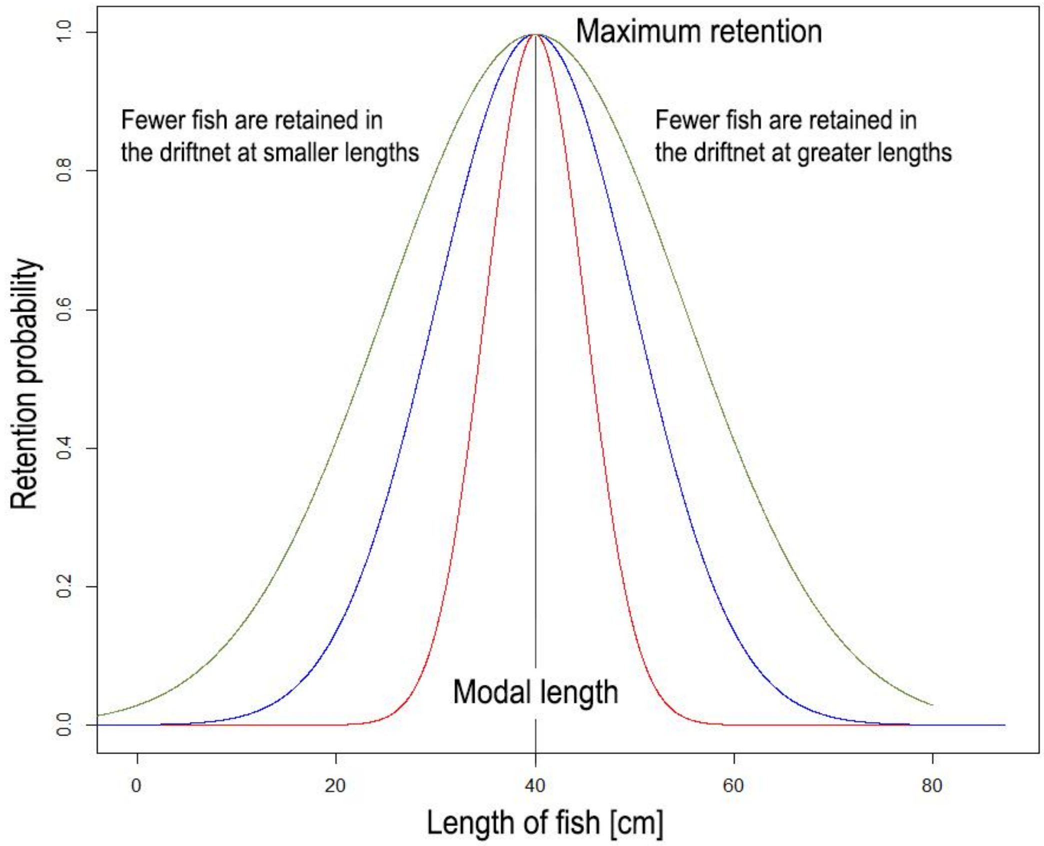
Since driftnets are generally much longer than deep, it is an advantage for the manufacturer to orient the netting lengthwise (against the "run"); see below (*Annex 3 General specifications of the main gear metrics)* for details. In this way several nets can be braided together to reach any desired length. In contrast the catching efficiency of entangling nets may be enhanced with the netting oriented with the N-direction (with the "run”) lengthwise, because of mesh, shape and slack hanging. Fleet (or *gang*) dimension depends on the vessel, and fleet structure will often be different due to different mesh sizes fishing together in a gang.

1.2.6. Mesh size

Mesh size is a major parameter affecting selectivity and has therefore been extensively explored. According to the theory of relative fishing efficiency the "right" mesh size in relation to the species to be caught crucially affects fishing efficiency. The fishing efficiency of the driftnet for a particular fish species can be demonstrated by the relative fishing efficiency or **selectivity curve**.

The selectivity of gillnets has thoroughly been studied by Hamley (1975) and Hovgård and Lassen (2000). A typical configuration of a selectivity curve is shown in Figure 3. **For a net of given mesh size, the selectivity curve expresses the ratio of the number of caught fish with a certain length to the total number of fish for all actual fish lengths**. As the curve demonstrates, a net with a particular mesh size catches fish of a particular length most efficiently and has considerably reduced catching efficiency of both smaller and larger fish.

Figure 3: Typical 'bell-shaped' selectivity curves of three hypothetical mesh sizes of driftnets and other gillnets

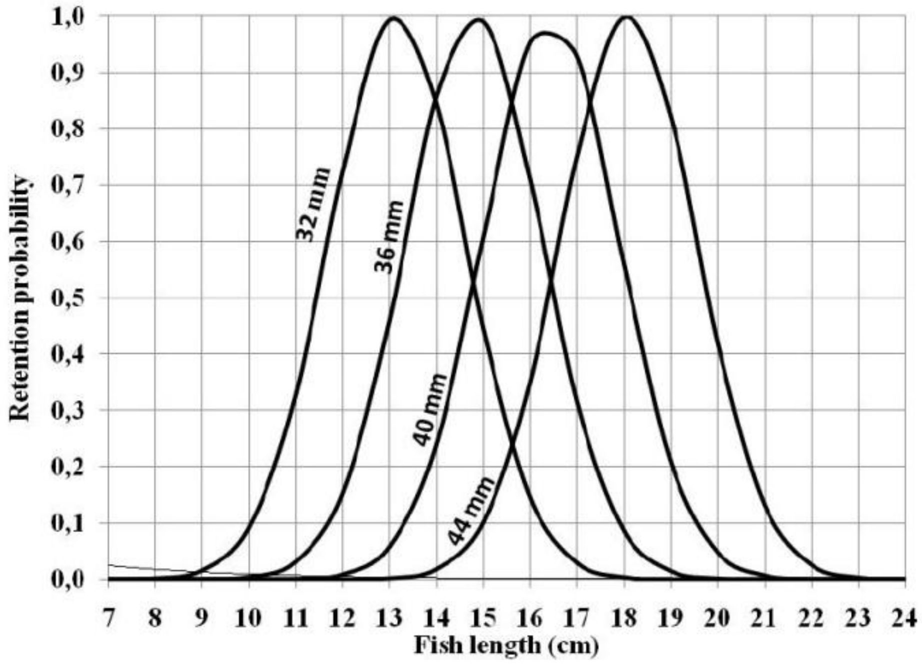


Source: A. Sala

Note: In the diagram the mode corresponds to the optimum length of fish caught; the width is the selection range; the height is how efficiently the mesh catches fish of the optimum length, and the shape varies according to several characteristics of net and fish.

Most studies investigate variations in mesh size while keeping constant the other factors that are known to affect selectivity. In the example reported in Figure 4, Dinçerand Bahar (2010) showed that the optimum lengths for red mullet (*Mullus barbatus*) for all meshes tested were above an MLS of 13 cm. Of the four mesh sizes, the 36-mm mesh had the highest catching efficiency (35 %) and was therefore recommended since it was more conservative with regard to fisheries management policies.

Figure 4: Selectivity curves for red mullet (*Mullus barbatus*) caught by monofilament gillnets of four different mesh sizes (32, 36, 40, 44 mm)



Source: Dinçer and Bahar (2010)

To understand why catching efficiency is closely dependent on the ratio of mesh size to fish length it is essential to understand how fish are actually caught in driftnets (and other gillnets). According to the literature the main catch processes in static gears are (Figure 5):

(a) **snagging**: the fish is enmeshed at the level of the head; this catch process is most common for species with protruding maxillae or preopercula;

(b) **gilling**: the fish is enmeshed immediately behind the gill cover;

(c) **wedging**: the fish is enmeshed around the body somewhere behind the gill cover. Wedging is hardly distinguishable from gilling when the maximum girth is close to the gill cover;

(d) **entangling**: the fish is wrapped into the netting, held by pockets of netting or attached to the net by teeth, fins, spines or other projections. Fish that are already caught by other catch processes may subsequently become entangled while struggling to free themselves. When recording catch processes, care should be taken to classify such catches by the primary catch process.

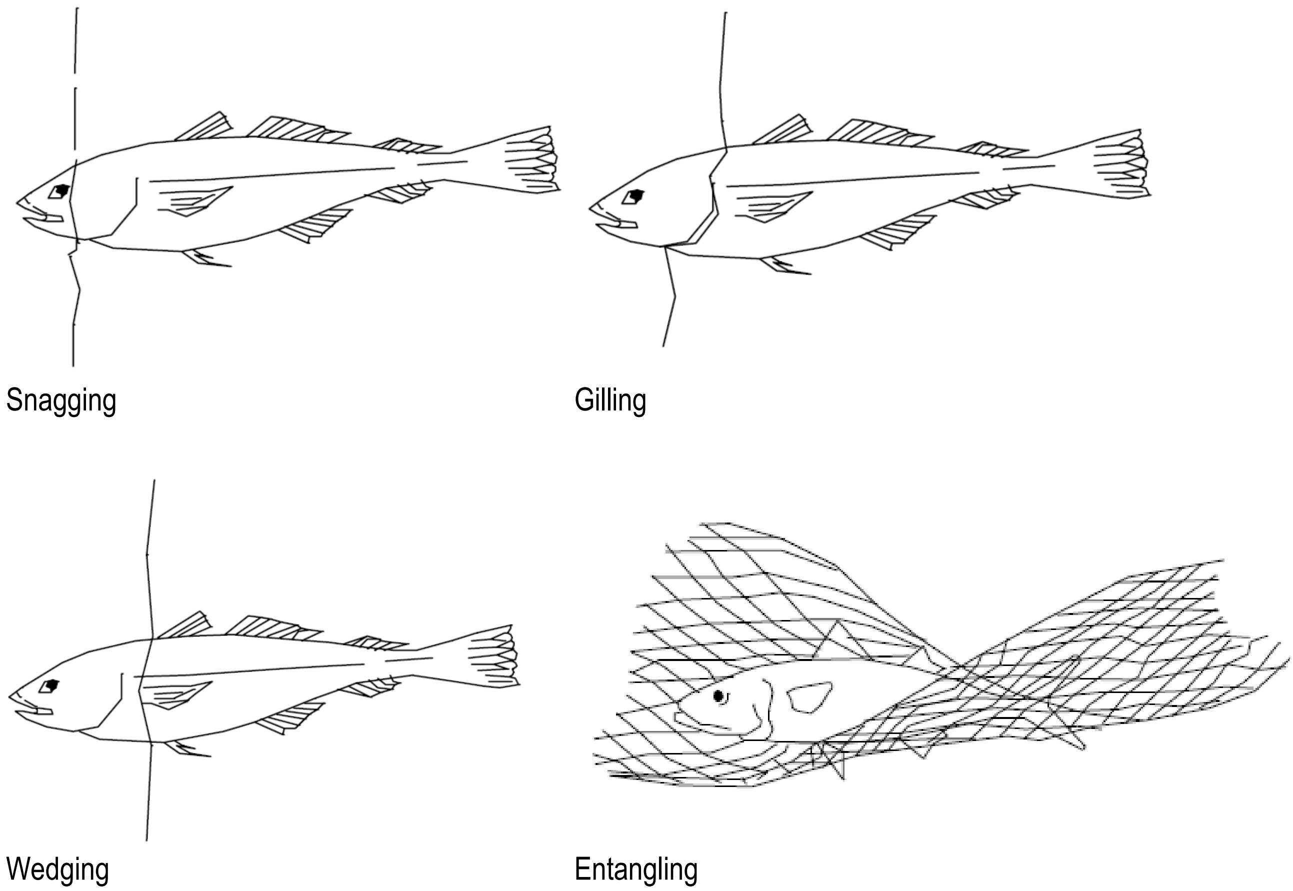
Efficient catching according to (a), (b) and (c), involves a relationship between mesh size and the width of different parts of the fish body. If the fish is too small, it can pass through the net without being caught in any single mesh, and if it is too large it cannot penetrate far enough into the mesh to get snagged or gilled. Consequently, (a) to (c) are the methods that contribute most towards the narrow, high, efficient part of the selectivity curve and are the main factors affecting mesh selection.

Optimum mesh selection in fishing a particular stock depends on several factors such as fish shape, the softness of its skin, and the elasticity of the twine in the net. This may entail a dual benefit:

1) if the stock has a uniform fish size, a successful catch rate can be obtained if the mesh size has maximum efficiency for that particular fish length;

2) in case of widely different fish lengths the average length of the catch can be selected by the mesh size. In some cases it will be profitable to select the mesh size corresponding to the largest year class of fish, but other factors such as special market requirements may involve a preference for smaller fish.

Figure 5: Four fish catch processes using static gears



Source: adapted from Karlsen and Bjarnason (1986)

Method (d) does not rely heavily on mesh size, and entangling efficiency depends mainly on factors related to the type of fish, twine twisting (soft or hard lay), the hanging ratio of the net, and the ballast and floats used. Entangling nets are generally loosely hung with few floats and little ballast. They can be made of thinner twine than nets designed to catch the same or similar species by gilling. In some developing countries entangling nets are mostly used as an alternative to gillnets, because gillnet material is not available. **Trammel nets** are nets specially designed to catch fish by entangling.

2. DRIFTNET FISHERIES IN EU WATERS

KEY FINDINGS

- There are currently 45 active driftnet fisheries identified in nine Member States (Bulgaria, France, Italy, Poland, Portugal, Romania, Spain, Sweden, and UK) operating in EU waters. Together they account for around 3640 vessels, of which about 1380 are involved in marine driftnet fisheries and ca. 2260 in inland fisheries, more than half of the latter vessels being accounted for by the Romanian fisheries targeting shad species (1355 vessels). The 45 fisheries target over 20 different species including marine species, and anadromous and catadromous species.
- Driftnet fisheries are largely small-scale, most vessels measuring less than 10 m in length and operating from a range of ports. Vessels participating in driftnet fisheries are generally polyvalent and use a variety of gears throughout the year; driftnets may only be employed in certain months for particular target species.

The present study uses information on driftnets, including fishing capacity, composition of catches and environmental impact that has been published by EC-DGMARE (2014a; 2014b). The author's personal contacts with the Swedish and Spanish fisheries bodies have allowed to add three further small-scale driftnet (SSD) fisheries not mentioned in the EC studies. Overall, 45 active SSD operating in EU waters were identified in 9 Member States (Bulgaria, France, Italy, Poland, Portugal, Romania, Spain, Sweden, and UK), accounting for about 3640 vessels in total. Of these vessels, close to 1,380 operate in marine fisheries and about 2260 operate in inland driftnet fisheries, more than half of the latter vessels (n=1,355) belonging to the Romanian fisheries targeting shad species. The 45 fisheries target over 20 different species including marine species and anadromous and catadromous species. A description of EU fisheries using driftnets ≤ 2.5 km long and the main technical features of the gears used in each fishery are summarised in Table 3. Fisheries were attributed unique reference numbers (ID) to permit cross-referencing across the earlier study. Fisheries are summarised by target species and region in Table 4 and are then summarised by Member State in Table 5. Data collection and reporting for driftnet fisheries is fragmented, with limited information available. For example, driftnet vessels are not obliged to complete logbooks since they are generally less than 10 m long (EU Reg. No 1224/2009).

2.1. Baltic Sea

In the Baltic Sea there is currently one “semi-driftnet” fishery targeting salmonids and operating from Poland both offshore and inshore. Unlike vessels fishing inshore, offshore vessels are typically over 12 m in length. Before the implementation of regulations limiting driftnet use in the Baltic, driftnets were deployed using different techniques in the Gulf of Gdansk (including Puck Bay) and in the open sea. Both techniques used drifting surface nets with a mesh size of 157 mm (EC-DGMARE, 2014a). In the Gulf of Gdansk a single net (35-70 m long) was set with one end anchored to the bottom (“semi-driftnets”), whereas in the open sea nets were laid out in sets up to several kilometres long (EC-DGMARE, 2014a). The latter technique has been prohibited in the Baltic since 2008. The main or secondary gears of vessels involved in the inshore semi-driftnet fishery are entered in the EU fleet register as GNS (gillnet), not GND (driftnet). According to EC-DGMARE (2014a), it is therefore difficult to establish the number of vessels participating in the semi-driftnet fishery; a few dozen vessels are believed to be in operation today. River fishing targeting salmonids is also practiced with driftnets located at the mouth of River Vistula over a distance of 7 km. Three small vessels (5-8 m) operate in this leased area, but information on the quantity of fish caught by driftnets is poor.

2.2. Black Sea

Three fisheries were identified in the Black Sea, all located in FAO division 37.4.2 (GFCM area 29). One is the Bulgarian fishery for Atlantic bonito (*Sarda sarda*), which albeit not subject to quotas in the Black Sea is an unauthorised species. This fishery normally operates from September to December with a total of 135 vessels, most of which are under 12 m in length and work around 25 % of the year (ca. 90 days). Since Atlantic bonito is a primary target of the fishery, Council Regulation (EC) 1239/98 - banning the use of driftnets to target Annex VIII species (Council Regulation (EC) No 1239/98) - has clearly not been effective.

Vessels tend predominantly to use driftnets, but also employ drifting longlines. Mesh size varies from 36 to 48 mm, depending on the season and the size of the species targeted. Nets tend to be 500 m in length, but 2-3 nets are often deployed together. The depth of the nets extends from the surface to the seafloor (normally 20-50 m). This net is referred to as a *"fustanela"* and vessels regularly carry on board and set multiple nets.

Most fishing vessels operate within 2 nm of the coast. Nets are usually soaked for 2-3 hours but are often used overnight, in which case they soak for 8-9 hours. According to EC-DGMARE (2014a), 324 fishermen, 2-4 per vessel, are involved in this fishery. Atlantic bonito catches were not abundant in 2012. No other species have been recorded as bycatch or discard, and interactions with protected species have not been reported.

EU driftnet regulations were included in Bulgarian legislation – the Fisheries and Aquaculture Act - in 2001. The second fishery is the Bulgarian inland river fishery, which mainly operates on the River Danube, targeting various species with a local drifting trammel net called *"difana"*. The target species depends on mesh size: a 18 mm mesh size catches small-sized fish such as *Alburnus alburnus* and *Chalcaburnus chalcoides*; a 55-65 mm size is used for larger species like *Carassius auratus*, *Barbus barbus*, *Cyprinus carpio*, *Carassius carssius*, *Lota lota*, *Sander lucioperca*, and *Perca fluviatilis,* and a 110-120 mm size for the larger species (*Esox lucinus*, *Ctenopharingo donidela*, *Hippophthalamitrix molitrix*, and *Silurus glanis*). Information on this fishery is limited.

In 2012, approximately 650 fishing vessels operated on the River Danube, of which only 250 actively used driftnets. Most were small (5-6 m length overall, LOA), open boats powered by outboard motors (10-20 Hp). About 250 vessels are estimated to use driftnets in inland waters. Inland fishing employs 1620 people at the national level, of whom approximately 500 use *"difana"* driftnets along the Danube and in other inland water bodies.

Most activities are seasonal or relate to fishing for personal use, which explains the low added value of inland fishing. There is even less information on the third fishery, the Romanian river fishery targeting Pontic shad (*Alosa immaculata*), carp (*Cyprinus carpio*), barbel (*Barbus barbus*), perch (*Stizostedion lucioperca*), and several other species (22 in total); this involves rivers including the Danube, the Siret and the Prut.

Around 1355 vessels, all under 10 m in length (EC-DGMARE, 2014a), are involved; they use drifting gillnets measuring 200-300 m, spanning two thirds of the river width. Driftnetters also use pots and traps. There are 3388 fishermen operating in the Danube fishery, 2-4 per vessel. There is no driftnet fishery in the Romanian Black Sea (EC-DGMARE, 2014a).

2.3. Mediterranean Sea

Eight driftnet fisheries have been identified in the Italian Mediterranean by the DRIFTMED Study (EC-DGMARE, 2014b). The Italian western coast has six fisheries from the far north to the far south, including Sicily (GFCM subareas 9 and 10). They target a range of species that include small pelagics such as anchovy (*Engraulis encrasicolus*) and European pilchard (*Sardina pilchardus*), larger pelagics such as amberjack (*Seriola dumerili*), Atlantic mackerel (*Scomber scombrus*), chub mackerel (*Scomber colias*), bogue (*Boops boops*), horse mackerel (*Trachurus trachurus*), and bluefish (*Pomatomus saltatrix*), and demersals including saddled sea bream (*Oblada melanura*). There are numerous landing ports used by 5-30 vessels each. Mesh size is variable due to the different target species: small mesh sizes (from 19 to 29 mm) called "*menaide*" or "*menaica*" mainly target European pilchard and anchovy; medium mesh sizes (from 70 to 90 mm) mostly target larger pelagics. In these areas driftnet fishing is concentrated in spring-summer, whereas other gears such as gillnets, combined gillnets-trammel nets, longlines and purse seines are used in the rest of the year. Driftnet fisheries result highly selective, target species representing almost the totality of catches. Discards and catches of protected and vulnerable species are negligible.

There is also a driftnet fishery on the north-eastern coast of Sicily, in Catania (GFCM subarea 19), which operates almost all year round. Its target species vary and include anchovy and European pilchard. There are 28 vessels in this fishery, and landings data are currently available only for a single fishery where anchovy and European pilchard are landed with little bycatch. Negligible discards of pilchard are reported in relation to size and market demand. Some Annex VIII species of EU Reg. No 1239/98 (see Table 12) have been reported in the catches of the "*occhiatara*" fisheries in the Ligurian Sea (GSA9): small quantities of cephalopods *Todaro dessagittatus* and *Ommastrephes bartramii* (3.9 % of the total bycatch), and Atlantic bonito (1.5 % of the total bycatch). The "*sgomberara*" fisheries in northern Sicily (GSA 10) captured three Annex VIII species as bycatch (EU Reg. No 1239/98): Atlantic bonito, bullet tuna (*Auxis rochei*) and little tunny (*Euthynnus alletteratus*). Bullet tuna, although listed as a bycatch species in this fishery, comprises 95.2 % of total catches, accounting for approximately 200 tons annually.

According to the author's personal contacts with the Spanish Ministry, another driftnet fishery targeting sardine that is not included in the EC-DGMARE study (2014a; 2014b) is found in the EU Mediterranean. Some vessels in the area of Malaga (Spain) use a net called *"Sardinal"* that is very similar to the *"Xeito"* driftnet originating from the north of Spain. It has a mesh size of 30-40 mm and consists of a fleet of 10 nets, each of 75 m long and 20 m deep, joined end-to-end and operated as a single net. There are 180 boats, usually 6-8 m LOA that could use this type of net, but just around 100 boats per year use *Sardinal* from May to September when the sardine´s price is higher.

2.4. North Sea

Seven driftnet fisheries operate in the North Sea, six of which originate from the UK. The latter all lie in ICES divisions IVb and IVc; they mainly target cod, salmon, herring, sole and sea bass. Vessels in each fishery range from 2 to around 50 and are all less than 10 m long; each fishery comprises 4 to 100 fishermen. Vessels in this area are believed to use different gear types throughout the year. Interactions with protected species are held to be uncommon. There are local regulations regarding mesh size and closed areas. The seventh fishery targets mackerel, mainly from May to June, and is operated in the Skagerrak and Kattegatt area by Sweden. Mesh sizes are less than 75 mm and maximum length and depth are less than 2500 m and 7.5 m, respectively. About 76 vessels are estimated to have used driftnets in 2013.

2.5. North East Atlantic

A number of driftnet fleets are currently active throughout the North-East Atlantic, with vessels originating both from France and the UK. The majority of recorded vessels are less than 12 m long and target several species, including cod, herring (Blackwater stock or Thames Estuary herring), common sole (*Soleasolea*), sea bass (*Dicentrarchus labrax*), Atlantic herring (*Clupea harengus*) (North Sea autumn spawners), mackerel (*Scomber scombrus*), allis shad (*Alosa alosa*), twaite shad (*Alosa fallax*), lamprey (Petromyzontidae spp), meagre (*Argyrosomus regius*), salmon (*Salmo salar*), sea trout (*Salmo trutta*), sea bream (gilthead or black) (Sparidaespp), and mullet (Mugilidae spp).

The UK exploits stocks in ICES divisions VIId, VIIe, and VIIf. Most of these fisheries comprise small numbers of vessels and operate close to the coast. Pilchard is targeted in division VIIe by approximately 12 driftnetters. Fishing takes place from June to September less than 6 nm from shore and accounts for annual landings of 99 tonnes. Herring and mackerel are targeted by 3-5 vessels from January to May in ICES division VIId. Annual landings are estimated at less than 10 tonnes. France's driftnet fishing effort is primarily concentrated in estuaries in ICES division VIIIa and VIIIb. The largest active driftnet fishery seems to comprise 40-45 vessels fishing at various times of the year for meagre and sea lamprey within ICES division VIIIb. This fishery uses drifting trammel nets in the Gironde Estuary. France has two offshore driftnet fisheries targeting herring and sea bass and operating in the English Channel (ICES division VIId) with 13 vessels targeting herring and 5 targeting sea bass.

There are freshwater fisheries in several French rivers targeting lamprey, shad and salmon (EC-DGMARE, 2014a). Herring stocks in ICES division VIId are the only stocks to be exploited by French as well as British vessels. Since the closure of two substantial driftnet fisheries for albacore and salmon, driftnet activity in Ireland has been minimal. Incidental driftnet fisheries are thought to target mackerel, herring, and sprat. However, the annual effort is held to involve less than 30 vessels fishing for less than 10 days. Anecdotal evidence suggests that most of the catch is used as bait for other fisheries.

Portugal has two main driftnet fisheries targeting small pelagic species (mainly sardine) in the north. Close to 110 vessels are involved. Freshwater fisheries in rivers target lamprey and shad. In Spain an SSD fishery, the so called *"Xeito"*, exploits sardine in ICES division IXa. There are around 450 artisanal fishing boats involved in this fishery (435 in 2013, 433 in 2013, 427 in 2014), all under 10 m LOA. The fisheries are controlled by Regional Regulations (*Diario Oficial de Galicia, No 31 of 15/02/2011*) laying down technical measures that include a legal mesh size of 23-40 mm; the requirement to keep one end of the netting attached to the vessel during fishing; a maximum net depth of 16 m; a maximum netting panel length of 100 m; a maximum authorised total net length per vessel and day of 1000 m; and a weekly fishing closure from Saturday 12:00 to Sunday 12:00.

Table 3: Summary of current driftnet fisheries in EU waters[3] *(continued on next page)*

Region	MS	ID	Target species	Sub-Area	Area	Gear	Net length [m]	Mesh size [mm]	No. of boats	Type
Baltic Sea	Poland	**13**	SAL, TRS	ICES 24-26, 22-32	Baltic	Semi-driftnet	400+	65-90	< 50	M, E
Black Sea	Bulgaria	**29**	BON	GSA29	-	SSD (*Fustanela*)	500, 1000, 1500	36, 48	135	M
	Bulgaria	**41**	SHC	GSA29	Danube river	DTR	400-500	25-34	250	R
	Romania	**6**	SHC	GSA29	Danube delta	SSD	200-300	70-120	1355	E, R
Mediterranean	Italy	**32**	SBS	GSA9	Liguria	SSD *(Occhiatara)*	375-500	70-90	5	M
	Italy	**33**	ANE	GSA10	Cilento	SSD *(Menaide)*	300-500	26-29	19	M
	Italy	**34**	HOM, HMM, MAS, MAC, BOG	GSA10	Northern Sicily	SSD *(Sgomberara)*	500-1500	71-85	30	M
	Italy	**35**	AMB	GSA10	Sant'Agata di Militello	SSD *(Ricciolara)*	800-1000	70	3	M
	Italy	**36**	ANE	GSA10	Sant'Agata di Militello	SSD *(Menaide)*	500	20	7	M
	Italy	**37**	BLU	GSA10	Gulf of Naples	SSD *(Ferrettara)*	2400	88	2	M
	Italy	**38**	ANE	GSA19	Catania	SSD *(Menaide)*	240-300	19-22	28	M
	Italy	**43**	PIL	GSA16	Selinunte	SSD *(Menaide)*	200-210	20	5	M
	Spain	**48**	PIL	GSA1	Malaga	SSD *(Sardinal)*	750	30-40	100	M
North Sea	UK	**3**	HER	ICES IVc	North Sea	SSD	-	55-65	< 50	M
	UK	**10**	SAL	ICES IVb	-	SSD	< 550	100-120	14+	M, E
	UK	**12**	TRS	ICES IVc	-	SSD	< 550	100-120	27	M, E
	UK	**22**	BSS	ICES IVc	North Sea	SSD	-	90-220	< 40	M
	UK	**24**	SOL	ICES IVc	ICES IV	DTR	400	100 (1200)	~ 10	M
	UK	**28**	COD	ICES IVc	ICES IV, VIId, IIIa	SSD	-	120-220	< 20	M
	Sweden	**46**	MAC	ICES IIIa	Skagerrak and Kattegat	SSD	≤ 2500	< 75	76	M

[3] SSD = Small Scale Driftnets; DTR = Drifting trammel nets. For the acronyms of target species and gear see respectively Table 13 and Table 14 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*. MS = Member State; Type: Marine (M), Estuarine (E), River (R).

Table 3: ***(continued from previous page)***

Region	MS	ID	Target species	Sub-Area	Area	Gear	Net length [m]	Mesh size [mm]	No. of boats	Type
NE Atlantic	France	**1**	HER	ICES VIId	North Sea	SSD	150-400	42-54	25	M
	France	**5**	SHZ	ICES VIIIa	Loire	DTR	< 500	60 (400)	15	M, E
	France	**5.2**	SHZ	ICES VIIIb	Adour	DTR	< 180	120 (540)	*ref. # 9*	M, E
	France	**8**	LAS	ICES VIIIa	Loire	DTR	< 500	120 (400)	*ref. # 5*	M, E
	France	**8.2**	LAS	ICES VIIIb	Gironde-Garonne	DTR	200-300	~ 70	*ref. # 15*	M, E
	France	**8.3**	LAS	ICES VIIIb	Adour	DTR	< 600	68 (540)	*ref. # 9*	M, E
	France	**9**	SAL	ICES VIIIb	Adour	DTR	< 180	120 (540)	15	M, E
	France	**15**	MGR	ICES VIIIb	Gironde-Garonne	SSD	300-400	90	45	M, E
	France	**15.2**	MGR	ICES VIIIb	Gironde-Garonne	DTR	300-400	130 (800-1000)	*ref. # 15*	M, E
	France	**16**	SBX	ICES VIIIb	Arcachon	SSD	300	100	5	M
	France	**16.2**	SBX	ICES VIIIb	Adour	SSD	300	100	*ref. # 9*	M
	France	**17**	BSS	ICES VIIIb	Adour	DTR	< 180	100 (540)	*ref. # 9*	M
	France	**18**	BSS	ICES VIId	English Channel	SSD	200-300	90-120	< 5	M
	Portugal	**23**	BSS, SBG, MGR	ICES IXa	-	SSD	40	60	50	M
	Portugal	**27**	PIL	ICES IXa	ICES VIIIc, IXa	SSD	400-600	35-60	62	M
	Portugal	**44**	LAS	ICES IXa	-	DTR	80	70	482	R
	Portugal	**45**	SHZ	ICES IXa	-	DTR	50	100	*ref. # 44*	R
	Spain	**47**	PIL	ICES IXa	Galicia	SSD *(Xeito)*	≤ 1000	23-40	450	M
	UK	**2**	HER, MAC	ICES VIId	NE Atlantic	SSD	350-450	55-65	< 30	M
	UK	**14**	SAL, TRS	ICES VIIa	Lune, River Ribble	SSD	< 300	-	11	M, E
	UK	**19**	BSS	ICES VIId	English Channel	SSD	< 2300	150	~ 6	M
	UK	**20**	BSS, MUL	ICES VIId,e,f	English Channel, western coast of UK	SSD	400	90, 112-127	< 70	M
	UK	**21**	BSS, MUL	ICES VIId,e	English Channel	SSD	-	112	< 6	M, E
	UK	**25**	SOL	ICES VIId	Eastern channel	DTR	-	100-120	< 30	M
	UK	**26**	PIL	ICES VIIe,f	-	SSD	450	45	~ 30	M

Source: adapted from EC-DGMARE (2014a; 2014b) and author's contacts with Member States

Table 4: Summary of current driftnet fisheries, by region and target species[4]

FAO ISO-3 code	Primary Target Species	Latin Name	Baltic Sea	Black Sea	Mediterranean	North Sea	NE Atlantic
BON	Atlantic bonito	*Sarda sarda*		29			
AMB	Greater amberjack	*Seriola dumerili*			35		
ANE	Anchovy	*Engraulis encrasicolus*			33, 36, 38		
COD	Atlantic cod	*Gadus morhua*				28	
HER	Atlantic herring	*Clupea harengus*				3	1, 2
BLU	Bluefish	*Pomatomus saltatrix*			37		
SOL	Common sole	*Solea solea*				24	25
PIL	European pilchard	*Sardina pilchardus*			43, 48		26, 27, 47
LAS	Lamprey nei	*Petromyzontidae*					8, 8.2, 8.3, 44
MGR	Meagre	*Argyrosomus regius*					15, 15.2
SAL, TRS	Atlantic salmon, Sea trout	*Salmo salar, Salmo*	13			10	9, 14
BSS	Sea bass	*Dicentrarchus spp*				22	17, 18, 19, 20, 21, 23
SBX	Sea bream	Sparidae			32		16, 16.2
TRS	Sea trout	*Salmo trutta*				12	
SHZ	Shad	*Alosa spp*		6, 41			5, 5.2, 45
MAC	Atlantic mackerel	*Scomber scombrus*				46	
BOG HMM HOM MAC MAS	Bogue Mediterranean horse mackerel Atlantic horse mackerel Atlantic mackerel Chub mackerel	*Boops boops* *Trachurus mediterraneus* *Trachurus trachurus* *Scomber scombrus* *Scomber japonicus*			34		

Source: adapted from EC-DGMARE (2014a; 2014b) and author's contacts with Member States

[4] ID Reference numbers refer to fisheries detailed in Table 3. For the acronyms of target species and gear see Table 13 and Table 14, respectively *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

2.6. Economic and social parameters of driftnet fisheries

2.6.1. Fleet segmentation, number of vessels and total employment in the driftnet fisheries industries

Table 5 illustrates the statistics of active vessels taken from different official sources at the EU and national level. There are discrepancies between data extracted from the EU fleet register and the information provided by national administrative bodies regarding gear or vessel licensing. The main reasons for such differences are administrative: the fleet register only reports the first two gears a vessel is registered for, while national administrations may grant licences authorising up to five gears; this entails that the number of licences granted by national administrations may be higher than the number of vessels recorded in the register. In addition, for some Member States, the register may report changes in important data, such as a new vessel owner or registration port. Furthermore, a particular driftnet fishery may be completely closed, but the information held in the register may still report the gear code GND for months or years, as long as the vessel remains active in the same fishing port with the same owner. Data extracted from the EU fleet register may therefore include more vessels than are actually licensed by national administrations.

Table 5: Vessel statistics by country[5]

Member States	GND Fisheries	No. of vessels			Employment		
		Total	Marine	Inland	Total	Marine	Inland
Bulgaria	2	385	135	250	824	324 *(8.2 %)*	500
Denmark	-	-	-	-	-	-	-
France[(6)]	13	283	110	173	570	310 *(6.0 %)*	260
Ireland	-	-	-	-	-	-	-
Italy	8	99	99	-	297	297 *(2.5 %)*	-
Poland	1	50	47[(7)]	3	107	100 *(8.6 %)*	7
Portugal	4	594	112	482	1354	394 *(3.7 %)*	960
Romania	1	1355	-	1355	3388	-	3388
Spain	2	550	550	-	1100	1100 *(-)*	-
Sweden	1	76	76	-	152	152 *(-)*	-
UK	13	251	251	-	502	502 *(4.0 %)*	-
TOTAL	**45**	**3643**	**1380**	**2263**	**8294**	**3179**	**5115**

Source: adapted from EC-DGMARE (2014a; 2014b) and author's contacts with Member States

5 Total number of vessels actively using driftnets (GND) in marine and inland EU waters. Total employment figures (and percentage of those employed on vessels under 12 m) are based on interviews.

6 The outermost marine fisheries are not included. Employment figures of marine fisheries are estimated from EC-DGMARE data (2014a).

7 Semi-driftnets.

Some of the currently active fisheries operate in rivers and estuaries, and are referred to as such in preceding sections. However, the boundary between marine and inland waters is highly variable in the different Member States, and the two areas are usually managed separately by two different licensing systems, commonly by different bodies. Only fishing vessels operating in marine waters are recorded in the EU register; not all Member States hold a specific register for fishing vessels and/or fishermen operating in inland waters.

Marine fisheries are usually managed by a specific fisheries administration at the national or regional level (in case of decentralisation); in contrast, a variety of administrations manage inland fisheries, and vessels licensed by these authorities may sometime fish in marine waters. Where feasible the present study distinguishes between fisheries managed under marine and inland jurisdictions.

Consultations with key stakeholders in Member States, surveyed by EC-DGMARE (2014a; 2014b), indicated that current driftnet fleets are mainly comprised of vessels under 10 m in length. This has important consequences in terms of data collection, since these vessels are usually less constrained in terms of landings declarations, since they are not required to use logbooks under Control Regulation (EC) No 1224/2009. However some countries have strict reporting requirements: the UK has implemented the Register of Buyers and Sellers (RBS), resulting in better coverage of actual landings, although the gear code associated with the catch is sometimes not reported accurately.

2.6.2. Economic importance of the driftnet fisheries

The majority of fisheries identified are seasonal, with fleets comprised of polyvalent vessels. For most fishermen employing driftnets this represents only a few months of fishing in any year, and some use them for less than a month (i.e. the herring fisheries in the English Channel). Accurate landings data from driftnet fisheries are not available except for the UK, which severely hampers evaluation of the economic importance of the gear at the EU level.

In Italy, the data collected by the DRIFTMED project (EC-DGMARE, 2014b) have contributed to a greater understanding of the importance of the gear for the fisheries identified there. For 90/99 driftnet vessels identified for which data have been provided, the driftnet accounts for almost 77 % of volume landed and for 68 % of value generated. When these indicators were examined by fishery, the vessels deploying "*menaide*" close to Catania were found to use almost exclusively a driftnet, which accounted for 91 % of the quantity and of the value landed by these vessels. At the other end of the spectrum, the other two "*menaide*" fisheries and the "*occhiatara*" account for only 21-25 % of the value landed by these vessels. For the three remaining fisheries ("*sgomberara*", a general "*ferrettara*" and "*ricciolara*") the driftnet accounts for close to half of fishing activities.

3. MAIN TECHNICAL FEATURES OF DRIFTNETS IN EU FISHERIES

KEY FINDINGS

- The EU Reg. No 809/07 defines driftnets as: *"any gillnet held on the sea surface or at a certain distance below it by floating devices, drifting with the current, either independently or with the boat to which it may be attached. It may be equipped with devices aiming to stabilise the net or to limit its drift"*. Therefore, a driftnet is currently merely defined as a gillnet (with a single netting panel) drifting freely with the current.
- This generic definition prevents a clear separation to be made between a gillnet and a driftnet based on technical features, nor is there any set of rules providing for such distinction. However, some general considerations help setting them apart.
- Nearly all small-scale driftnets are manufactured with T90 or 'turned mesh' netting, whereas traditional fixed gillnets are always manufactured using diamond mesh.
- Set gillnets have netting panels rigged to the floatline and leadline with low hanging ratios, usually less than 0.5, whereas the hanging ratio of small-scale driftnets usually exceeds 0.7.
- With the exception of some local Mediterranean small-scale driftnets, like the *"menaide"* and the *"bogara"*, the twine diameter is greater than 0.25 mm whereas in fixed gillnets it is commonly less than 0.25 mm.

The DRIFTMED project (EC-DGMARE, 2014b) provided direct measurement of Mediterranean small-scale driftnets (SSDs) and collection of key technical gear metrics, and has allowed accurate identification of the different net typologies. Technical features such as net rigging, mesh opening, hanging ratio, and twine diameter, seem to be related both to the characteristics of target species (i.e. shape, behaviour) and of fishing grounds (depth, bottom type). Such features are rarely or never found in other gillnets.

3.1. Driftnet gear metrics

3.1.1. Types of netting material

As in other types of gillnets, several types of textiles can be used for the driftnet twine. In Denmark multifilament is typically used for trammel nets targeting flatfish, multi-monofilament for those targeting cod, and hake fisheries mostly use monofilament nets. In the Mediterranean both mono- and multifilament are widely used (EC-DGMARE, 2014b).

3.1.2. Colour of netting

Driftnets in EU fisheries are marketed in a variety of colours and shades, and individual fishermen often have strong preferences for some colours. However a geographical trend is also often observed; for instance, in Danish fisheries orange nets predominate in the Baltic, whereas grey or green nets are preferred in North Sea fisheries. In the Mediterranean netting is more often brown, reddish, ochre and reddish (EC-DGMARE, 2014b).

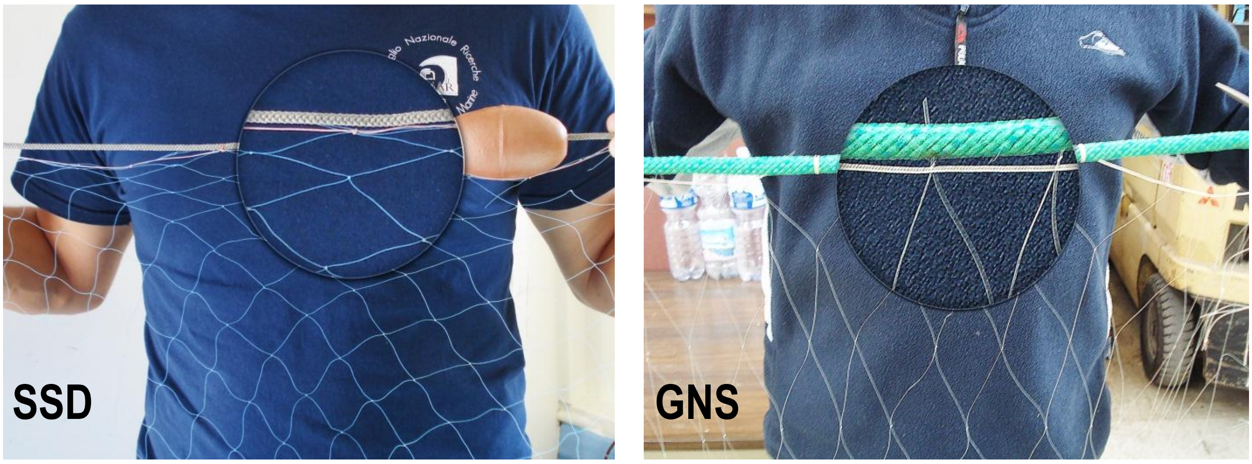
3.1.3. Twine thickness

SSDs targeting both small pelagics such as anchovy, sardine, saddled sea bream, and bogue and medium-sized pelagic species such as mackerel and greater amberjack, have twine diameters ranging from 0.20 to 0.30 mm. The same diameters are also commonly found in fixed gillnets. In other cases, like driftnets targeting strong swimmers such as Atlantic bonito and bullet tuna, the nets are made in thicker materials, and twine diameter is usually greater than 0.5-0.6 mm.

3.1.4. Net hanging ratio

The values of driftnet hanging ratios found by the DRIFTMED project ranged from 0.70 to 0.98, which is normally higher than the ratio of other static gears (Figure 6). In fixed gillnets the hanging ratio usually ranges from 0.40 to 0.50, providing more slack in the netting and enabling catches by **entanglement**.

Figure 6: Details of different hanging ratios in a small-scale driftnet (SSD) and a set gillnet (GNS)



Source: adapted from Lucchetti (CNR, Italy)

3.1.5. Mesh configuration

SSD meshes need to be open widely to ensure optimal catching performance. The DRIFTMED project found that in the Mediterranean nearly all SSDs were manufactured with **T90 or 'turned-mesh'** netting, resulting in use of less netting material. The selectivity benefits of 'turned-mesh' or T90 netting have been known for some years. Other advantages, such as improved water flow and catch quality, have been investigated more recently (Moderhak, 2000). Previous studies have concentrated on the application of this netting configuration for use in codends and extension sections as a means to improve size selectivity.

The introduction of new netting configurations for any reason (to improve selectivity and fish quality, reduce netting drag, etc.) invariably raises questions from gear technologists and fishermen alike about practicality and usability. The main concern is usually strength. With T90 netting, which involves a change in the direction of the stretching forces acting on the turned meshes, mesh stability must be at least comparable to that of conventional netting if the material is to be a practicable alternative.

3.1.6. Mesh size

The SSDs measured by the DRIFTMED project were always under 100 mm of mesh opening (Table 3). This was mainly due to the Italian Ministry Decree of 21/09/2011, which authorises only *"ferrettara"* nets having a mesh size ≤ 100 mm. Illegal driftnets (e.g. *spadara* nets for swordfish) may accidentally catch endangered species such as marine mammals, mainly due to the larger meshes (more than 300 mm of mesh opening) and the zigzag setting of the nets on the sea surface (see for details Oceana, 2005; 2007; 2008).

3.1.7. Net floating

Driftnets are currently defined as *"any gillnet held on the sea surface or at a certain distance below it by floating devices, drifting with the current, either independently or with the boat to which it may be attached"*, thus they usually employ more floats than common gillnets.

3.2. Gear metrics and target species similarities across member states

The driftnet fisheries of Member States share a number of similarities in terms of species targeted and characteristics of the gear used. France and UK both target Atlantic herring in ICES region VIId. French driftnet fisheries reportedly use net lengths of 150 m to 450 m, while UK fishermen use a less variable length of 350 to 450 m. French fishermen use slightly smaller meshes (42 to 54 mm) than their British counterparts (55 to 65 mm).

European pilchard is exploited by driftnet fishermen from Italy, Portugal, Spain, and the UK. Italians use the smallest mesh size (ca. 20 mm); the British a slightly larger mesh (45 mm); the Portuguese use a range of mesh sizes (from 35 to 60 mm), and Spanish driftnetters use slightly smaller meshes (23-40 mm). Italian fishermen use the shortest nets (200 m); the British use longer nets (450 m); and Portuguese and Spanish fishermen use even longer nets (400-600 m and 750-1000 m, respectively). Therefore, gear feature overlap is found for mesh size and net length in Portuguese and British driftnet fleets.

European sea bass is targeted by driftnet fisheries of France, Portugal, and Britain. The British fishery operates in ICES region VIId and uses the longest nets, approximately 2300 m maximum length. French vessels operate in divisions VIId and VIIIb using nets that are respectively 300 m and < 180 m long. Portuguese vessels work ICES division IXa with net lengths of 40 m. Therefore the three Member States use different net lengths to catch European sea bass though operating in the same area. Mesh sizes also vary: the UK fishery targets larger sea bass with a 150 mm mesh size and smaller sea bass with a 90 mm mesh size; French vessels use a mesh size of 100 mm or 90-120 mm; Portuguese fishermen use a smaller mesh size of 60 mm but operate a mixed fishery also targeting sea bream and meagre. Mesh size therefore shows an overlap only for 90 mm netting (France and UK).

Salmon and sea trout are targeted by France, UK, and Poland. Net lengths and mesh sizes vary within and between fisheries. France uses the shortest net lengths, with all nets less than 180 m, whereas UK salmon driftnet fisheries reportedly use the longest lengths, up to 550 m. The Polish fishery uses 400 m semi-driftnets that exceed 400 m in length. Therefore, despite the highly variable lengths, Polish and British salmon and sea trout fisheries use nets between 400 m and 550 m. Mesh sizes for salmon seem to be less variable, since Britain and France both use sizes of 100 to 120 mm and Poland uses 65-90 mm mesh sizes.

Shad is targeted by France, Romania, Bulgaria and Portugal in several geographical areas: ICES divisions VIIIb, VIIIa, and IXa and GFCM area 29. There are five distinct fisheries, two in France, one in Bulgaria, one in Portugal and one in Romania. Romania and Bulgaria both target shad in GFCM area 29 and all fisheries use gears with different characteristics. The Portuguese fishery uses 50 m long nets; the French fisheries use lengths ranging from 180 to 500 m; the Bulgarian fishery uses nets 400-500 m in length and Romanians use net lengths of 200-300 m. As regards mesh size, the French use a 110-120 mm size in ICES division VIIIb and a 70-120 mm size in division VIIIa; the Bulgarians use a 25-34 mm mesh in GFCM area 29; the Romanians use sizes of 70-120 mm, and the Portuguese use a mesh size around 100 mm in area IXa. A possible overlap of mesh sizes for shad thus regards the French fishery located in ICES division VIIIb, the Romanian, and the Portuguese fisheries.

4. IMPACT ANALYSIS

KEY FINDINGS

- The impacts of the 45 active fisheries identified in EU waters on unauthorised species (Annex VIII species) are overall low. There is one remaining driftnet fishery targeting unauthorised species in the Black Sea and a small number of driftnet fisheries in the Mediterranean that catch some unauthorised species as bycatch.
- Nine of the 45 driftnet fisheries identified target species listed in Annex II of the Habitats Directive, with measures in place to manage the fisheries except in Romania. However, none of the 45 fisheries target strictly protected species (Annex IV of the Habitats Directive). Nonetheless, current data are insufficient to determine how many of the 45 fisheries have substantial, regular and inevitable interactions with protected species, or to assess the impacts of such interactions.
- There are at least anecdotal accounts of interactions between some fisheries and Annex IV species, which would be caught as bycatch given their behaviour and proximity to driftnet fisheries. Evidence of such interactions is rare due to poor data availability regarding these fisheries.
- Several protected bird species listed in Annex I of the Birds Directive exhibit behaviour (diving) that could make them susceptible to capture in driftnets. About 22/45 driftnet fisheries have the potential to interact with species protected by the Birds Directive, but their impact on protected species, if any, is unclear.

In general driftnets have a high degree of size selectivity, which can efficiently be regulated by mesh size. The main negative environmental impact of this type of nets is bycatch of non-target species like marine mammals, seabirds, and to a lesser extent turtles. Various instruments have been devised to reduce the adverse impact of drift-netting on non-targeted biological resources. In 1991 the UN banned large-scale high seas driftnets exceeding 2.5 km in length. Prior to the ban they were of enormous proportions and reached lengths of 40-60 km. However there is serious concern regarding ban violations (Oceana, 2005; 2007; 2008).

4.1. Interaction of driftnet fisheries with protected / Annex VIII species

Determining which fisheries are most likely to interact with protected/Annex VIII species (EU Reg. No 1239/98) requires a number of actions including reviewing species distributions against fishery locations, assessing the behaviour of protected species to establish how likely they are to interact with gears, and the ways in which they do so. Information on such interactions is often reported for combined gear categories such as polyvalent gears or static or set nets, which encompass gillnets, tangle nets, trammel nets as well as driftnets. The potential for the risk of interaction might be based on a combination of different sources of information: stakeholder consultations, literature review, comparisons of relevant Special Area of Conservation (SAC) and Special Protection Area (SPA) site locations, qualification of species population status, and other indicators of species hotspots such as Important Bird Areas (IBAs) (Birdlife, 2013), nesting locations for turtles, or other conservation designations.

4.1.1. Protected species targeted by current driftnet fisheries

Several driftnet fisheries target species listed under Annex II of the Habitats Directive (Council Directive 92/43/EEC, 1992), including sea lamprey, shad, and Atlantic salmon. In the **Black Sea** two fisheries target shad (ID6) in the Romanian Danube River and the Danube Delta, and there is evidence of a fishery (ID41) targeting Pontic shad in the Bulgarian Danube and other inland water bodies.

All fisheries targeting Annex II species (92/43/EEC) in the **North-East Atlantic** operate in France and Portugal and use drifting trammel nets less than 600 m long. In France the River Adour and Estuary host three separate fisheries targeting shad (ID5.2), lamprey (ID8.3) and salmon/sea trout (ID9). In the Loire River and Estuary one fishery targets shad (ID5) and another targets lamprey (ID8). In the Garonne River and the associated Gironde Estuary one fishery targets lamprey (ID8.2). In Portugal, two inland fisheries deploy drifting trammel nets less than 80 m long, targeting lamprey (ID44) and shad (ID45). None of the fisheries that are currently active in the **Baltic Sea**, the **Mediterranean** or the **North Sea** are reported to target protected species (EC-DGMARE, 2014a).

Table 6: Current driftnet fisheries targeting protected species, by region[8]

Primary target species	Acronym	BAL	BS	MED	NS	ATL
Sea lamprey	**LAS**					8, 8.1, 8.2,
Salmon / Sea trout	**SAL / TRS**				10	14
Shads	**SHZ**		6, 41			5, 5.2, 45

Source: adapted from EC-DGMARE (2014a)

4.1.2. Protected species incidentally caught in current driftnet fisheries

Data gathered in 2013 during the two studies funded by DGMARE (EC-DGMARE, 2014a; 2014b) indicate that some protected species are caught as bycatch by some driftnet fisheries (Table 29). In the **Baltic Sea** semi-driftnet fisheries for salmon and sea trout there is evidence of incidental catches of harbour porpoise (*Phocoena phocoena relicta*) and grey seal (*Halichoerus grypus*), listed in Annex IV and Annex II of the Habitats Directive (92/43/EEC), respectively.

Several French drifting trammel net fisheries in rivers and estuaries in the **North-East Atlantic**, which target Annex II species (Habitats Directive 92/43/EEC) such as Alosa spp and sea lamprey (ID5, ID5.2, ID8, ID8.2, ID8.3), also capture Atlantic salmon as bycatch, which is also included in Annex II. Three of these fisheries targeting lamprey (ID8, ID8.2, and ID8.3) also take sturgeon species as bycatch. The sea bass fishery in the North Sea, located in ICES division IVc (ID10) has reported incidental catches of harbour seal (*Phoca vitulina*) and grey seal. This fishery operates in the vicinity of the Wash SAC, on the eastern coast of England for which harbour seal are a primary reason for site selection. The Wash is the largest embayment in the UK, the extensive intertidal flats there and on the north Norfolk coast provide ideal conditions for harbour seal breeding and hauling out.
This site is the largest colony of common seals in the UK, hosting some 7 % of the total UK population (Joint Nature Conservation Committee, 2013). Two instances of bycatch involving harbour porpoise have been observed out of a total of 131 observed driftnet hauls; of these

[8] Region indicates Baltic Sea (BAL), Black Sea (BS), Mediterranean (MED), North Sea (NS), North East Atlantic (ATL). ID reference numbers refer to fisheries detailed in Table 3. For the target species refer to Table 13 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

80 were with driftnets and 51 were drifting trammel net hauls operating in the North Sea and off the south-western British coast between 1995 and 2012.

Atlantic salmon (*Salmo salar*), listed in Annex II of the Habitats Directive (92/43/EEC) when found in freshwater, is also retained in the sea trout fishery (*Salmo trutta*) (ID12) operating between the river Humber and Walton on the Naze. This fishery extends 6 nm into the **North Sea**; as a consequence it occurs in marine waters. Therefore, salmon is not considered as a species requiring designation of special areas of conservation.

No data have been reported by national authorities on protected species taken incidentally in the driftnet fisheries currently active in the **Black Sea**. If caught incidentally, sturgeon species (*Acipenser ruthenus*, *A. stellatus*, *A. guldenstaedtii*, and *Huso huso*) must be released alive according to national laws. There are also no reported data regarding bycatch of protected species from the fisheries surveyed by the DRIFTMED project (EC-DGMARE, 2014b) or reported to national authorities in the **Mediterranean**.

Table 7: Current driftnet fisheries for which there is evidence of bycatch or incidental catches of protected species, by region[9]

Primary target species	Acronym	BAL	BS	MED	NS	ATL
Sea lamprey	**LAS**					8, 8.1, 8.2
Salmon / Sea	**SAL /**	13				
Sea bass	**BSS**				22	
Sea trout	**TRS**				12	
Shads	**SHZ**					5, 5.2

Source: adapted from EC-DGMARE (2014a; 2014b)

4.1.3. Protected species at potential risk of being incidentally caught or taken as bycatch in current driftnet fisheries

The fisheries where there is a potential risk of interaction with protected species are summarised in Table 8. Information is based on a review of SAC and SPA site locations, the qualifying species population status, and other indicators of species hotspots such as IBAs (Birdlife, 2013), turtle nesting locations, and comparison with fishery location. Since comprehensive bycatch information is not available, this section merely highlights possible interactions between driftnet fisheries and species of conservation concern, but does not represent an exhaustive list of protected species that might interact with these fisheries.

The **Black Sea** fishery targeting Atlantic bonito (ID29) involves a risk of incidental catch or interaction with harbour porpoise (*Phocoena phocoena relicta*) based on the corresponding distributions and reported interactions of this species with driftnets in the Baltic Sea.
Although there are no reports of interactions for common dolphin (*Delphinus delphis ponticus*) or bottle nosed dolphin (*Tursiops truncatus ponticus*) based on the potentially similar distributions of these species with the target species, there is a possibility they might also interact with driftnets: all three species are listed in Annex IV of the Habitats Directive (92/43/EEC) and are therefore subject to strict protection. The Black Sea is also an IBA (Birdlife, 2013) for a number of bird species, including the great cormorant (*Phalacrocorax*

9 Region indicates Baltic Sea (BAL), Black Sea (BS), Mediterranean (MED), North Sea (NS), North East Atlantic (ATL). ID reference numbers refer to fisheries detailed in Table 3 For the target species refer to Table 13 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

carbo), pygmy cormorant (*Phalacrocorax pygmeus*), black-necked grebe (*Podiceps nigricollis*), red-necked grebe (*Podiceps grisegena*), great northern loon/diver (*Gavia immer*), red-throated loon/diver (*Gavia stellata*), and tufted duck (*Aythya fuligula*). The semi-driftnet fishery (ID13) in the Baltic involves a risk of incidental capture or interaction with grey seal and Baltic ringed seal (*Pusa hispida*) due to their distribution and to interactions with similar gear types. Based on feeding behaviour and IBA locations (EC-DGMARE, 2011) the following Annex I species (Directive 2009/147/EC) are at risk of interacting with Polish semi-driftnet fisheries: Slavonian grebe (*Podicep sauritus*), long-tailed duck (*Clangula hyemalis*), and smew (*Mergus albellus*).

A number of **North-East Atlantic** driftnet fisheries are found in the vicinity of SACs and SPAs. In the UK these include the European sea bass fisheries (ID20, ID21) operating in divisions VIId and VIIf from October to January close to the Pembrokeshire Marine/Sir Benfro Forol SAC, for which grey seal is the primary reason for site selection. Pembrokeshire in south-west Wales is representative of grey seal colonies in the south-western part of the UK breeding range.

Table 8: Current driftnet fisheries posing potential risk of incidental catch or interaction with 'protected' species, by region[10]

Primary target species	Acronym	BAL	BS	MED	NS	ATL
Atlantic bonito	**BON**		29			
Amberjack	**AMB**			35		
Anchovy	**ANE**			33, 36, 37, 38		
Atlantic cod	**COD**				28	
Atlantic herring	**HER**				3	1, 2
Common sole	**SOL**				24	25
European	**PIL**					26
Sea lamprey	**LAS**					8
Mackerel, bogue	**JAX, BOG**			34		
Salmon, Sea	**SAL, TRS**	13			12	
Sea bass	**BSS**				22	18, 19, 20, 21
Sea bream	**SBS**			32		16
Sea trout	**TRS**				12	
Shads	**SHZ**		5			6

Source: adapted from EC-DGMARE (2014a; 2014b)

Driftnet fisheries targeting European pilchard (*Sardina pilchardus*) in divisions VIId,e (ID26) are also in the vicinity of the Plymouth Sound and Estuaries SAC, for which Allis shad (*Alosa alosa*), listed in Annex II of the Habitats Directive (92/43/EEC), is a qualifying feature but not the primary reason for site selection. Allis shad are rare in the UK, although formerly known to spawn in several British river systems. The only recently confirmed spawning site is in this SAC (EC-DGMARE, 2014a). Based on behaviour and habitat preference, Allis shad bycatch in the herring driftnet fishery operating in divisions VIId,f could be considered a risk,

[10] Region indicates Baltic Sea (BAL), Black Sea (BS), Mediterranean (MED), North Sea (NS), North East Atlantic (ATL). ID reference numbers refer to fisheries detailed in Table 3. For the target species refer to Table 13 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

but there are no SACs in the vicinity of this fishery, where this species is a qualifying species. All of the UK driftnet fisheries in the North-East Atlantic are also found in or close to SPAs placed to protect overwintering or breeding bird species. These include overwintering populations of species that might interact with driftnets based on their feeding behaviour, such as great crested grebe (*Podiceps cristatus*), cormorant, and red-breasted merganser (*Mergus serrator*) in divisions VIId,e,f, and breeding populations of Manx shearwater (*Puffinus puffinus*), guillemot (*Uria aalge*), and razorbill (*Alca torda*) in divisions VIIe,f.

Common guillemot bycatch has been observed in the **North Sea**, which suggests that fisheries off the south coast of the UK might also interact with them. The French marine driftnet fishery (ID1) targeting herring and sea bass in division VIId operates from October to December, therefore it risks interacting with overwintering populations of black-throated, red-throated, and great northern diver (*Gavia arctica*). The drifting trammel net fisheries targeting lamprey (ID8) in the Loire Estuary (January-June) may risk interacting with overwintering populations of great northern loon/diver, black-throated loon/diver, and red-throated loon/diver in river areas. These three species use an area between the plateau and Banche Bay of La Baule in the Loire Estuary, mainly from December to February. Although the Barthes de l'Adour SPA is situated in the Adour Estuary, no Annex I species of the Birds Directive (Directive 2009/147/EC) are likely to interact with fishing gear. The Bassin d'Arcachon and banc d'Arguin SPA is located in the vicinity of the estuarine driftnet fishery targeting seabream in division VIIIb (ID16), and may involve a risk of incidental capture of overwintering/pre-migration populations of black-throated, great northern, and red-throated diver, and of aggregations of Cory's shearwater (*Calonectris diomedea*) all year round.

Both the Portuguese (ID27) and the Spanish (ID47) driftnet fisheries targeting European pilchard in ICES division IXa may also pose a risk to foraging Cory's shearwater based in a nearby IBA located on the northern coast of Spain. In the North Sea, three SACs are found in proximity to current driftnet fisheries. The salmon/sea trout driftnet fishery operating in ICES division IVb (ID10, ID12) within 6 nm off the Northumberland coast coincides within the Berwickshire and North Northumberland Coast SAC for which grey seal is a primary reason for site selection. The north-eastern England coastal section is representative of grey seal breeding colonies in the south-east of its breeding range in the UK. This fishery is also estimated to take 10-15 % of the River Tweed salmon stock for which a SAC has been established inshore along the River Tweed. An additional driftnet fishery targeting sea trout in the vicinity also takes Atlantic salmon as bycatch.

In the **Mediterranean** current SSDs involve the risk of interaction with loggerhead turtles (*Caretta caretta*) (Annexes II and IV of the Habitats Directive, 92/43/EEC) - due to the proximity of Italian fisheries to nesting sites on the Italian coast - and with a number of species listed in Annex I of the Birds Directive (2009/147/EC), including yelkouan shearwater (*Puffinus yelkouan*); Cory's shearwater (*Calonectris diomedea*); European shag (*Phalacrocorax aristotelis*); Adouin's gull (*Larus audouinii*) and Mediterranean gull (*Larus melanocephalus*) based in IBAs currently in place in GFCM areas GSA 9, 10 and 19. Similar to the **Black Sea**, although there are no reports of interactions with common dolphin and bottle nosed dolphin, their distributions in these regions involve the possibility of interaction with driftnets.

5. EVALUATION OF THE EU REGIME ON SMALL-SCALE DRIFTNET FISHERIES

KEY FINDINGS

- The ban on 'large-scale' driftnet fishing (i.e. driftnets longer than 2.5 km and/or targeting unauthorised species) is still necessary, but its enforcement has met with problems and has not stopped the expansion of large-scale pelagic driftnets.
- The current definition of 'driftnet' in Regulation (EC) No 809/2007 is not specific enough to determine the technical scope of the regulation, i.e. what should or should not be considered a driftnet fishery. As a result, it is unclear whether the semi-driftnet and drift trammel net fisheries identified should be under the driftnet regime.
- The EU driftnet regime would benefit from revision of the definition of driftnet both to improve clarity in the scope of the definition and to ensure that inland driftnet fisheries targeting *anadromous* or *catadromous* species are covered by the regime.
- Member States are required to monitor fisheries for impacts on protected species under the Habitats and the Birds Directives. However there is limited evidence that this has been done for driftnet fisheries in all Member States.
- The available information on the environmental impacts of current driftnet fisheries does not indicate that they have significant impacts on target species. Furthermore, it suggests that their environmental impacts on non-target species, including protected species, are similar to those of other passive fisheries that use static nets (e.g. gillnets, trammel nets).
- As recommended by the Scientific, Technical and Economic Committee for Fisheries, in regions where interactions are anticipated but data on incidental capture of protected species are scarce or not available, Member States could be asked to conduct pilot studies to identify the most high-impact fisheries, establish and monitor the effectiveness of mitigation measures, and facilitate the adoption of more environmentally acceptable fishing gears.
- There is too little information to determine the impacts of all driftnet fisheries on protected species, and the EU driftnet regime has not helped achieve this goal.

5.1. Context and problem definition

Since June 1992 the keeping on board or use of driftnets whose individual or total size exceeds 2.5 km is prohibited in EU waters (except in the Baltic Sea, the Belts and the Sound). The ban also involves EU vessels outside EU waters (EU Reg. No 345/92).

However, enforcement of the ban has met with a number of practical problems (e.g. use of driftnets by fishermen claiming they are bottom-set gillnets; low risk of detection; cooperative behaviour among vessels) and has not stopped the expansion of large-scale pelagic driftnets. Use of illegal driftnets and incidental taking of protected species has continued to be reported in different EU regions, particularly in the Mediterranean (Oceana, 2008). Therefore in 2002 the EU banned all driftnets, regardless of length, when intended to capture a number of pelagic species including tuna, swordfish, billfish, sharks and cephalopods (EU Reg. No 1239/98).

In addition, to address the serious threat posed by salmon driftnet fisheries to depleted harbour porpoise populations, all types of driftnets have also been banned on board and for fishing in the Baltic Sea as of 1 January 2008 (EU Reg. No 2187/05).

Finally, EU vessels are allowed to keep on board and use small-scale driftnets (SSDs), except in the Baltic, provided that:

a) their individual or total length is ≤ 2.5 km;

b) they are not intended to capture species listed in Annex VIII of EU Reg. No 1239/98 as amended by EU Reg. No 1239/98, and

c) any Annex VIII species (EU Reg. No 1239/98) that are caught in driftnets are not landed.

Specifically, Art. 8(2) of EU Reg. No 1967/06 prohibits the catching of most Annex VIII species (EU Reg. No 1239/98) with bottom-set gillnets in the Mediterranean, thus closing a loophole that would have made it possible to use illegal driftnets under the pretence of their being bottom-set gillnets. Further technical provisions are envisaged for different types of bottom-set gillnet (e.g. maximum length, height, and twine thickness) to facilitate controls.

Council Regulation (EC) 809/07 provides a definition of 'driftnet' to support the other regulations. Despite this legal framework, difficulties in applying the EU driftnet rules are still being reported, particularly in the Mediterranean. These issues have also acquired a wider international dimension. To overcome enforcement problems, some non-governmental organizations (NGOs) have repeatedly called for a ban on all driftnet fisheries (Oceana, 2005; 2007; 2008).

Compliance problems within the EU have been addressed following European Court of Justice (ECJ) rulings against France (C-556/07 and C-479/07) and Italy (C-249/08), which had failed to exert effective control and to enforce driftnet rules. Changes in national regulations by the relevant Member States following these rulings, and monitoring by the EC, have resulted in greater compliance. For example, **France** now authorises only a <u>mesh size under 50 mm</u> in the Mediterranean, within 2 nm of the coast. **Italy** has recently adopted national legislation stipulating a one-net rule (i.e. no fishing gear other than the driftnet can be taken on board) and authorising SSDs with a <u>maximum mesh size of 100 mm,</u> only within 3 nm miles of the coast. **Spain** is controlling its *"Xeito"* fisheries by technical measures laid down in regional regulations, allowing only mesh sizes in the 23-40 mm range and a maximum authorised total net length of 1000 m per vessel and day.

Data from the EU fishing fleet register indicate that there is still a large number of EU vessels involved in SSD fisheries in coastal areas, from the Black Sea to the North Sea (except the Baltic Sea). However, some driftnet fisheries may interact with protected species (e.g. marine mammals, sea turtles) or unauthorised species (e.g. tuna, swordfish), probably because EU rules may be relatively easy to circumvent.

Furthermore, the effectiveness of controls against illegal drift-netting can be adversely affected by the current legal framework while placing a heavy burden, in terms of human and technical resources, on national control bodies. This regards in particular countries with a large number of small-scale artisanal fishing vessels deployed along an extensive coastline with a large number of potential landing places including islands (e.g. the Mediterranean).

5.2. Overview

The EU driftnet regime has been successful in banning large-scale driftnet fisheries. None of the 45 driftnet fisheries identified are known to use gear in excess of 2.5 km in length: in particular, 37/45 fisheries actually use nets less than 600 m long. Furthermore, there is no evidence of indiscriminate catches, and the stakeholders consulted have expressed no concern for environmental impacts relating to SSD use with the exception of one NGO, which was concerned over incidental catches of birds. Consequently, the situation regarding driftnet fisheries differs greatly from that of the 1980s and early 1990s.

5.3. Relevance of the EU driftnet regime to the current situation

The ban on 'large-scale' driftnet fishing (i.e. driftnets longer than 2.5 km and/or targeting unauthorised species) is still necessary. However there is a lack of clarity regarding the objectives of the regulations comprising the EU driftnet regime, in particular whether they are all aimed at both large-scale and SSD fisheries. For example, recital 4 of Regulation (EC) 1239/98 states that the uncontrolled increase in driftnet fishing efforts could present grave risks to target species, but it is unclear whether it refers specifically to the targeting of medium or large migratory species with large-scale driftnets or to driftnet fisheries in general.

The current definition of 'driftnet' in Regulation (EC) No 809/07 is not specific enough to allow the technical scope of the regulation to be determined, namely what should or should not be considered a driftnet fishery. As a result it is unclear whether the semi-driftnet and drift trammel net fisheries identified should be subject to the driftnet regime. Moreover the definition of 'driftnet' is too restrictive in scope, since it excludes driftnet fisheries targeting *anadromous* and *catadromous* species in river fisheries, even though these fisheries fall within the scope of the Common Fisheries Policy (CFP) and, by extension, of the driftnet regime, and despite the fact more than two thirds of vessels using driftnets deploy them in inland fisheries.

5.4. Control and enforcement of the EU driftnet regime

In some cases, predominantly in the Mediterranean, changes to the national legislation have been required to improve control over driftnet fisheries (for instance the introduction of the prohibition to carry driftnets and longlines at the same time in Italy), and the potential for driftnet fisheries to interact with Annex VIII species of EU Reg. No 1239/98 been limited (e.g. by introducing restrictions on maximum distance from the coast and mesh size in French, Italian and Portuguese law). This does not indicate a weakness of the EU driftnet regime, but highlights the potential for future relaxation of national regulations, which could compromise the effectiveness of the EU driftnet regime. Additionally there is currently an SSD fishery targeting Annex VIII species (EU Reg. No 1239/98), the Atlantic bonito (*Sarda sarda*) fishery in the Black Sea, demonstrating that control and enforcement activities by some Member States are in some cases insufficient to deter illegal driftnet fisheries from targeting unauthorised species.

5.5. Environmental aspects of the EU driftnet regime

Regulation (EC) No 812/04 includes measures to monitor the impacts on cetacean species of fisheries, including driftnet fisheries, through investigations and pilot projects. Despite the continued need for driftnet fishery monitoring, to understand their impacts on cetacean species, the current monitoring requirements of EU Reg. No 812/04 do not involve all driftnet fisheries that pose risks to cetacean species, i.e. the driftnet fisheries in the Black

Sea and potentially those in the Mediterranean Sea. Therefore, even though monitoring for impacts on cetacean species has been undertaken in some driftnet fisheries (i.e. the UK fisheries in ICES division IVc and subarea VII), the EU regime has clearly not achieved comprehensive monitoring of the impacts of driftnet fisheries on cetaceans in EU waters. With the exception of cetaceans, the EU driftnet regime makes no provisions for monitoring the impacts of driftnet fisheries on protected species. However, Member States are required to collect this type of data under the Habitats and the Birds Directives (92/43/EEC and 2009/147/EC, respectively).

The Habitats Directive (Council Directive 92/43/EEC, 1992) requires Member States to monitor the habitats and species listed in its Annexes, maintain and/or restore listed species to favourable conservation status, and ensure strict protection of the species listed in Annex IV (92/43/EEC). Driftnet fisheries should therefore be monitored to ensure that they do not impact on Annex IV species (92/43/EEC) and to assess their impacts on Annex II species (92/43/EEC). The Birds Directive (2009/147/EC) requires Member States to maintain populations of wild bird species across their natural range, establish a general scheme of protection for all wild birds, prohibit large-scale non-selective means of bird killing, and encourage research. Driftnet fisheries should therefore be monitored to ensure that their impacts on bird species do not compromise the ability of Member States to meet the Directive's requirements.

5.6. The need for a separate EU Driftnet Regime

The present assessment of the current situation of EU driftnet fisheries suggests that a separate regime for these fisheries is needed. The environmental impacts of large-scale driftnet fisheries have been addressed by Regulation (EC) No 1239/98. Consequently, the main objectives of an EU driftnet regime would be to continue the ban on large-scale driftnet fisheries targeting unauthorised species (i.e., Annex VIII of EU Reg. No 1239/98 medium and large migratory target species) and to contribute towards the monitoring and mitigation of impacts of driftnet fisheries on protected species. These objectives are consistent with the aims of the EU Technical Conservation Measures (TCM) framework, which suggests that the EU driftnet regime could easily be incorporated into the TCM framework, given that Regulation (EC) No 812/2004 is considered as part of it.

5.7. Policy options being considered

Three policy options in addition to status quo have been proposed by DG-MARE to revise the EU driftnet regime.

5.7.1. Option 1: Status quo - No policy change *(baseline scenario)*

This approach involves taking no specific steps to change the spirit or technical content of the current driftnet regime laid down in Council Regulation (EC) No 894/97 as amended by EU Reg. No 1239/98 except, where necessary, to introduce changes in the wording to reconcile the driftnet regime with the discard ban policy being discussed within CFP reform.

5.7.2. Option 2: EU action on technical measures and/or control

This option seeks to remove the scope for misinterpretation by introducing specific provisions regarding:

a) Technical measures (e.g. standards for the rigging of fishing gears: maximum mesh size, twine thickness; maximum distance from the coast, depths), and/or

b) Control and monitoring (e.g. one-net rule, compulsory fishing authorisations; vessel monitoring; logbook revision, cut of the list of designated ports/landing places).

This option would result in a more stable and standardised EU legislation, which could remove certain loopholes that provide room to circumvent rules and weaken controls. Such an approach would also tackle the risk that some States might eventually relax recently adopted measures. However, it would still require a sophisticated control system.

5.7.3. Option 3: Selective EU ban

A selective EU ban of the driftnet fisheries identified as being at the highest risk of harming protected species and/or those unable to avoid unwanted bycatch of unauthorised species would involve the identification and examination of driftnet fisheries having inevitable, regular and substantial interactions with protected and/or unauthorised species in EU waters, resulting in incidental catches. Furthermore, no new driftnet fisheries besides those already registered and authorised at the time of the coming into force of the regulation should be allowed by Member State before certification that they comply with the goals of not catching Annex VIII species (EU Reg. No 1239/98) and having no or very limited interactions with protected species that do not endanger their survivability. This option will also require a sophisticated control system.

5.7.4. Option 4: Total ban of driftnets fisheries

This option would make it illegal to take on board or use driftnets irrespective of fishery and net length; the existing definition of driftnet (EU Reg. No 809/07) would help in this sense. Options 2 and 3 are not mutually exclusive.

While the details are still to be agreed, also depending on the final outcome of CFP reform in terms of technical measures, discard ban, and regionalisation, the most likely instrument to carry out these initiatives would be a regulation dealing specifically with driftnets amending the existing Council Regulation (EC) No 894/97. Another option would be a stand-alone legislation gathering all rules concerning driftnets in a single act and repealing existing provisions.

Except for the adoption of the full ban of all of driftnet types, and provided that EU provisions are solid enough to prevent possible risks of future weakening through national measures, part of the process could be left to self-regulation by stakeholders (e.g. non-binding eco-labelling scheme). Such measures would however be merely complementary to provisions on control.

6. ALTERNATIVE FISHING METHODS AND POTENTIAL TECHNICAL SOLUTIONS

KEY FINDINGS

- There are limited alternative fishing methods to catch the same species or group of species as driftnets.
- Where alternatives exist, pots and trap nets are often used in combination with driftnets to catch the same species or group of species. Other alternatives include set gillnets, hooks and ring nets.
- The environmental impact of some of the alternative gear types is controversial.
- From an economic point of view, the alternative gears do not seem to have the same “fishing power” and would not allow catching the same volume of fish.

The purpose of this section is to identify and describe alternative fishing methods to catch the species or group of species exploited by small-scale driftnets (SSDs), and to evaluate their fishing power, their likely environmental impact, and whether they are suitable for the fishing vessels using SSDs.

Despite the limited available information, a number of considerations may be advanced: few alternative fishing methods are used by driftnetters to catch the same species or group of species. Alternative gears were reported in 35 of the 45 driftnet fisheries identified by EC-DGMARE (2014a; 2014b); they consisted of pots and trap nets, often used in combination with driftnets to catch the same species or group of species (e.g. in France). Other alternative gears include trap nets (in Poland, for salmon/sea trout), gillnets (in France and Portugal, for sea bream, sea bass and meagre, and in Bulgaria for shad), hooks (in France, for sea bass), and ring nets (in Britain, for pilchard).

The environmental impact of some alternative gear types is controversial. Additionally, from the economic standpoint pots do not seem to have the same “fishing power” or to allow catching the same volume of fish.

Although in the **Baltic Sea** driftnets are illegal, the “semi-driftnet” fleet is still operational in Poland. Due to the severe problem of seals predating on salmon captured in fishing gears, trap net use has increased in the coastal fishery because they protect salmon from seals. No significant problems of cetacean bycatch have been reported for trap nets in Poland; nonetheless in Sweden seals mainly get caught in salmon and Baltic herring trap nets, salmon, turbot and cod gillnets, and driftnets. Swedish studies show that Baltic herring gillnets and salmon driftnets are a greater danger to seals than nets anchored to the bottom. All gears targeting salmonids in coastal fisheries therefore pose a potential threat to cetaceans. Whenever set gillnets are the alternative gear used, the potential impact on birds is equivalent to that of driftnets. In addition, set nets might be less effective and thus result in an increased fishing effort to catch the same value of fish.

In the **Mediterranean** the Italian small-scale fishery is a typically seasonal activity, only driftnets are therefore used to target the species listed in Table 4. For other target species most vessels alternate SSDs with other gears such as trammel nets, combined gillnets-trammel nets, longlines, gillnets, and purse seines; in Liguria (“*occhiatara*” gear in GSA09), trammel nets, gillnets and combined nets are employed to target saddled sea bream (*Oblada melanura*).

Replacement of driftnets with set gillnets, trammel nets or set longlines is likely to lead to increased fishing pressure on demersal stocks (EC-DGMARE, 2014b). Likewise, increasing the fishing effort by boat seine might impact on coastal species, whereas replacement with drift longlines and purse seines both targeting large pelagic fish might create conflicts with blue fin tuna and swordfish catches. In the Cilento area ("*menaide*" gear in GSA10), purse seines and gillnets are also used in the same fishing area to target anchovy. However, the purse seine fisheries in this area are used by completely different vessels to those involved in SSD fisheries. In northern Sicily ("*sgomberara*" gear in GSA10), the main alternative gears employed to catch mackerel and bogue are purse seines and to a lesser extent gillnets. However, a lower price is fetched for these species caught with purse seines (EC-DGMARE, 2014a; 2014b).

Although the available data do not allow comparison of environmental impacts, the potential impacts on birds and cetaceans are considered to be similar for purse seines and SSDs. In northern Sicily ("*ricciolara*" gear, GSA10), the main alternative gears employed to target amberjack (*Seriola dumerilii*) are trammel nets, gillnets and combined nets. If alternative gears prevail, replacement with set gillnets, trammel nets or longlines will increase fishing pressure on demersal stocks.

Hooks have been reported as an alternative gear for targeting sea bass in France (ICES division VIId); they may have a lower impact on bird bycatch, but no concrete data or studies are available to compare their environmental impacts. Details for each of the 45 driftnet fisheries identified are listed in Table 9.

Table 9: Summary of alternative gears used to exploit species targeted by driftnets[11] ***(continued on next page)***

ID	Gear	Member State	Fishery Area	Target species	Alternative gear(s)	Impact of alternative gear(s) compared to GND
1	GND	France	VIId	HER	TM	Cetacean interaction
2	GND	UK	VIId, VIIf	HER, MAC	GNC, LHP, OTM, PTM	-
3	GND	UK	IVc	HER	GNC, LHP, OTM, PTM	-
5, 5.2	DTR	France	VIIIa, VIIIb	SHZ	-	-
6	GND	Romania	GSA29	SHC	-	-
8, 8.2, 8.3	DTR	France	VIIIab	LAS	FPO	Potential impact on birds
9	DTR	France	VIIIb	SAL, TRS	-	-
10	GND	UK	IVb	SAL, TRS	-	-
12	GND	UK	IVc	TRS	-	-
13	S-GND	Poland	24-26, 22-32	SAL, TRS	FIX, LL	FIX: potential threat to cetacean LL: lower SAL selectivity
14	GND	UK	VIIa	SAL, TRS	-	-
15	GND	France	VIIIb	MGR	TX, GTR, LX	-
15.2	DTR	France	VIIIb	MGR	TX, GTR, LX	-
16, 16.2	GND	France	VIIIb	SBX	TX, GN	-
17	DTR	France	VIIIb	BSE	TX, LX, GN	LX: potential cetacean interaction
18	GND	France	VIId	BSE	TX, LX, GN	LX: potential cetacean interaction

[11] ID reference numbers refer to fisheries detailed in Table 3. See Table 13 for the acronyms of target species and gears *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

Table 9: *(continued from previous page)*

ID	Gear	Member State	Fishery Area	Target species	Alternative gear(s)	Impact of alternative gear(s) compared to GND
19	GND	UK	VIId	BSS	FPO, GN, GNC, GNS, GTR, LHM, LL, LX, OTB, TBB	GN: similar to GND
20, 21	GND	UK	VIId,e,f	BSS, MUL	*Ref. ID19*	*Ref. ID19*
22	GND	UK	IVc	BSS	*Ref. ID19*	*Ref. ID19*
23	GND	Portugal	IXa	BSS, SBX, MGR	GN	Equivalent seabirds impact
24	DTR	UK	IVc	SOL	GN, GNS, OTB, TBN	-
25	DTR, GND	UK	VIId	SOL	*Ref. ID24*	-
26	GND	UK	VIIe,f	PIL	GNC, GNS, LHM, PS	-
27	GND	Portugal	IXa	PIL	PS	Cetacean interaction
28	GND	UK	IVc	COD	FPO, GN, GNS, LL, OTB, TBN	
29	GND	Bulgaria	GSA29	BON	LLS, LL	-
32	GND	Italy	GSA9	SBS	GN, GTR, GTN	-
33, 36, 37.2	GND	Italy	GSA10	ANE	PS, GN	-
34	GND	Italy	GSA10	JAX, BOG	PS, GN	-
35	GND	Italy	GSA10	AMB	PS, GN	-
37	GND	Italy	GSA10	BLU	PS, GN	-
38	GND	Italy	GSA16	PIL	PS, GN	-
41	DTR	Bulgaria	GSA29	SHC	GN, GNS, FIX	-
44	DTR	Portugal	IXa	LAS	FPO	Potential seabirds impact
45	DTR	Portugal	IXa	SHZ	FPO	Potential seabirds impact

Source: adapted from EC-DGMARE (2014a; 2014b)

7. SELECTIVITY OF DRIFTNETS

KEY FINDINGS

- Passive gears like driftnets and other gillnets are highly selective for different fish sizes, more so than active gears. Selectivity estimates of passive gears are based on comparative fishing with gillnets of different mesh sizes (*indirect technique*).
- The catch process of driftnets is a function of fish size and mesh size (*principle of geometric similarity*). For each species, there is an optimum fish size that will be retained by a net with a particular mesh size. Above and below optimum fish length the ability of the net to retain it decreases.
- Major factors affecting the fishing behaviour of driftnets include mesh size, mesh configuration, net hanging ratio, twine thickness and elasticity, colour of netting, type of netting material, net floating, and soaking time.

7.1. Background

The first manual describing methods to measure fishing gear selectivity was written by Pope et al. (1975). In the same year an extensive review of gillnet selectivity was published by Hamley (1975). The present study discusses the most important factors affecting gillnet selectivity as well as the methods used by different authors to estimate selectivity curves. Important contributions provided over the past few decades have furthered our understanding of selection principles related to different types of fishing gears. At the same time, the introduction of new statistical models for data analysis, due to the increasing availability of computational instruments, has played a major role in the development of new methods and the improvement of existing ones.

In recent years considerable effort has been devoted to studying the selectivity of the static fishing gears used to capture commercial species and developing new static gears with improved selection properties. Static gears include bottom-set gillnets, driftnets, trammels, tangle nets, semi-trammel nets, and mixed (gillnet and trammel) nets.

7.2. Selection process and selectivity

According to Parrish (1963), selection in fishing can be defined as *"any process that gives rise to differences in the probability of capture among the members of the exploitable body of fish"*. Such a general definition encompasses both between-species and within-species selection during the different stages of the catch process. In fact, the catch process, hence selection can be thought of as being divided into three distinct phases:

- probability that the presence of fish belonging to one or more species coincides in time and space with the use of the fishing gear;
- probability that fish belonging to one or more species encounter the fishing gear, provided they are present when and where the gear is deployed (i.e., that fish are accessible to the gear);
- probability that the fishing gear retains fish belonging to one or more species, provided they have encountered it (i.e., that fish are vulnerable to the gear).

Whereas the first two phases essentially depend on fish distribution and behavioural patterns, in the third the key role is played by the specific characteristics of the fishing gear. With regard to between-species selection, capture will depend mainly on the behaviour of each species towards the fishing gear. In the case of within-species selection fish retention will depend on their specific characteristics (age, length or girth); in the latter case, selection is often taken as a synonym for length selection, in spite of the fact that where meshes are concerned selection is essentially a girth/mesh-opening related process.

Selectivity is merely the quantitative expression of selection. Unlike trawl codend selection studies, gillnet selection investigations suffer from a lack of knowledge of the structure of the population encountering the gear, with the obvious exception of direct estimation studies. As a consequence, selectivity estimates are based on comparative fishing with gillnets of different mesh sizes (the so-called **indirect technique**), keeping the other physical characteristics of the gear constant.

Furthermore, some basic assumptions are usually taken into consideration, the most important of which is Baranov's ***"principle of geometric similarity"***, whereby if selection depends only on the relative geometry of fish and meshes, then all selection curves are similar (Baranov, 1948). Therefore, selectivity will be the same for any combination of fish length and mesh size for which their ratio is constant (Hamley, 1975); in other words all meshes are equally efficient for the length class they catch best.

Nonetheless, there is evidence that nets with large mesh size are more efficient for large fish (Ricker, 1949; Hamley and Regier, 1973). According to several authors this is related to the fact that larger fish are more active than smaller fish, thus increasing their probability of encountering the nets (Rudstam et al., 1984; Henderson and Wong, 1991).

7.3. Factors affecting selectivity

In the list of the major factors affecting gear selectivity presented below some, like those related to the gear, are easy to control, whereas those related to the fish or environmental conditions can be controlled to a very limited extent (Sala et al., 2006; 2007; 2008; 2015).

Gear-related parameters
- Mesh size
- Gang (fleet) and net dimensions
- Hanging ratio (vertical and horizontal)
- Twine characteristics (i.e. material, construction, thickness and colour)
- Floatation and weight
- Soaking time
- Arrangement of nets in the fleet - sequence and joining between nets.

Fish-related parameters
- Abundance
- Availability to the net
- Behaviour towards the net
- Size
- Shape (i.e. girth at different body points)
- Presence of bycatch
- Presence of predators (can reduce soaking time)
- Net saturation
- Patchy distribution in the net (includes attracting effects by individuals caught).

Parameters related to fishing operations
- Vessel dimension (low-lying vs. high-lying boats)
- Net handling techniques
- Environmental parameters
- Light
- Sea condition and currents
- Seabed type
- Depth

7.3.1. Selection of mesh size in driftnets for particular fisheries

The ideal basis for mesh size selection in driftnets for a given fishery is information on fish stock size distribution. Mesh size is selected on the basis of earlier experience in the same fishery or of general information from other fisheries targeting the same species. Some mesh size ranges of commercial driftnets for major species and fishing areas are reported in Table 10 (Karlsen and Bjarnason, 1986). The data demonstrate that mesh size can range widely in the different fisheries. The smallest size is only 31 mm (a sardine driftnet), whereas the largest are eight or ten times larger (240 and 300 mm in a driftnet for yellowfin tuna and sharks, respectively). These data are merely reported to illustrate the relationships between mesh size and target species, since most of these fisheries are no longer legal.

Clupeid (PIL, HER) driftnets: Mesh size in clupeid driftnets requires careful consideration for several reasons. One is that clupeids generally school in year classes, and the size of individuals is therefore fairly uniform. Mesh sizes that are not closely related to the size of the fish sought would therefore be inefficient. This is even more important in the case of clupeids, because they are fairly smooth and do not tend to become entangled. Another reason is that clupeids are small fish that have to be caught in large numbers to provide a sufficient economic return. Mesh size should therefore be small enough to prevent large-scale wedging, i.e., penetration of the body too far into the mesh (this would also complicate release, since the soft skin can easily be cut and damaged by the twine of the netting). Even a mesh size large enough to allow only gilling would not be advisable in Norwegian clupeid fisheries, because of the release problem and of possible damage to the fish. For this reason, the best mesh size for that particular driftnet fishery is the one into which most of the fish cannot pass their head, but which fastens over it (snagging). A problem with excessively small mesh sizes is that it reduces net catching efficiency. Another is that part of the snagged fish may escape from the net during hauling. Experiments in Norway have explored the problems related to mesh size selection for clupeid driftnets. They found that the mesh size corresponding to the common practice of the fishery, 60 mm, was too small. By fishing on a stock of herring ranging in individual length from about 300 mm to 400 mm, the experiments found that even with a 66 mm mesh size, which was more efficient in catching larger herring, many of the largest species (about 30 %) were lost during hauling, even when special care was taken when retrieving the nets to reduce losses (Karlsen and Bjarnason, 1986). The experiment found that the most efficient mesh size for large herring 350-400 mm long was about 70 mm.

Salmon driftnets: Unlike clupeids, salmon is a large, expensive fish of which a few individuals are sufficient to achieve a good commercial return in small-scale fisheries. The main consideration in mesh size selection for salmon driftnets is therefore to prevent salmon from freeing itself. The mesh size should be large enough to encircle the body of the salmon (gilling or wedging) and the material firm enough to prevent subsequent escape. In addition, salmon gillnets should be loosely hung to promote entangling, thus increasing the probability of capture. The differences in salmon gillnet mesh sizes shown in Table 10 are mainly due to the different size of salmon targeted by different fisheries and/or to market demands, since large salmon fetch a better price than smaller ones.

Tuna driftnets: Tuna driftnets also differ considerably in mesh size, because they must suit the different tuna species. The mesh size of multi-species tuna driftnets (skipjack, yellowfin) is thus about 15O mm, whereas nets for the larger bluefin have a much larger mesh size (240 mm). These fisheries are no longer legal in the Mediterranean.

Table 10: Examples of mesh size in commercial driftnet fisheries[12]

Target species	Area	Country	Mesh size
PIL	Mediterranean	France	31
HER	Hokkaido	Japan	49-52
	English channel	France	53
	North Sea	Norway	52-60
	North Atlantic	Iceland	63
SSM	Gulf of Siam	Thailand	82-100
SAL	North Pacific	Japan	121
	Puget Sound	USA	125-200
	Barents Sea	Norway	120-135
	Baltic Sea	Germany	160
SKX, TUN	Indian Ocean	Sri Lanka	150
SKX	Inshore waters	Australia	150
	Coastal waters	Mexico	300
BFT	Mediterranean	France	240

Source: adapted from Karlsen and Bjarnason (1986)

Note: This information is merely provided to illustrate the relationships between mesh size and target species, because most of these fisheries (e.g. BFT in EU waters) are no longer legal.

7.3.2. Types of netting material

The most common synthetic material used in driftnets is polyamide (PA), i.e. nylon. Its main advantage compared with other synthetic fibres is elasticity. The stretching ability of PA twines has also been found to increase selection range, i.e., the width of the selectivity curve, because the stretched mesh becomes larger when strained by a fish swimming into it. This translates into increased net efficiency for fish larger than the optimal size for the mesh size selected. This positive effect is related to twine thickness and fish size (swimming force), since these two factors influence twine elasticity and tension. Mesh elongation is most important in the case of fish that are normally snagged, gilled or wedged.

[12] For the target species refer to Table 13 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register)*.

7.3.3. Net hanging ratio

The **hanging ratio** (HR) has considerable influence on both the catching efficiency and the fish size selectivity of driftnets. The main finding is that looser hung nets (which have a low HR) catch more and a larger range of fish lengths than the same nets more tightly hung. Also, more fish become entangled (Hamley, 1975). Commercial gillnets typically have an HR of 0.25 to 0.50, whereas the driftnet HR exceeds 0.7 (EC-DGMARE, 2014b).

In European marine fisheries the lower HRs are applied in flatfish fisheries, whereas nets for catching roundfish typically have HRs between 0.4 and 0.5. Riedel (1963) noted that a lower HR resulted in an increased number of (mainly) smaller Mozambique tilapia (*Oreochromis mossambicus*) becoming entangled in the net. Similarly, Engås (1983) found reduced selectivity when the HR decreased from 0.6 to 0.4, due to more small fish being caught in the loosely hanging nets. Samaranayaka et al. (1997) noted a small increase in the amount of tuna entangled when the HR was reduced from 0.6 to 0.5.

The **height** of a driftnet is considered to be of greater importance for fishing efficiency than the length of the individual nets. Height needs careful consideration in relation to the migrating behaviour of fish. For surface migrating fish, like salmon, the nets can be set shallower than for other pelagic fish, like herring and sardine. Moreover, when fish are concentrated in limited water layers the nets can be shallower than when fish are scattered in taller layers of the water column. Driftnet rigging and fishing tactics have to be considered when deciding net height. When shooting on the basis of fish detection and location by echo sounders, if the nets are easily depth-regulated there is less need for higher nets than in cases when they are to be set without any knowledge of fish distribution.

Bottom driftnets are usually lower than mid-water and surface driftnets, both because most demersal species remain close to the bottom and because high bottom driftnets would be more exposed to damage in shallow waters, where they are deployed most commonly. Other factors that explain the reduced height of driftnets are cost and handling effort, which are both greater with higher nets. In small-scale fisheries driftnet number and size are normally restricted by cost, handling, and space constraints. As shown in Table 11, the heights of commercial mid-water and surface driftnets is from 7 m to 15 m, whereas bottom driftnets are only 2 m high.

Table 11: Some examples of driftnet height[13]

Type of driftnet	Height of netting	
	No of meshes	Stretch height [m]
Bottom GND	50	2
HER	150-200	7-10
SAL	50-120	8-15
TUN, BFT	50-100	12-15

Source: adapted from Karlsen and Bjarnason (1986)

[13] For the acronyms of target species see Table 13 *(see Annex 2: Standard, Data structure and associated code lists in the Master Data Register).*

7.4. Statistical analysis

Knowledge of the size selectivity of commercial fishing gears is crucial for fishery management if yield is to be maximised and juvenile fish protected (Gulland, 1983; Wileman et al., 1996; Sala and Lucchetti, 2010; 2011). Selectivity experiments with static gears typically involve simultaneous fishing with several nets with different mesh sizes. **Specific experiments examining driftnet selectivity have not yet been conducted.**

If the length distribution of the fished population is ‘‘known’’, then net selectivity can be estimated **directly**. However, good knowledge of the population length distribution is rare; in practice one might conduct an experiment using only the recaptures of a tagged fish sub-population (Hamley and Regier, 1973). Direct estimation is usually not feasible; **indirect estimates** of selectivity are therefore obtained by comparing the observed catch frequencies across the various meshes used. Methods to calculate indirect estimates of static gear selectivity from comparative catch data have been developed by Holt (1963), Regier and Robson (1966), Hamley (1975), Kirkwood and Walker (1986), Henderson and Wong (1991), Millar (1992), and others. The reader is referred to Holst and Moth-Poulsen (1995) for a brief review of several of these methods, including their application to a common dataset. Millar and Holst (1997) present a general statistical model that is suitable to estimate gillnet selection curves (i.e. retention probability) from comparative gillnet catch data. In many cases the model is log-linear. Log-linear reduction has been used by Holt (1963) to estimate normal-shaped selection curves using catch data from pairs of similar-sized mesh gillnets.

Notably, all methods support and agree with Baranov's principle of geometrical similarity (see above under *7.2. Selection process and selectivity*), which states that selectivity depends only on the relationship between fish circumference and mesh size in use. It is however clear that the morphology of certain species disagrees with the principle, and that there are multiple ways to capture fish. For a more comprehensive discussion of the principle's validity the reader is referred to Hamley (1975).

8. POLICY RECOMMENDATIONS

KEY FINDINGS

- The environmental impacts of driftnet fisheries on non-target species are similar to those of other passive gears.
- Large-scale driftnet fisheries targeting unauthorised species should continue to be banned because they are not selective.
- Despite the economic importance of driftnets and their public criticism, too little is known of their actual efficiency and selectivity. A selectivity study might provide valuable data to fishery managers.
- The enforcement of mesh size limits would be more successful than the adoption of alternative fishing gears or conversion to other activities.
- Revision of driftnet fisheries regulations is essential and should include technical parameters like maximum mesh size and twine thickness for each driftnet fishery, with special emphasis on maximum headline and footrope dimension.
- The one-net rule – no other gears on board when fishing with driftnets – should be the mainstay of a regime that can be enforced with a high degree of success.

The main objectives of the EU driftnet regime with regard to current driftnet fisheries should be to maintain the ban on large-scale driftnet fisheries targeting unauthorised species (medium and large migratory target species listed in Annex VIII of EU Reg. No 1239/98 and bycatch of associated non-target species) because of their indiscriminate/non-selective nature, and to support actions towards the monitoring and mitigation of the impacts of driftnet fisheries on protected species.

This Chapter provides and discusses research data and options regarding alternative fishing gears, driftnet selectivity, and measures to improve selectivity that can contribute to mitigate the impact of driftnet fisheries on the environment, and offers recommendations for consideration by policymakers.

8.1. EU driftnet regime

The environmental, social and economic case for the proposed policy options related to small-scale driftnets is not conclusive. The EU driftnet regime would also benefit from revision of the definition of 'driftnet' to improve clarity in the scope of the definition and to ensure that:

1. inland driftnet fisheries targeting *anadromous* or *catadromous* species are covered by the EU driftnet regime, or that;
2. the definition of driftnets applies to all nets made up of one or more walls of netting; hung jointly in parallel on the headline(s); and held on the water surface or at a certain distance below it by floating devices and drifting with the current, including semi-driftnet and drift-trammel net.
3. Given the difficulties in implementing controls despite the efforts of national authorities, a one-net rule – no other gears allowed on board when fishing with driftnets – should be the mainstay of a regime that can be enforced with a high degree of success.

8.2. Alternative fishing methods

The available information on current driftnet fisheries does not indicate that they have significant environmental impacts on non-target species, including protected species, but rather suggests that their impact is similar to that of other passive fisheries. This, for example, is the conclusion of the last two EU projects (EC-DGMARE, 2014a; 2014b), which have recently examined purse seines, set gillnets, trammel nets, set longlines, drifting longlines, and boat seines as alternative fishing gears/methods. The need for a separate regime for driftnets warrants review of driftnet fisheries as more information becomes available.

8.3. Setting mesh-size limits by type of driftnet fisheries (*selectivity-based recommendation*)

According to Hovgärd (1996) driftnets, like any other gillnets, are highly size-selective, and retain fish of lengths that do not exceed 20 % of the optimum length. Similar findings have been reported by other authors such as Grant (1981), Nakatani et al. (1991), De Silva and Sirisena (1987) and Rojo-Vazquez et al. (2001).

Accurate information on the relationship between driftnet mesh size and selectivity for target species is critical if fishery managers are to set appropriate minimum fish landing sizes (MLS) and primary net mesh sizes. This knowledge may allow them to discuss such technical measures on a regional basis according to the new CFP, and to set regulations that can help minimise wasteful or unsustainable fishing practices, for instance reducing the likelihood of undersized fish being caught in the driftnets and of incidental catches or bycatch of unwanted species, including endangered species such as cetaceans, turtles and sharks if improper larger mesh sizes are used.

As recommended by Scientific, Technical and Economic Committee for Fisheries, in areas where interactions are anticipated but data on the incidental capture of protected species are scarce or unavailable, Member States might be asked to carry out pilot studies to identify high-impact fisheries, thus freeing resources to fund studies directed at:

a) Devising, applying and monitoring of the effectiveness of mitigation measures;

b) identifying potential driftnet designs that may reduce the catch of non-target species and/or evaluating differences in catch composition (i.e. selectivity) between driftnets with different mesh sizes. More selective driftnets entail reduced mortality of non-target species, and operational efficiency and profitability can be enhanced by more selective driftnet designs.

Despite the economic importance of driftnets and their public criticism, data on their actual efficiency and selectivity are scanty. In particular, selectivity investigations may be valuable to fishery managers to control and minimise the possible negative impact of driftnet fisheries on the environment. **Current information on driftnet mesh size and species selectivity is poor. This gap could be bridged by using selectivity data for similar gillnets until specific driftnet studies are conducted, to provide advice to manage driftnet selectivity over a range of mesh sizes.** Studies are therefore required, to provide new data on the selectivity of different driftnets including information concerning efficiency and selectivity of target species, bycatch and discard, thus providing the basis for informed decision-making.

An effective regulation is one that can be enforced with a high degree of success. The adoption of alternative gears, which do not possess the same “fishing power” and would not allow catching the same volume of fish, would place a heavy economic burden on fisheries, whereas mesh size limits and restriction of the types and dimension of fishing gears and of fishing methods would be more effective in managing driftnet fisheries.

Mesh size limits can be enforced at the EU, national or regional level with a higher degree of success than the adoption of alternative gears or conversion to other activities. The current study emphasises the need to revise driftnet fisheries regulations by laying down the necessary technical specifications including maximum mesh size and twine thickness, with special emphasis on maximum headline and footrope dimensions.

If the implementation of further technical measures and controls as in *Policy option 2* were considered inadequate to address the remaining problems, despite still requiring a disproportionate amount of national resources to ensure proper control, then a selective ban of those driftnet fisheries (*Policy option 3*) that are found to be most harmful to protected species and/or are unable to avoid unwanted bycatch of unauthorised species might also be also contemplated.

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Annex 1: List of protected species in the Annex VIII

Table 12: List of protected species in the Annex VIII of EU Reg. No 894/97 as amended by EU Reg. No 1239/98

English name	Scientific name
Albacore	*Thunnus alalunga*
Bluefin tuna	*Thunnus thynnus*
Bigeye tuna	*Thunnus obesus*
Skipjack	*Katsuwonus pelamis*
Atlantic Bonito	*Sarda sarda*
Yellowfin tuna	*Thunnus albacares*
Blackfin tuna	*Thunnus atlanticus*
Little tuna	Euthynnus spp
Southern bluefin tuna	*Thunnus maccoyii*
Frigate tuna	Auxis spp
Oceanic sea breams	*Brama rayi*
Marlins	Tetrapturus spp; Makaira spp
Sailfishes	Istiophorus spp
Swordfishes	*Xiphias gladius*
Sauries	Scomberesox spp; Cololabis spp
Dolphinfishes	Coryphaena spp
Sharks	*Hexanchus griseus; Cetorhinus maximus;* Alopiidae; Carcharhinidae; Sphyrnidae; Isuridae; Lamnidae
Cephalopods	*all species*

Annex 2: Standard, Data structure and associated code lists in the Master Data Register

The Master Data Register (MDR)[14] contains data structures and lists of fishery codes for use in electronic information records and data exchange among Member States to record and report fishing activities. The main tables used in the present study were downloaded from the ACDR v.1.1.0 data structure and associated code lists (*Aggregate Catch Data Reporting between Member States and the Commission from 2014 onwards*). The main code lists used are shown in Table 13 and Table 14.

Table 13: Species Codes (ISO-3 codes). Note that only those species of interest for the current report have been reported *(Ordered by FAO ISO-3 code)*

FAO ISO-3 code	Scientific name	English name	Family	Order
AMB	*Seriola dumerili*	Greater amberjack	Carangidae	Percoidei
ANE	*Engraulis encrasicolus*	European anchovy	Engraulidae	Clupeiformes
BFT	*Thunnus thynnus*	Atlantic bluefin tuna	Scombridae	Scombroidei
BLU	*Pomatomus saltatrix*	Bluefish	Pomatomidae	Percoidei
BOG	*Boops boops*	Bogue	Sparidae	Percoidei
BON	*Sarda sarda*	Atlantic bonito	Scombridae	Scombroidei
BSS	*Dicentrarchus labrax*	European seabass	Moronidae	Percoidei
COD	*Gadus morhua*	Atlantic cod	Gadidae	Gadiformes
HER	*Clupea harengus*	Atlantic herring	Clupeidae	Clupeiformes
HMM	*Trachurus mediterraneus*	Mediterranean horse mackerel	Carangidae	Percoidei
HOM	*Trachurus trachurus*	Atlantic horse mackerel	Carangidae	Percoidei
JAX	*Trachurus spp*	Jack and horse mackerels nei	Carangidae	Percoidei
LAS	*Petromyzontidae*	Lampreys nei	Petromyzontidae	Petromyzontiformes
LAU	*Petromyzon marinus*	Sea lamprey	Petromyzontidae	Petromyzontiformes
MAC	*Scomber scombrus*	Atlantic mackerel	Scombridae	Scombroidei
MAS	*Scomber japonicus*	Chub mackerel	Scombridae	Scombroidei
MGR	*Argyrosomus regius*	Meagre	Sciaenidae	Percoidei
MUL	*Mugilidae*	Mullets nei	Mugilidae	Mugiliformes
PIL	*Sardina pilchardus*	European pilchard	Clupeidae	Clupeiformes
SAL	*Salmo salar*	Atlantic salmon	Salmonidae	Salmoniformes
SBG	*Sparus aurata*	Gilthead seabream	Sparidae	Percoidei

[14] The MDR website with data structure and all code lists are freely accessible at: https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp

Table 13: *(continued from previous page)*

FAO ISO-3 code	Scientific name	English name	Family	Order
SBS	*Oblada melanura*	Saddled seabream	Sparidae	Percoidei
SBX	*Sparidae*	Porgies, seabreams nei	Sparidae	Percoidei
SHC	*Alosa pontica*	Pontic shad	Clupeidae	Clupeiformes
SHZ	*Alosa spp*	Shads nei	Clupeidae	Clupeiformes
SKX	Elasmobranchii	Sharks, rays, skates, etc. nei	-	Pisces miscellanea
SOL	*Solea solea*	Common sole	Soleidae	Pleuronectiformes
SSM	*Scomberomorus maculatus*	Atlantic Spanish mackerel	Scombridae	Scombroidei
TLM	*Oreochromis mossambicus*	Mozambique tilapia	Cichlidae	Percoidei
TRS	*Salmo trutta*	Sea trout	Salmonidae	Salmoniformes
TUN	Thunnini	Tunas nei	Scombridae	Scombroidei

Table 14: Gear type codes as provided in the Master Data Register repository (*Version 1.0, updated the 01/03/2011*)

Code	Description
SURROUNDING NETS	
PS	With purse lines (purse seines)
PS1	- one boat-operated purse seines
PS2	- two boat-operated purse seines
LA	Without purse lines *(lampara)*
SEINE NETS	
SB	Beach seines
SV	Boat or vessel seines
SDN	Danish seines
SSC	Scottish seines
SPR	Pair seines
SX	Seine nets *(not specified)*
BOTTOM TRAWLS	
TBB	Beam trawls
OTB	Otter trawls
PTB	Pair trawls
TBN	Nephrops trawls
TBS	Shrimp trawls
TB	Bottom trawls *(not specified)*

Table 14: *(continued from previous page)*

Code	Description
MIDWATER TRAWLS	
OTM	Otter trawls
PTM	Pair trawls
TMS	Shrimp trawls
TM	Midwater trawls *(not specified)*
OTT	Otter twin trawls
OT	Otter trawls *(not specified)*
PT	Pair trawls *(not specified)*
TX	Other trawls *(not specified)*
DREDGES	
DRB	Boat dredges
DRH	Hand dredges
LIFT NETS	
LNP	Portable lift nets
LNB	Boat-operated lift nets
LNS	Shore-operated stationary lift nets
LN	Lift nets (not specified)
FALLING GEAR	
FCN	Cast nets
FG	Falling gear *(not specified)*
GILLNETS AND ENTANGLING NETS	
GNS	Set gillnets (anchored)
GND	Driftnets
GNC	Encircling gillnets
GNF	Fixed gillnets (on stakes)
GTR	Trammel nets
GTN	Combined gillnets-trammel nets
GEN	Gillnets and entangling nets *(not specified)*
GN	Gillnets *(not specified)*
TRAPS	
FPN	Stationary uncovered pound nets
FPO	Pots
FYK	Fyke nets
FSN	Stow nets
FWR	Barriers, fences, weirs, etc.
FAR	Aerial traps

Table 14: *(continued from previous page)*

Code	Description
TRAPS (continued)	
FIX	Traps *(not specified)*
HOOKS AND LINES	
LHP	Handlines and pole-lines (hand-operated)
LHM	Handlines and pole-lines (mechanized)
LLS	Set longlines
LLD	Drifting longlines
LL	Longlines *(not specified)*
LTL	Trolling lines
LX	Hooks and lines *(not specified)*
GRAPPLING AND WOUNDING	
HAR	Harpoons
HARVESTING MACHINES	
HMP	Pumps
HMD	Mechanized dredges
HMX	Harvesting machines *(not specified)*
MIS	**MISCELLANEOUS GEAR**
RG	**RECREATIONAL FISHING GEAR**

Annex 3: General specifications of the main gear metrics

Netting material and twine thickness

The standard measure of twine size is Rtex number (ISO 1107, 2003), which expresses the mass of 1000 m of finished twine. For each net section, Rtex number and mesh size (in mm) are shown respectively to the right and left in the area of the net section. Some twine and net manufacturers still designate twine size by its runnage, expressed either as yards per pound or metres per kilogram. Equivalent runnages for the twine sizes to be used for the net may be tabulated separately.
Units of textile measurement (**den** and **tex**):

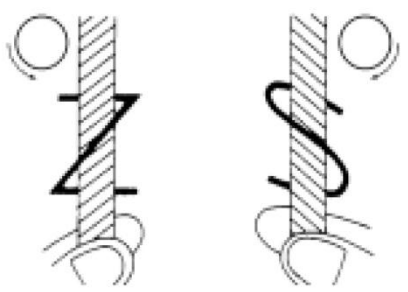
- **Denier (den).** It is a unit of measure for the linear mass density of fibres. It is defined as the mass in grams per 9000 m.
- **Tex (tex).** It is a unit of measure for the linear mass density of fibres defined as the mass in grams per 1000 m. The most commonly used unit is actually the decitex (**dtex**), which is the mass in grams per 10000 m. Sometimes the resultant linear mass density (**Rtex**) of the rope is given on net drawings.

Construction and manufacturing process of the sewing thread

Chemical fibre products such as polyester and nylon thread are increasingly used for a wide range of products. Filament threads such as spun-, woolly-, and monofilament thread are used based on product and application. Threads are different from one another in construction and manufacturing process.

The sewing thread is normally twisted by doubling 2-3 yarns and applying left twist (second twist) to the yarn after application of right twist (first twist) to single yarn. The reason is that return of the twist due to hook rotation should be protected, and that in case of normal stitching the form becomes stable due to limited friction between needle eyelet and thread, and return of twist of thread is difficult to move.

In contrast when using right-twisted thread in normal stitching, the stronger friction between needle eyelet and thread makes the twist easy to move. The thread loop in the state of return of twist is thus formed, resulting in stitch skipping or thread breakage.

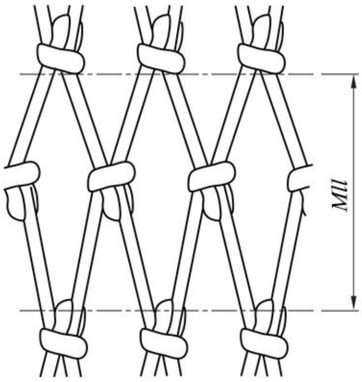


The right twist is called **S twist** and the left twist **Z twist**. However, to distinguish the twist direction, if a thread is held between right thumb and first finger the twist line running from upper left to lower right along the thumb is the right twist, whereas if the thread is held with the left hand the twist line running from upper right to lower left is the left twist.

Mesh size

According to Commission Regulation (EC) No 517/08, the definition of mesh size for **knotted netting** is the longest distance between two opposite knots in the same mesh fully extended in N-direction, as shown in Figure 7. For **knotless netting** it is the inside distance between the opposite joints in the same mesh when fully extended along its longest possible axis (Commission of the European Communities, 1992). The mesh size information provided in the present study is based on these definitions. Mesh size must be determined by the procedures specified in Commission Regulation (EC) No 517/08.

Figure 7: Definition of 'mesh size' (*Mll*) according to Commission Regulation (EC)

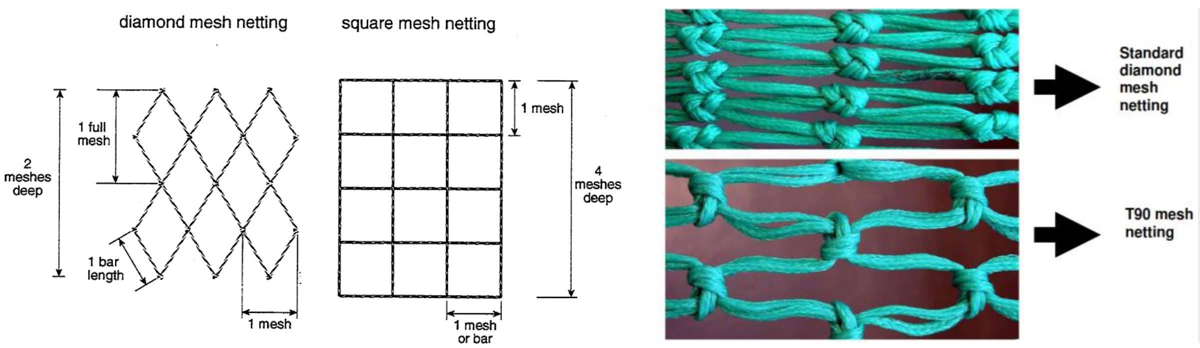


Mesh configuration

The three most common mesh configurations used in the fisheries sector are the diamond, square, and T90 mesh. According to Commission Regulation (EC) No 517/2008:

- **'diamond-mesh'** (or *T0*) is composed of four bars of the same length, where the two diagonals of the mesh are perpendicular and one diagonal is parallel to the longitudinal axis of the net;
- **'square-mesh'** is a quadrilateral mesh composed of two sets of parallel bars of the same length, where one set is parallel to, and the other is at right angles to the longitudinal axis of the net. It is usually a standard diamond mesh turned 45°;
- **'T90 mesh'** is a diamond mesh turned 90° and mounted so that the T-direction of the netting is parallel to the longitudinal axis of the net.

Figure 8: Turning standard diamond mesh through 45° (square-mesh) or 90º (T90 mesh)

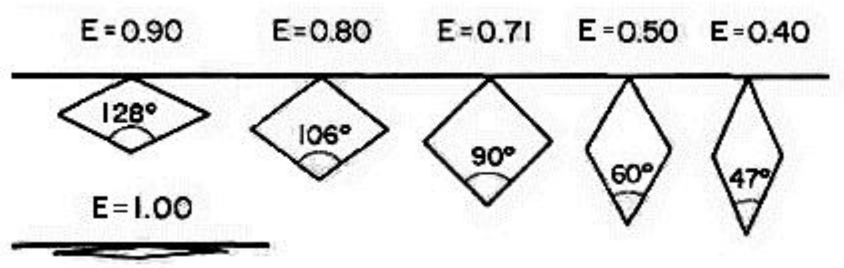


Source: adapted from Sala et al. (2008; 2013; 2015)

Hanging ratio *(E)*

The hanging ratio (*E*) is the ratio of the length of the final rope (*L*) to the fully extended length of the side of the netting to which it is attached prior to being hung (ISO 1107, 2003). The ability of netting to change shape and area can be harnessed in the design, construction and operation of fishing nets to increase fishing efficiency and reduce netting costs.

Example: effect of changes in hanging ratio on mesh geometry.



The actual mesh shape is determined by the process of hanging it onto the rope frame. Three variations produced by hanging the same netting panel ABCD onto lines is shown in Figure 9. The different shapes of the netting panel are obtained by modifying the primary hanging ratio E_1 and the secondary hanging ratio E_2. The primary hanging ratio is defined as:

$$E_1 = L/L_0$$

where *L* is the hung length or the mounted length of the main mounting rope, and L_0 is the length of the same netting fully extended, as shown in Figure 9(1). Similarly, the secondary hanging ratio E_2 is the ratio of the hung height or depth of the netting panel or the mounted length of the side hanging line *(H)* to the fully extended height of the netting *(H_0)*:

$$E_2 = H/H_0$$

The hanging ratios that determine the particular shape of the netting panel also determine the shape of the individual meshes, which in this case are open in a similar way as those of the panel hung length and height (Figure 10).

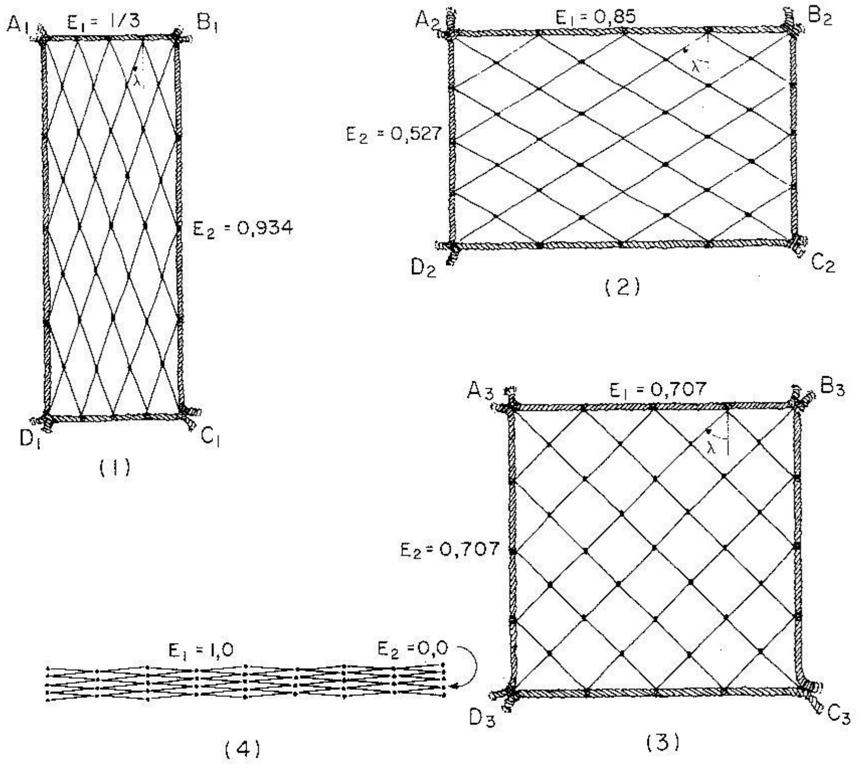
$$E_1 = m_w/mll$$

$$E_2 = m_h/mll$$

where m_s is the length of the mesh side (the distance between the centres of the adjacent knots), m_w is the hung mesh width, m_h is the hung mesh height, and *mll* is the extended mesh length. The relationship between the two hanging ratios is:

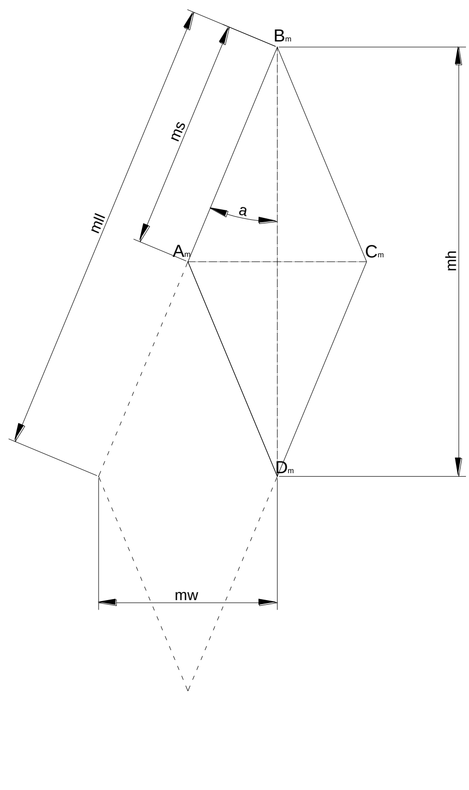
$$E_1^2 + E_2^2 = 1$$

Figure 9: Hanging ratios in hung netting. E_1 primary/horizontal hanging ratio, E_2 secondary/vertical hanging ratio



Source: adapted from Fridman (1986)

Figure 10: Mesh proportions, *mll* is the mesh length fully extended, *ms* is the mesh bar, *mw* is the hung mesh width, *mh* is the hung mesh height, and *a* the half mesh angle



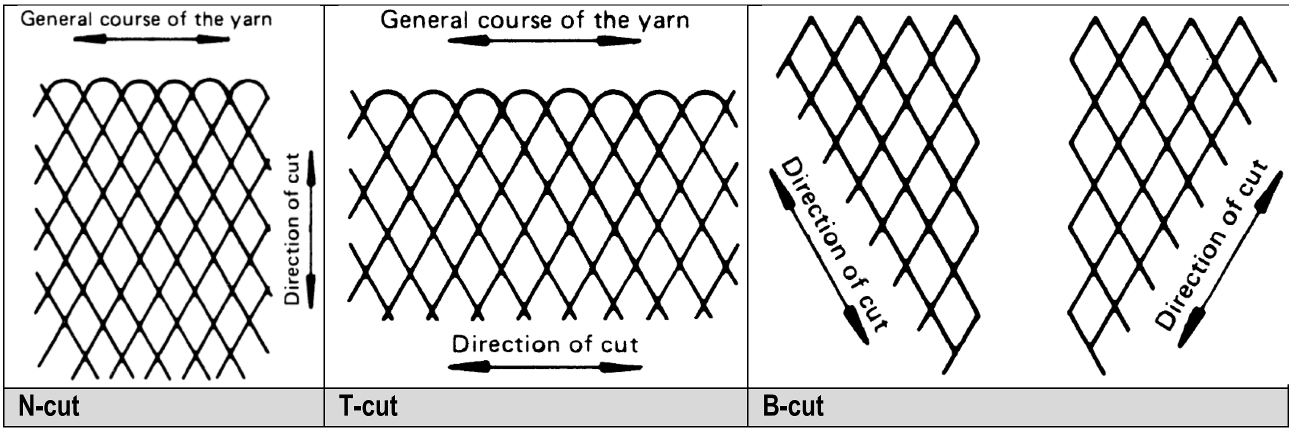
Source: Sala et al. (2013)

Cutting rate, taper rate and cut angle

Oblique or trapezoidal netting panels, such as are required for trawls, must be cut according to pre-calculated taper rates from rectangular sheets of netting as they come from the factory (Figure 11). The types of cuts are fully explained in the ISO standard for cutting netting to shape (ISO 1532, 1973). Three types of cut are used to shape netting:

- **N-cut** (*vertical cut*) through both twines at the side of a knot, advancing the taper cut in the netting one mesh in the direction normal to the general course of the twine;
- **T-cut** (*horizontal cut*) through both twines at the top or bottom of a knot, advancing the taper cut in the netting one mesh in twinewise direction, i.e. the direction parallel to the general course of the twine;
- **B-cut** (*bar-cut*) through one twine at a knot, advancing the taper cut in the netting half a mesh across the strip in the direction normal to the general course of the twine plus half a mesh either way along the strip in twinewise direction. The B-cut is also called *'bar' cut*.

Figure 11: Cutting netting to shape ("tapering")[15]



Source: adapted from ISO 1532-1973

[15] A cut at right angles to the general course of the netting yarn is a 'vertical cut' (N-cut); a cut parallel to the general course of the netting yarn is a 'horizontal cut' (T-cut); a cut parallel to a line of sequential mesh bars, each from adjacent meshes and severing one or more bars is a 'bar-cut' (B-cut).

Annex 4: Review of regulatory rules and technical measures

The rules and measures introduced in the driftnet fisheries legal framework can be summarised at the substantive level as follows (for details see Table 15):

a) Council Regulation (EEC) No 345/92 introduced a ban on driftnets of individual or total length greater than 2.5 km, thereby giving effect to UNGAR 44/225 and the requirement for driftnets > 1 km in length to remain attached to fishing vessels if deployed offshore (i.e. > 12 nm from the coast) or to be monitored if deployed inshore;

b) Council Regulation (EC) No 894/97 re-stated the ban on driftnets of individual or total length greater than 2.5 km and requirements for driftnets > 1 km in length;

c) Council Regulation (EC) No 850/98 no substantive impact as the provisions on driftnets were not amended;

d) Council Regulation (EC) No 1239/98 prohibited the use of driftnets to catch tuna and other Annex VII species I and removed the requirement for driftnets > 1 km in length to remain attached to fishing vessels or to be monitored;

e) Council Regulation (EC) No 812/2004 introduced a limited monitoring scheme for cetacean bycatch;

f) Council Regulation (EC) No 809/2007 introduced for the first time a definition of driftnets.

Therefore, the current situation is that except in the Baltic Sea, the Belts and the Sound, EU-flagged vessels may keep on board and use driftnets provided that:

- their individual or total length is less than 2.5 km; and
- they are not used to catch and/or land tuna and other species listed in Annex VIII of Council Regulation (EC) No 894/97 (as amended by Council Regulation (EC) No 1239/98);
- a scheme for monitoring cetacean bycatch has been introduced for driftnet fisheries in a limited number of areas in the North Sea and the Atlantic.

Table 15: EU regulations and technical measures

EU Reg.	Date	Area of application	Rules/technical measures implemented
No 345/92	From 01/06/1992	EU waters	No vessel may keep on board, or use for fishing, one or more driftnets whose individual or total length exceeds 2.5 km Derogation until 31/12/1993 for vessels that fished long-finned albacore in the NE Atlantic in 1990-1992: authorisation to use driftnets ≤ 2.5 km provided that total length does not exceed 5 km and headlines are submerged at a minimum depth of 2 m
		Offshore fisheries *(> 12 nm)*	Driftnets > 1 km long must be attached to the fishing vessel
		Inshore fisheries *(< 12 nm)*	Driftnets > 1 km long do not need to be attached to the vessel, provided constant observation is maintained
No 894/97	From 29/04/1997	EC waters (except Baltic Sea, Belts and Sound)	No vessel may keep on board, or use for fishing, one or more driftnets whose individual or total length exceeds 2.5 km
		Offshore fisheries *(> 12 nm)*	Driftnets > 1 km long must be attached to the fishing vessel
		Inshore fisheries*(< 12 nm)*	Driftnets > 1 km long do not need to be attached to the vessel, provided constant observation is maintained
		Waters under the sovereignty of Spain or Portugal in ICES subareas VIII, IX, and X, Spanish waters off Canary Islands	Ban on driftnets for catching tunas

Table 15: (continued from previous page)

EU Reg.	Date	Area of application	Rules/technical measures implemented
No 1239/98	From 01/07/1998	All EU waters except Baltic Sea	The maximum number of vessels authorised to keep on board/use driftnets for fishing must not exceed 60 % of the fishing vessels that used one or more driftnets in 1995-1997. A list of authorised vessels must be sent to the Commission every year. Vessels are no longer required to keep driftnets more than 1 km long attached to the fishing vessel
	From 01/07/1998 to 31/12/2001	All EU waters except Baltic Sea	A vessel may be authorised by the national competent authorities to keep on board/use for fishing driftnets intended for the capture of Annex VIII species All fishing vessels using driftnets intended for the capture of Annex VIII species are required to: - keep the net under constant visual observation while fishing - use floating buoys with radar reflectors at each end of the netting so its position can always be determined The master of a fishing vessel using driftnets intended for the capture of Annex VIII species is required to keep a logbook and record the following information on a day-to-day basis: - total length of the nets on board - total length of the nets used in each fishing operation - the quantity of each species caught during each fishing operation, including bycatch and discards at sea, in particular cetaceans, reptiles and sea birds - the quantity of each species held on board - the date and position of such catches The master of a fishing vessel using driftnets intended for the capture of species listed in Annex VIII is required to: - send a declaration to the MS of landing giving the quantities of each species landed and the catch dates and zones - notify the authorities in the MS concerned at least 2 hours before arrival in port, of planned landing location and time - keep on board the prior authorisation to fish (issued by national authorities)
	From 01/01/2002	All EU waters except Baltic Sea	No vessel may keep on board or use for fishing one or more driftnets whose individual or total length exceeds 2.5 km
			Ban on driftnets to catch certain tuna and other Annex VIII species

Table 15: (continued from previous page)

EU Reg.	Date	Area of application	Rules/technical measures implemented
No 812/04	From 01/07/2004 to 31/12/2007	Baltic Sea, Belts and Sound	A vessel may keep on board or use for fishing driftnets if authorised by the national competent authorities All fishing vessels using driftnets must keep on board the authorisation of their national competent authorities Floating buoys with radar reflectors must be moored to each end of the netting so that its position can be determined at any time. The buoys must be permanently marked with the registration letter(s) and number of the vessel to which they belong A list of all vessels that have been authorised to use driftnets must be sent to the Commission each year The master of a fishing vessel using driftnets is required to keep a logbook and to record the following information on a day-to-day basis: - total length of nets on board - total length of nets used in each fishing operation - quantity of bycatch of cetaceans - date and position of such catches
	2005	Baltic Sea, Belts and Sound	The maximum number of vessels authorised to keep on board or use driftnets for fishing must not exceed 60 % of those that used driftnets in 2001-2003
	From 01/06/2005	South Swedish coast (Baltic Sea)	Acoustic deterrent devices are mandatory in driftnet fisheries
	2006	Baltic Sea, Belts and Sound	The maximum number of vessels authorised to keep on board or use driftnets for fishing must not exceed 40 % of those that used driftnets in 2001-2003

Table 15: (continued from previous page)

EU Reg.	Date	Area of application	Rules/technical measures implemented
No 812/04	From 01/01/2006	ICES IV, VIa, VII except VIIc, VIIk	Driftnet fisheries in these areas must be monitored for cetacean bycatch
	2007	Baltic Sea, Belts and Sound	The maximum number of vessels authorised to keep on board or use driftnets for fishing must not exceed 20 % of those that used driftnets in 2001-2003
	From 01/01/2007	ICES subdivision 24	Introduction of mandatory acoustic deterrent devices in driftnet fisheries
	From 01/01/2008	Baltic Sea, Belts and Sound	Ban on driftnets on board or used for fishing in the Baltic Sea
No 809/07	From 05/07/2007	All EU waters	Definition of driftnet: *"any gillnet held on the sea surface or at a certain distance below it by floating devices, drifting with the current, either independently or with the boat to which it may be attached. It may be equipped with devices aiming to stabilise the net or to limit its drift"*

Source: A. Sala

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