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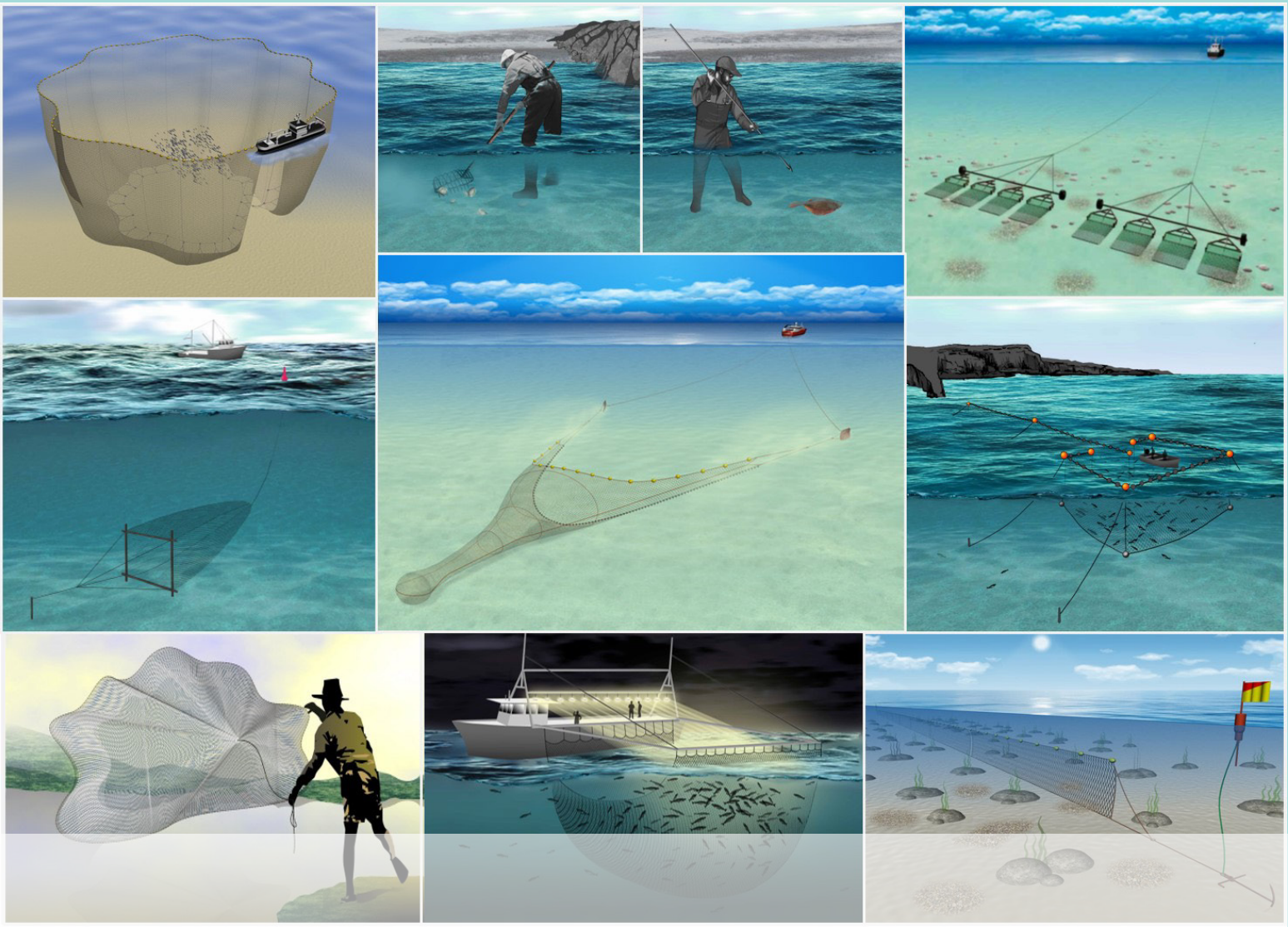

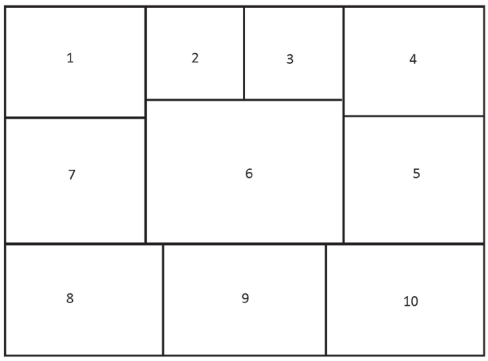

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Preparation of this document

The Technical Paper, Classification and illustrated definition of fishing gears, including the revision of the International Standard Statistical Classification of Fishing Gear (ISSCFG), updates and replaces *Nédélec, C.; Prado, J. Definition and classification of fishing gear categories*. FAO Fisheries Technical Paper, No. 222. Revision 1. Rome, FAO, 1990, 92p. The revision of ISSCFG was initiated by the Food and Agriculture Organization of the United Nations (FAO), and involved experts from the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and the secretariate of the Coordinating Working Party (CWP). The revised ISSCFG for which this document is intended to elaborate was endorsed by CWP at its meeting in February 2016 in Rome, Italy. The following persons from WGFTFB and CWP secretariate were heavily involved in the revision of the classification, and initiation of the document: R.S.T. Ferro, F. Chopin, P. Suuronen, S. Tsuji, S. Walsh, E. Dahm, B. Chokesanguan, and S. Eayrs. The document was expanded and finalized by P. He. The preparation of the report was supported by former branch heads of Fishing Industry and Operations Branch, Mr Ari Gudmundsson and Mr Matthew Camilleri, and the current Responsible Fishing Operations team leader, Mr Raymon van Anrooy. Seafish (United Kingdom of Great Britain and Northern Ireland) generously permitted the use of 35 drawings. Additional drawings were done by Southeast Asian Fisheries Development Centre (Thailand) and Mr T. Cracolichi (United States of America) under the commission of FAO. Line drawings were done by P. He.

Abstract

This document elaborates the revised International Standard Statistical Classification of Fishing Gear (ISSCFG), as endorsed and adopted for implementation by the FAO Coordinating Working Party on Fishery Statistics (CWP) at its Twenty-fifth Session in February 2016 in Rome, Italy. The classification applies to commercial, subsistence and recreational fisheries in marine and freshwater fisheries. The document provides definitions and illustrations of the configuration and mode of operation of typical fishing gears. The primary purpose is to assist FAO Members, regional fishery bodies, as well as those working on fishery statistics and management, to correctly attribute and report fisheries catches made by different gear types. The document also contributes to the prevention, deterrence and elimination of illegal, unreported and unregulated (IUU) fishing by providing monitoring, control and surveillance personnel with information to identify the type of fishing gear with regard to licence and authorization to carry out fishing operations. Finally, the document also provides context and references for some contemporary conservation issues related to major fishing gear types; it can therefore be used as a reference text for students and researchers in fisheries and marine conservation.

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Acknowledgements

In addition to those listed as authors, the following persons from ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) and CWP secretariate are acknowledged for their contribution to the revision of the classification, and initiation concept of the document: S. Walsh, E. Dahm, B. Chokesanguan, S. Eayrs and S. Tsuji. Other WGFTFB members are also acknowledged for their contribution during deliberation at various meetings. We would like to than Seafish (United Kingdom of Great Britain and Northern Ireland) for generously permitting the use of 35 drawings for this report, which are noted in their captions. We also thank Southeast Asian Fisheries Development Centre (Thailand) and Mr T. Cracolichi (United States of America) for making additional drawings under the commission of FAO.

Acronyms and abbreviations

aFAD	anchored fish aggregating device
AHD	acoustic harassment devices
BRD	bycatch reduction device
COFI	Committee on Fisheries (FAO)
CWP	Coordinating Working Party on Fishery Statistics (FAO)
dFAD	drifting fish aggregating device
EEZ	exclusive economic zone
ETP	endangered, threatened, and protected
FAD	fish aggregating device
FAO	Food and Agriculture Organization of the United Nations
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IPOA	International Plan of Action
ISSCFG	International Standard Statistical Classification of Fishing Gear
ITQ	individual transferable quota
IUCN	International Union for Conservation of Nature
IUU	illegal, unreported, unregulated (fishing)
IWC	International Whaling Commission
LED	light-emitting diode
MARPOL	International Convention for the Prevention of Pollution from Ships
MSC	Marine Stewardship Council
NAFO	North Atlantic Fisheries Organization
NGO	non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
NPOA	National Plan of Action
PA	polyamide
PES	polyester
RFB	regional fishery body
RFAB	Regional Fisheries Advisory Body
RFMO	regional fisheries management organization
SIOFA	South India Ocean Fisheries Agreement
TED	turtle excluder devices
UN	United Nations
UNGA	United Nations General Assembly
WGFTFB	ICES-FAO Working Group on Fishing Technology and Fish Behaviour

Introduction

The International Standard Statistical Classification of Fishing Gear (ISSCFG) was originally developed by FAO and published in 1971 as FAO Fisheries Circular 280. The classification was subsequently adopted in 1980 by the Coordinating Working Party on Atlantic Fishery Statistics (CWP), which was sponsored by FAO, the International Council for the Exploration of the Seas (ICES) and the International Commission for the Northwest Atlantic Fisheries (ICNAF, the predecessor of the North Atlantic Fisheries Organization, NAFO). The primary aim of standardizing codes in the ISSCFG was to prepare more accurate statistics on fish catches by gear type in the North Atlantic Area. Since then, the scope of CWP has expanded globally and it has become an FAO statutory body. The ISSCFG has provided a broad categorization of all types of fishing gear and operational practices to ensure the compatibility and comparability of data collected by different entities such as FAO Members and regional fishery bodies (RFBs) around the world. Accordingly, a revised edition of FAO fishing gear classification was published in 1990 as FAO Fisheries Technical Paper No. 222/Rev.1 (Nédélec and Prado, 1990).

In 2005, FAO initiated an effort to update the classification and to revise the contents of the 1990 publication. At the request of FAO, a group of technical experts from the ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB) was formed to deal with the subject. The group met in Rome (2005) and Izmir (2006) and prepared a revised draft of the classification in 2007. At the annual WGFTFB meeting in Ancona, Italy (May 2009), a special meeting was held, with participation of selected WGFTFB members, CWP Secretariat and FAO, to coordinate the process of finalizing the revision. The Fishing Industry and Operation Branch of FAO made final revisions to the classification in 2009 and submitted to CWP in 2010 that endorsed the classification in 2016.

This document elaborates on the classification with clear definitions and extensive illustrations for different gear types. Each gear is described with main characteristics of components and operations to distinguish similar and sometimes confusing gear types. The purpose of the document is primarily to assist readers in identifying different types of fishing gear for the purposes of attributing and reporting fisheries catches by FAO Members, RFBs – including regional fisheries management organizations (RFMOs) and regional fisheries advisory bodies (RFABs) – and intergovernmental organizations. The document also contributes to the prevention of illegal, unreported and unregulated (IUU) fishing by providing monitoring, control and surveillance personnel with information to assist them to identify the type of fishing gear with regard to an authorization to carry out fishing operations. The document also provides context and references for some contemporary conservation issues related to major fishing gear types and can therefore be used as a reference text for students and researchers in fisheries and marine conservation. This report and the FAO online fishing gear fact sheets (www.fao.org/fishery/geartype/search/en) complement each other in fishing gear classification and definition.

While this document did not discuss extensively on fishing vessels related to the operations of fishing gears, some gear types do require specialized vessels and deck machinery to operate. Readers are encouraged to refer to the FAO classification and definition of fishing vessel types (Thermes *et al.,* 2021) for further information.

Classification of fishing gear

The revised International Standard Statistical Classification of Fishing Gear shown in Table 1 (FAO, 2014) was adopted by CWP at its Twenty-fifth Session in Rome in 2016. Compared with the previous classification, this classification system was simplified to two tiers (or two levels). This change left the third tier to be defined by users requiring more detailed gear classification, for example, according to target species or other characteristics and/or including the use of bycatch reduction devices (BRDs).

TABLE 1
Revised International Standard Classification of Fishing Gears (ISSCFG), Rev.1 (2016)

Gear categories (First tier)	Subcategory (Second tier)	Standard abbreviations	ISSCFG code
SURROUNDING NETS			01
	Purse seines	PS	01.1
	Surrounding nets without purse lines	LA	01.2
	Surrounding nets (nei)	SUX	01.9
SEINE NETS			02
	Beach seines	SB	02.1
	Boat seines	SV	02.2
	Seine nets (nei)	SX	02.9
TRAWLS			03
	Beam trawls	TBB	03.11
	Single boat bottom otter trawls	OTB	03.12
	Twin bottom otter trawls	OTT	03.13
	Multiple bottom otter trawls	OTP	03.14
	Bottom pair trawls	PTB	03.15
	Bottom trawls (nei)	TB	03.19
	Single boat midwater otter trawls	OTM	03.21
	Midwater pair trawls	PTM	03.22
	Midwater trawls (nei)	TM	03.29
	Semipelagic trawls	TSP	03.3
	Trawls (nei)	TX	03.9
DREDGES			04
	Towed dredges	DRB	04.1
	Hand dredges	DRH	04.2
	Mechanized dredges	DRM	04.3
	Dredges (nei)	DRX	04.9
LIFT NETS			05
	Portable lift nets	LNP	05.1
	Boat-operated lift nets	LNB	05.2
	Shore-operated stationary lift nets	LNS	05.3
	Lift nets (nei)	LN	05.9
FALLING GEAR			06
	Cast nets	FCN	06.1
	Cover pots/Lantern nets	FCO	06.2
	Falling gear (nei)	FG	06.9

Gear categories (First tier)	Subcategory (Second tier)	Standard abbreviations	ISSCFG code
GILLNETS AND ENTANGLING NETS			07
	Set gillnets (anchored)	GNS	07.1
	Drift gillnets	GND	07.2
	Encircling gillnets	GNC	07.3
	Fixed gillnets (on stakes)	GNF	07.4
	Trammel nets	GTR	07.5
	Combined gillnets-trammel nets	GTN	07.6
	Gillnets and entangling nets (nei)	GEN	07.9
TRAPS			08
	Stationary uncovered pound nets	FPN	08.1
	Pots	FPO	08.2
	Fyke nets	FYK	08.3
	Stow nets	FSN	08.4
	Barriers, fences, weirs, etc.	FWR	08.5
	Aerial traps	FAR	08.6
	Traps (nei)	FIX	08.9
HOOKS AND LINES			09
	Handlines and hand-operated pole-and-lines	LHP	09.1
	Mechanized lines and pole-and-lines	LHM	09.2
	Set longlines	LLS	09.31
	Drifting longlines	LLD	09.32
	Longlines (nei)	LL	09.39
	Vertical lines	LVT	09.4
	Trolling lines	LTL	09.5
	Hooks and lines (nei)	LX	09.9
MISCELLANEOUS GEAR			10
	Harpoons	HAR	10.1
	Hand implements (Wrenching gear, Clamps, Tongs, Rakes, Spears)	MHI	10.2
	Pumps	MPM	10.3
	Electric fishing	MEL	10.4
	Pushnets	MPN	10.5
	Scoopnets	MSP	10.6
	Drive-in nets	MDR	10.7
	Diving	MDV	10.8
	Gear nei	MIS	10.9
GEAR NOT KNOWN			99
	Gear not known	NK	99.9

Major changes in the 2016 revision include:

a. A reduction of subclasses (tiers) from three to two to simplify reporting processes without loss of data integrity at the international level. FAO Members, regional fishery bodies, or other authorities or users, may develop or continue to use the third-tier classification for data collection. Data from the third tier can then be assimilated into the first or the second tier at the international level, such as for FAO statistics.
b. The "recreational" fishing gear category was removed since it was determined that this was not a gear category but rather a category of purpose, scale and management. Recreational gears can be reported under their respective gear types such as gillnets, hook-and-lines, and traps, among others.
c. The revised classification scheme does not include target species in the gear classification and definition. The classification focuses on the physical characteristics of the gear, how it is operated and the mechanism of fish capture.

In this document, fish includes all aquatic animals caught by fishing gear including, but not limited to fish, Crustacea and Mollusca, unless specifically described otherwise.

In this document, the definition of fishing gear as provided in Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) is adopted:

> *A fishing gear is any physical device or part thereof, or combination of items that may be placed on or in the water or on the seabed with the intended purpose of capturing or controlling for subsequent capture or harvesting marine or freshwater organisms.*

However, some gears or components of gear presented in this revised ISSCFG, which support fish capture but do not directly catch fish, are not classified as standalone, classifiable fishing gear for the purposes of landing statistics. They are considered as an auxiliary gear, or as a part of gear components that may increase fishing efficiency, reduce the unintended catch of fish and other animals, and/or reduce the physical impacts of fishing on the environment. One such auxiliary gear is the fish aggregating device (FAD), which has become an important tool to increase catch efficiency of some fishing gears, notably purse seines. Auxiliary gears and gear components are described together with the main gear they are associated with. The purpose of these auxiliary gears and gear components may include, but are not limited to:

a. Increasing capture efficiency
    1. Fish attraction: fish aggregating devices (FADs, anchored and drifting), acoustics, lights, light sticks, bait (chum).
    2. Stimulation: electric pulse generators and electrodes, noise generators or physical apparatus for driving fish towards drive-in nets.
    3. Fish finding: air spotting (helicopters, planes, drones), acoustic devices (sonars, echo-sounders, satellite-linked acoustic buoys, bird radars), underwater cameras.
    4. Equipment for deploying and handling gear: winches and net drums, guns and cannons for throwing harpoons, pontoons for lifting the fish holding compartment in Baltic pontoon traps.
    5. Gear location: radar reflectors, radio beacons, satellite transmitters.
    6. Fisheries information: real-time communication devices, forecasting and modelling tools, satellite data and information tools.
b. Mitigating impacts
    1. Deterrence/avoidance devices: tori lines, line shooters, pingers, acoustic harassment devices (AHDs), etc.
    2. Bycatch reduction devices: turtle excluder devices (TEDs), size and species selection grids, separator panels, catch and bait protection devices, lights, etc.

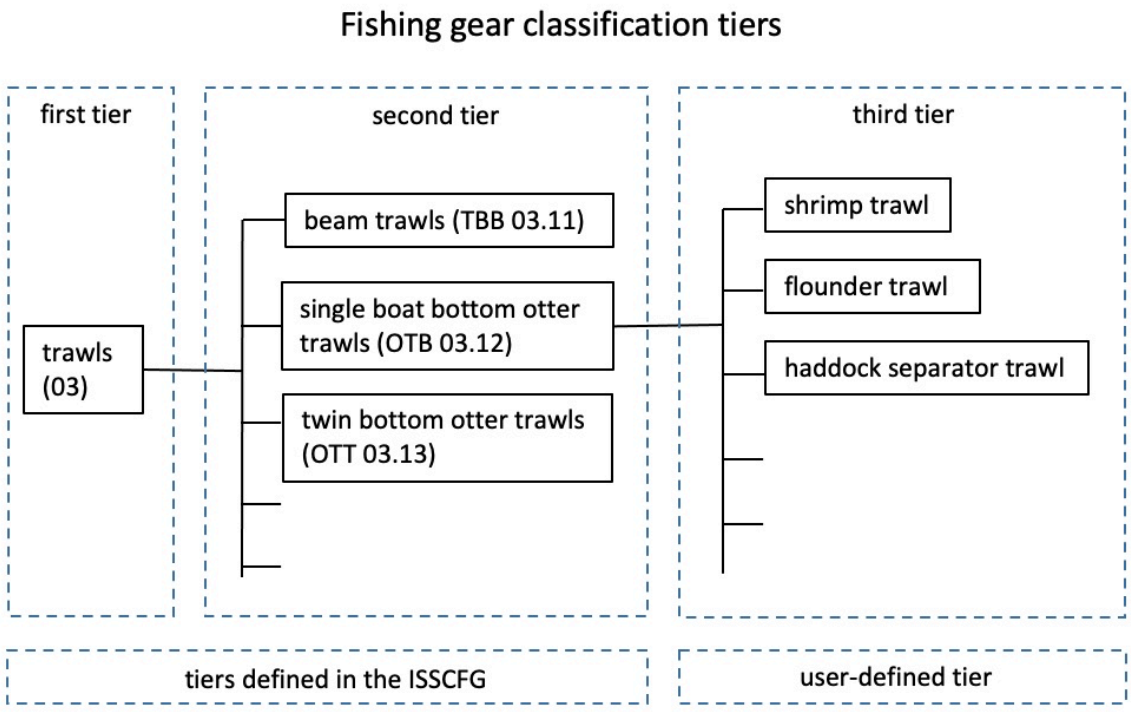
c. Facilitating the transfer of fish from fishing gear
   1. Fish transfer equipment: pumps and scoopnets for transferring fish from fishing gears (e.g. purse seines, trawls, pound nets or weirs) to a boat, cages, or shore facilities.
   2. Gillnets or small seines that are used to transfer fish already trapped in weirs, pound nets, or fixed gillnets to a boat or ashore.

Gear types in the second-level classification that include the use of some of these auxiliary devices/designs may well be recorded as a third-tier gear in practice by Members and/or RFBs to improve the usefulness of the resulting catch data for fisheries management and the fishing industry. For example, the haddock separator trawl, featuring a horizontal separator, may be considered as a third-tier classification gear under "Trawl" (first tier) – "Single boat bottom otter trawl" (second tier). The trawl with a horizontal separator that targets haddock (*Melanogrammus aeglefinus*) was given special access to the "Eastern United States of America/Canada Area" on Georges Bank off the north-eastern United States of America, with special allocations and reduced minimum codend mesh size (Federal Register, 2020). An example illustrating the potential third tier for "Trawl – Single boat bottom otter trawl" can be seen in Figure 1.

A comparison between the gear codes adopted in the current 2016 ISSCFG and those in the previous classification of 1980 (Nédélec and Prado, 1990) is provided in Appendix 1.

FIGURE 1

An example illustrating the potential third tier in a three-tier classification system: Trawls (first tier) – Single boat bottom otter trawls (second tier). The catch in the third-tier gear is recorded by local, national or regional authorities, but may be aggregated to the second tier when reporting to FAO



Definitions of fishing gears

This chapter defines the fishing gears in the 2016 classification, arranged in the order of classification shown in Table 1. The description starts with a concise definition for the first- and second-tier gear (where applicable), especially for widely used gear types. Illustrations for all gears in the second-level classification are provided to enable the reader to visualize the gear in operation, and to assist with its definition and description. Design features and terms for some important gears and their components are also illustrated. Some text and concepts provided in the 1980 ISSCFG revision (Nédélec and Prado, 1990) have been retained as this document serves a similar role. This document has also benefited from information about varieties of gears and their operations from *von Brandt's Fish Catching Methods of the World* (Gabriel *et al*., 2005).

1. Surrounding nets

A surrounding net is a long piece of net that is constructed mostly from rectangular sections of netting framed by ropes and catches fish by surrounding a school of fish.

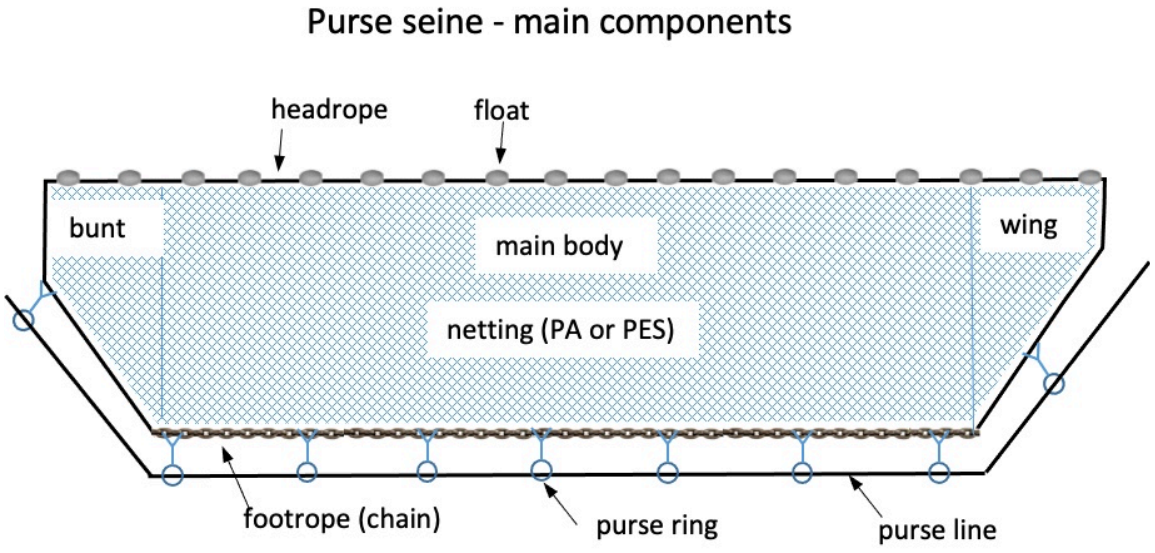
In a surrounding net, a headrope (also called headline or float line) with numerous floats runs across the top of the net, while a weighted footrope (or called fishing line) runs along the lower edge. The netting is generally comprised of small mesh sizes to minimize fish becoming enmeshed. Netting materials are usually comprised of polyamide (PA) or polyester (PES) that have densities higher than that of seawater to increase the netting's sink velocity. For nets used in shallow waters, the footrope may come into contact with the seabed. There are two types of surrounding nets: purse seines with a purse line, and other surrounding nets without a purse line.

1.1 PURSE SEINES

A purse seine is a wall of netting designed to encircle a school of pelagic fish near the surface and use a purse line to close the bottom of the net.

Purse seines use weights, lead lines or chain attached to the footrope, and dense netting materials such as PA or PES, to increase the sinking velocity of the net to prevent fish from escaping horizontally. The purse seine is characterized by a purse line threaded through purse rings spaced along the bottom edge of the net, through which the purse line can be drawn tight – hence "purse seine". The middle sections of the netting are deepest and gradually taper towards the wing and the bunt where fish finally accumulate (Figure 2). The bunt can also be at the middle of the net; in this case, hauling starts from both wings.

FIGURE 2
The anatomy and components of a purse seine for which the bunt is at the wing

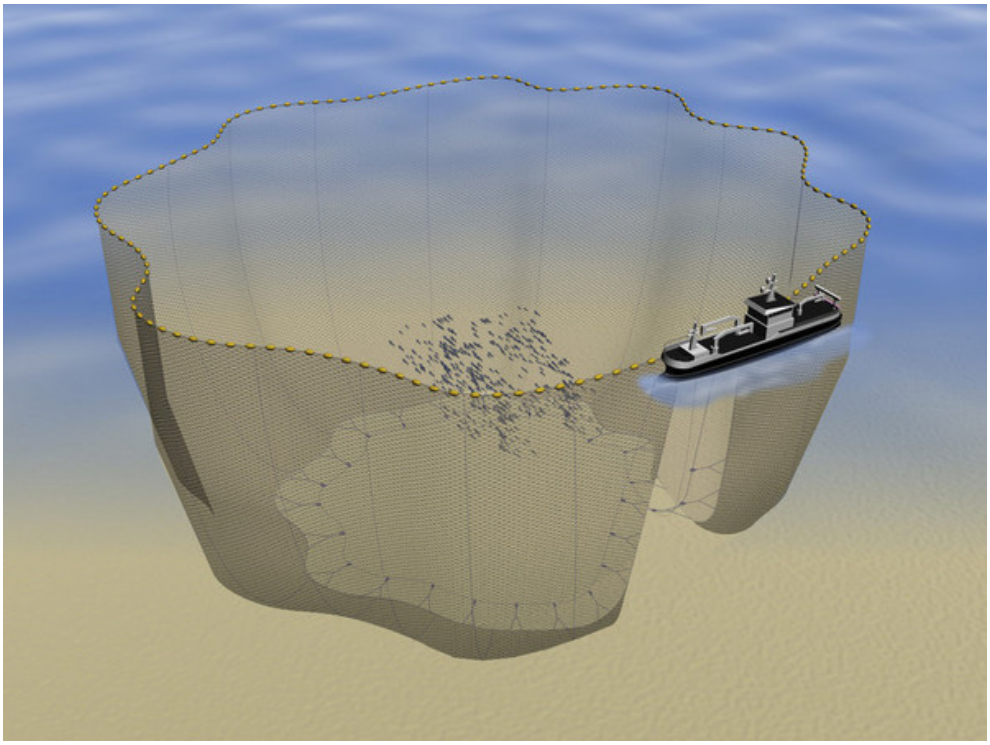


When a target fish school is identified, the vessel manoeuvres into a favourable position and the seine net is prepared for deployment. The vessel follows a course around the edge of the school, attempting to encircle it. With the net fully deployed, ropes attached to the ends of the net are hauled in order to close the seine around the school. At the same time, the purse line is drawn to close the seine net beneath the school. Typically, the headrope is longer than the footrope so as to reduce tension and prevent it from submerging, which can result in fish escaping over it.

A modern tuna purse seine, as illustrated in Figure 3, can be very large, measuring 2000 m or more in length, and 250 m or more in depth. Purse seines can be operated by one vessel, one main vessel with the assistance of auxiliary vessels, or two main vessels. Purse seines are often operated with assistance of artificial lights at night or with the use of fish aggregating devices (FADs) to concentrate fish, or by targeting free-swimming fish schools.

The purse seine is the most important fishing gear in marine capture fisheries in terms of the quantity of fish landed. According to recent FAO statistics, this gear accounts for about a third of total marine landings. Technologies that enhance the catch efficiency of modern purse seines include solar-powered, satellite-linked buoys for drifting fish aggregating devices (dFADs) equipped with an echo-sounder, bird radar and spotter planes/helicopters for locating surface schools, high-speed boats for deflecting fast-moving schools towards the net, and high density purse seine netting to ensure the net sinks rapidly and prevents fish from escaping (Scott and Lopez, 2014; Lopez *et al.*, 2014; Torres-Irineo *et al.*, 2014).

FIGURE 3
Modern purse seine (PS 01.1) encircling a free-swimming fish school

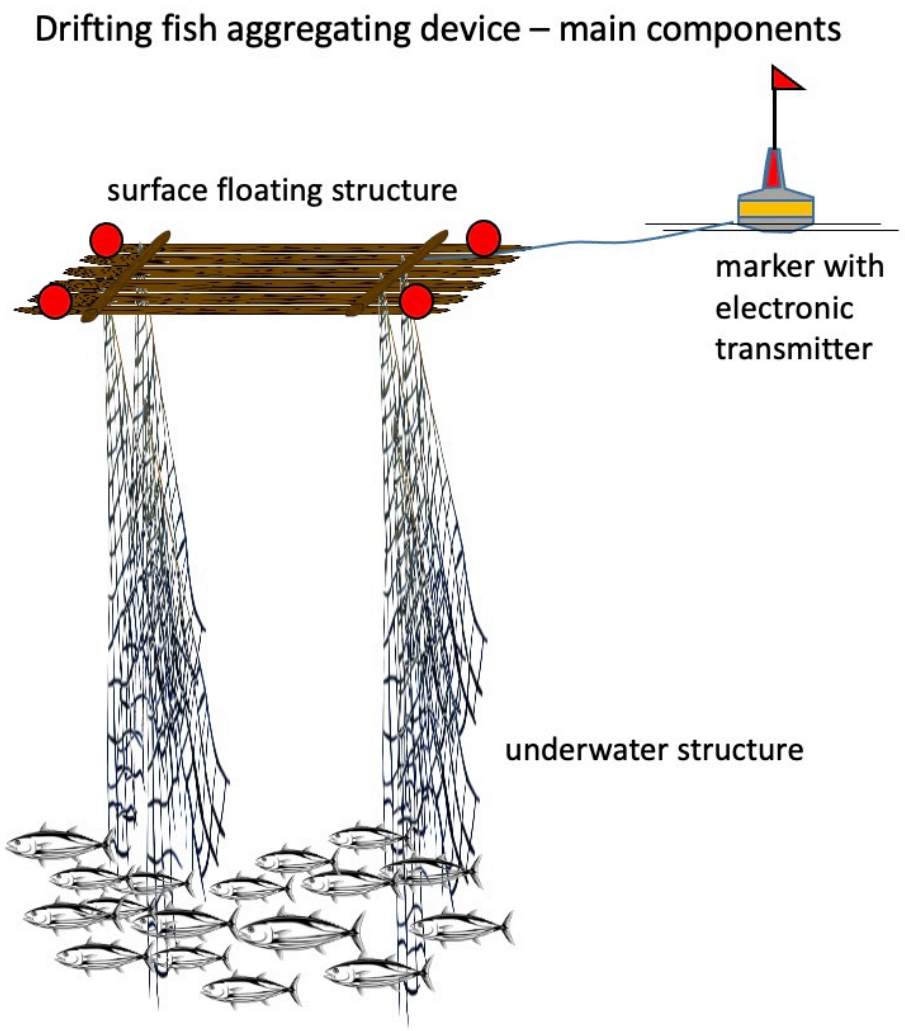


Source: Seafish, 2021.

A fish aggregating device (FAD) is a permanent, semi-permanent or temporary structure, which is deployed and/or tracked, and used to aggregate fish for subsequent capture (FAO, 2019). A FAD can be either an anchored FAD (aFAD) which is often deployed within a nation's EEZ, or a drifting FAD (dFAD), which is often deployed in the high seas (Figure 4). Both aFADs and dFADs are utilized by purse seine vessels. Anchored FADs are often set in coastal areas but can be set in archipelagic and/or offshore waters at depths greater than 2000 m. In addition to purse seines, aFADs are also often utilized by small-scale hook-and-line fishers.

The large numbers of dFADs deployed by industrial purse seine vessels operating within EEZs and on the high seas have resulted in numerous FADs becoming abandoned, lost or otherwise discarded. Furthermore, without a clear requirement to identify the ownership of dFADs, it is not easy to ascertain the vessel to which responsibility and/or obligation for retrieval should be attributed (Gilman *et al.*, 2018). Drift FADs deployed by purse seine vessels may drift for several years, raising concerns as to whether the boat operator has any intention of retrieving the gear. Moreover, concerns have also been expressed regarding the possibility that dFADs set by a vessel in one location may

FIGURE 4
A drifting fish aggregating device (dFAD) for aggregating pelagic species. The marker may not be separated from the surface floating structure



drift hundreds or thousands of kilometres, aggregating highly migratory tuna as they go, within and across multiple maritime boundaries (Hanich *et al*., 2019; Toonen and Bush, 2020).

FADs typically consist of surface components, underwater components and a marker to indicate or report its position (Figure 4). Drifting FADs often have a marker with an electronic transmitter, sometimes linked to satellite communication. Anchored FADs have a rope leading to an anchor or weight on the seabed. While earlier FADs were mostly made from natural degradable materials, the use of plastics for FADs has increased in recent decades, contributing to the marine plastic litter burden when FADs are abandoned, lost or discarded. In addition, both actively fished and derelict FADs may entangle and kill non-target fish and other animals, including endangered, threatened and protected (ETP) species. The impact on marine ecosystems and the benefit of the use of dFADs in tuna purse seine fisheries have been reviewed by Fonteneau *et al*. (2000) and Dagorn *et al*. (2012).

Some important purse seine fisheries include the anchoveta (*Engraulis ringens)* fisheries in Peru and Chile, Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) fisheries in the Northeast Atlantic, as well as skipjack tuna fisheries in all major oceans.

1.2 SURROUNDING NETS WITHOUT PURSE LINES

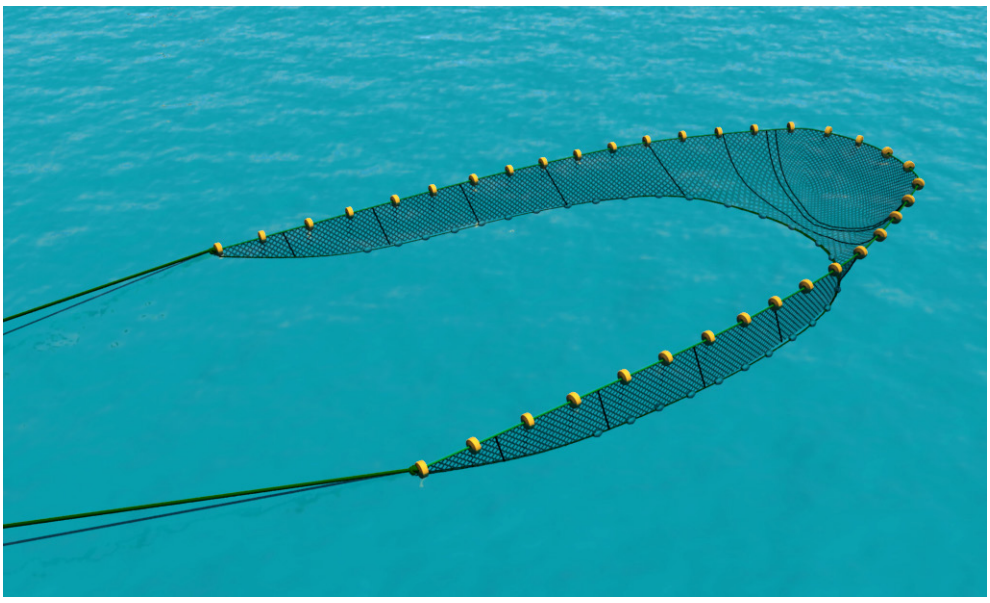
A "surrounding net without a purse line" is a long wall of netting that is designed to surround fish at the surface or in shallow water, but without the use of a purse line.

In this type of net, the footrope is much shorter than the headrope; as a result, when the net is retrieved, tension in the footrope pulls the wall of netting ahead of the headrope to prevent fish from escaping downwards. The gear can be operated by one or two boats. The lampara net is the most representative type in this category (Figure 5).

A lampara net has a central bunt (with smaller mesh) and two long wings, making it possible to surround the fish when the wings are hauled simultaneously through attached ropes. Lampara nets are often used at night with the assistance of light to attract and concentrate small pelagic fish so that they can be easily surrounded by the net. Lampara nets are often used in coastal areas to catch bait fish for hook-and-line fisheries, especially for pole-and-line fishing for tuna. Lampara nets are also used in lakes and rivers for harvesting small pelagic fish near the surface.

Lampara nets may have originated in the Mediterranean where lights were used with the net – as indicated by the Italian word *lampo* – but similar nets have been used in many countries such as China, Japan and the Philippines (Feng *et al.*, 1987; Cingolani *et al.*, 1996; Gabriel *et al.*, 2005). The net was introduced to California by Italians at the beginning of the twentieth century for sardine, mackerel and squid (Vojkovich, 1998). The net is also used in Florida for bait fish such as halfbeaks (Hemiramphidae) (McBride and Styer, 2002).

FIGURE 5
Lampara net, a type of surrounding net without a purse line (LA 01.2)



2. Seine nets

Seine nets can be cone-shaped nets with long wings and a codend, or a long piece of net without a codend, catching fish by encircling and herding.

A seine net is usually framed by a headrope along the upper edge and a footrope along the lower edge of the net. The weighted footrope is used to maintain ground contract and reduce net abrasion. The wings are often elongated and used in conjunction with long ropes which act simultaneously for herding fish and for hauling the net. The bunt is typically in the centre of the net and may consist of a netting bag similar to a trawl codend, but some seines may not have a bag. The mesh size in the bunt or the codend usually determines the size of animals caught. This gear may be set from the shore (beach seine) or from one or two boats (boat seine). Seine nets can also be operated under the ice in fresh and coastal waters in cold regions (Turunen *et al.*, 1997; Yoshida, 2015).

2.1 BEACH SEINES

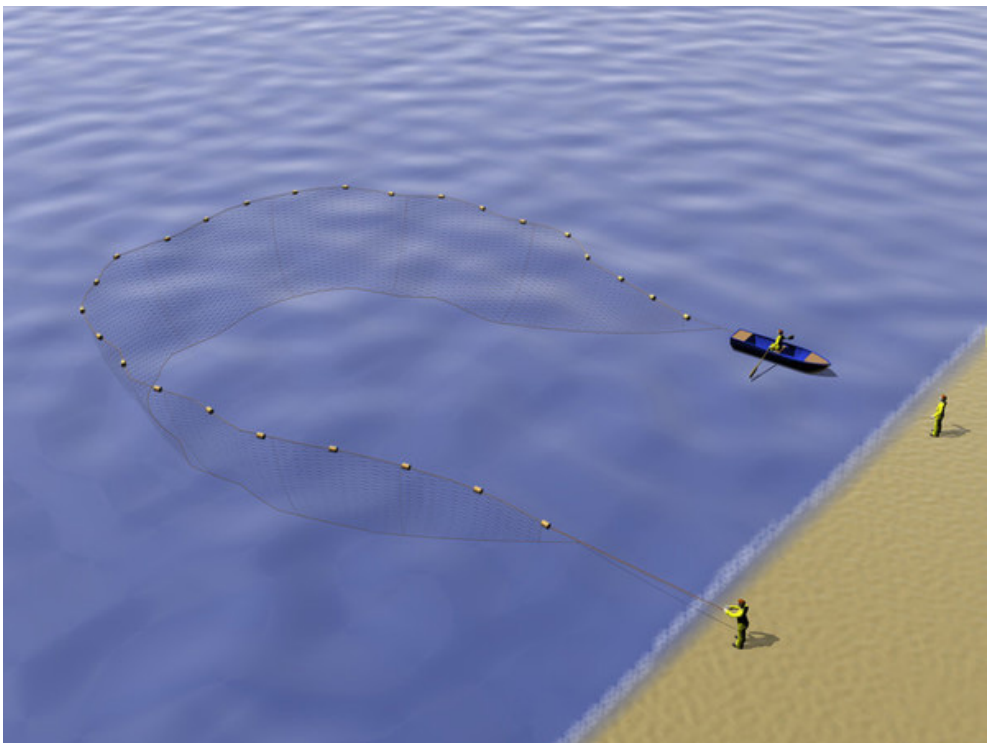
A beach seine is a long-winged net with or without a codend that encircles fish in shallow waters, typically on a beach.

The seine may be set from a small boat or by hand (wading) and hauled to the beach. The net usually extends from the surface to the bottom, both of which act as natural barriers, preventing the fish from escaping from the area enclosed by the net (Figure 6 and Figure 7). For seines without a codend, a bunt with small mesh netting is often included. Beach seines are hauled from the beach by hand, automobiles, or winches or other machinery installed on the beach. Historically, animals (such as horses) were often used for hauling beach seines.

FIGURE 6
Beach seine (SB 02.1) with a codend, pulled by hand to the beach

Source: Seafish, 2021.

FIGURE 7
Beach seine (SB 02.1) without a codend, pulled by hand to the beach



Source: Seafish, 2021.

Beach seines are widely used in small-scale and artisanal fisheries, as well as for fisheries research to sample fish assemblages. Beach seines are the most important fishing gear in countries such as Benin in West Africa, where landings from beach seines comprised 80 percent of the country's total marine catch in 2000 (Tietze *et al.*, 2011). There were more than 46 000 beach seines in operation in India in 2005 (CMFRI, 2006, cited in Tietze *et al.*, 2011). A survey of beach seines in selected countries and an extensive review of beach seine fisheries has been published by FAO (Tietze *et al.*, 2011).

2.2 BOAT SEINES

A boat seine is a cone-shaped net with elongated wings, seine ropes and a codend, and operated by one or two boats, capturing fish by encircling and herding.

Boat seines are often used on a smooth seabed with fewer obstructions to reduce net damage. Compared with a trawl net, a seine net usually has longer wings and utilizes long heavy ropes (seine ropes) that extend from the wings of the net through a pair of bridles to increase the area over which fish are herded.

A seine net also differs from a trawl in how the gear is operated. A seine net changes its shape during the fishing operation and relies heavily on ropes for herding fish towards the path of the net. Trawls, on the other hand, maintain their shape throughout the fishing operation once the net is stabilised. As a consequence, the path swept by the seine ropes and seine net changes constantly during fishing, whereas the swept width of the trawl remains more or less constant. A boat seine is usually towed slower and for a shorter time than a trawl.

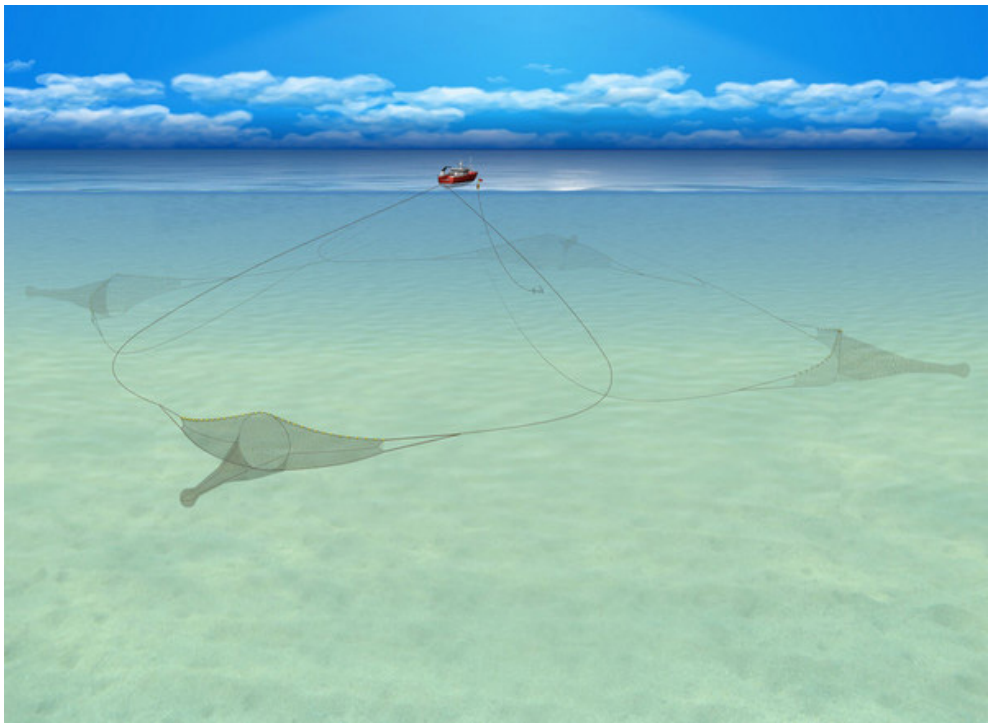
The seine can be operated by one or two boats (pair seining). During the fishing operation, the seine ropes herd the fish into the path of the net. The length of seine rope to a large extent determines the shape and size of the fished area. The boat seine is commonly used to catch benthic species such as flounders and soles, but also other demersal species such as cod.

For the one-boat operation, the ropes and the net are set out by a boat in the following sequence: highflyer, rope, net, and rope, to encircle an area of seabed and return to the highflyer. The highflyer acts as a marker and typically includes a buoy, a flag and a light if operated at night. At the end of the deployment, the boat picks up the highflyer and starts to haul the net using drums or winches. The two main variations of one-boat seines are: (i) the Danish seine and (ii) the Scottish seine. In Danish seining, the highflyer (also known as dhan or dan buoy) is anchored with one end of the seine rope attached to the buoy when the vessel sets out the rope and net to encircle an area. When the vessel returns to the buoy, the boat attaches to the anchor line and the net is hauled; it is therefore also referred to as anchor seining (Figure 8). Several sets can be made around the anchor as the tide turns (see Figure 8). In Scottish seining, the deployment sequence is similar, except that the highflyer is not anchored but free-floating. Upon retrieving the highflyer, the boat steams forward as the net is hauled, slowly at first but with increasing speed; it is thus also called “fly dragging” or “fly shooting” (Figure 9).

For the two-boat operation (pair seining), the second vessel picks up the highflyer that was dropped by the main (shooting) vessel or receives the end of seine rope passed from the shooting vessel. The main vessel pays out the rope, wing and bunt (with codend), the other wing and the other rope, attempting to encircle a large area; meanwhile the second vessel may manoeuvre accordingly, depending on the condition of the sea and the position of the main vessel (Figure 10). When the length of seine rope has been paid out and is equal on each side of the net, the two vessels start to tow the net slowly for a period of time while gradually closing the net (Positions 4 to 6 in Figure 10). The hauling speed is progressively increased while the ropes are retrieved. Towards the end of the haul, the rope in the second vessel is passed back to the main vessel where the codend is hauled onboard (Position 7 in Figure 10).

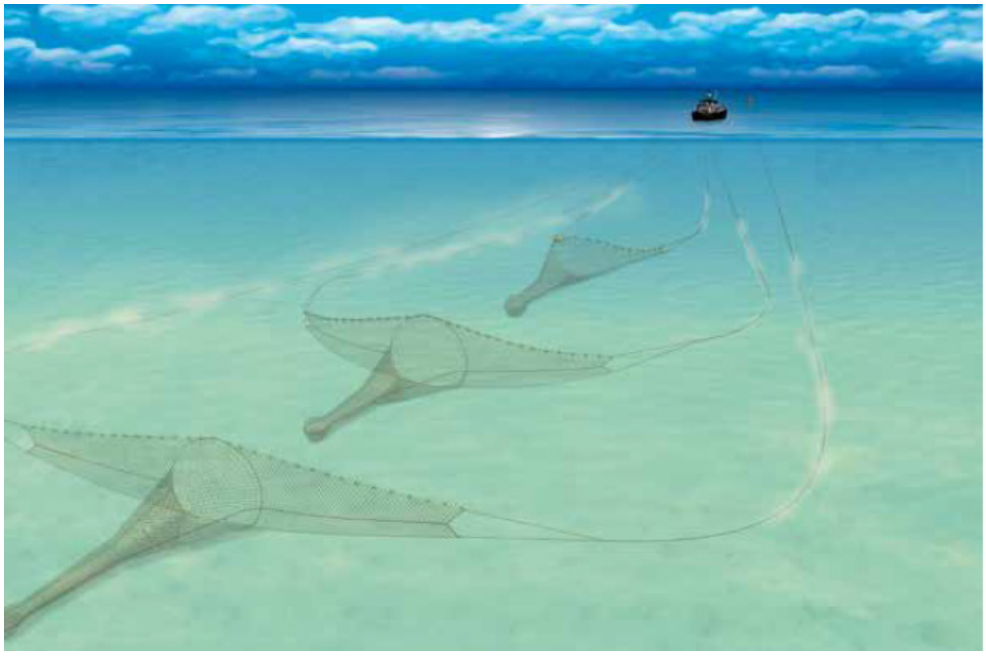
Danish seines and Scottish seines are widely used around the world. The gear, operation and variations of seine fishing were extensively described by Thomson (1978; 1981). The history, development, operation and ecosystem impact of boat seining was reviewed by Walsh and Winger (2011), with primarily focus on its development and application in Canada. The ecosystem impact of Danish seining was extensively evaluated by Noack (2017).

FIGURE 8
Danish seine (anchor seining) as a type of boat seine (SV 02.2), showing consecutive four sets around an anchor



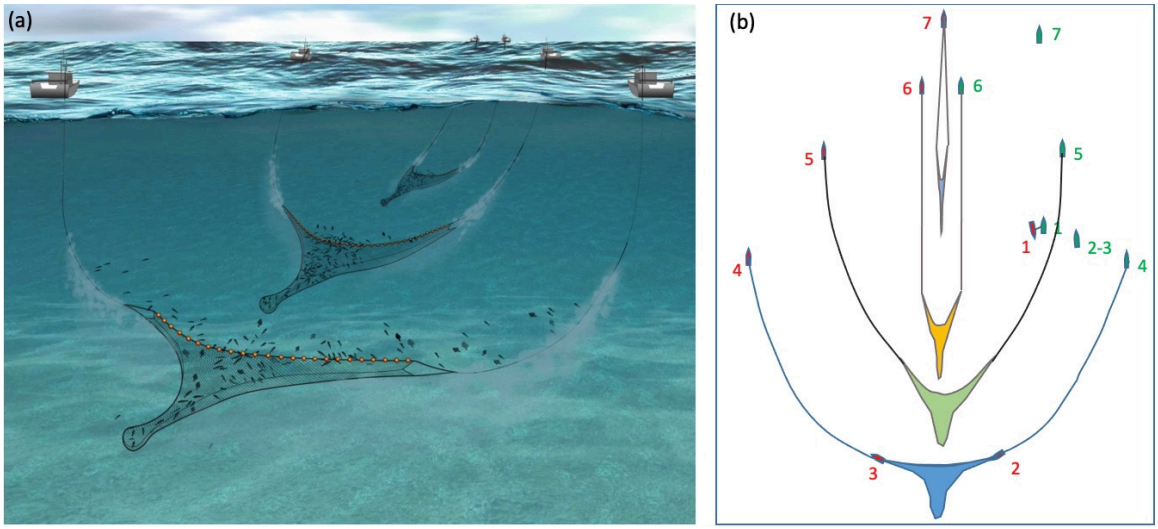
Source: Seafish, 2021.

FIGURE 9
Scottish seine (fly dragging or fly shooting) as a type of boat seine (SV 02.2), showing successive shapes during operation



Source: Seafish, 2021.

FIGURE10
Pair seining, a type of boat seine (SV 02.2)
(a) Shapes and relative vessel positions of three successive points in time, corresponding to 4, 5 and 6 in b).
(b) Relative position of two vessels during pair seining. Red: the main vessel, green, the second vessel



Pair seining (*due wang* in Chinese) was widely practised in China even before the time of powered boats. It peaked in the 1960s and early 1970s when the main target species, the large yellow croaker (*Larimichthys crocea*) and hairtail (*Trichiurus lepturus*), were harvested (ZMFRI *et al*., 1985). Pair seining is also widely used in Finnish inland waters, primarily for vendace (*Coregonus albula*). Developed in the 1950s and 1960s, vendace pair seining uses a very large net to encircle an area, followed by towing very slowly for a period of time. In Europe and North America, pair seining evolved from Scottish seining in the 1960s and primarily targets flounders (Walsh and Winger, 2011).

3. Trawls

The trawl is a cone-shaped body of netting, usually with one codend, towed behind one or two boats to catch fish through herding and sieving.

Trawls are designed to be towed across the seabed (bottom trawls) or in midwater (midwater trawls). A semipelagic trawl is a hybrid that can be set to fish on or off the seabed. A single boat can tow one trawl (most common), two trawls (twin trawl), or more than two trawls (multi-rig trawls). A single trawl can be towed by one boat (most common) or two boats (pair trawling). Trawls are very versatile and can be used to catch many different species. The towing speed is usually determined by the behaviour and swimming capacity of the target species and the power of the boat. The mesh size in the codend is the main factor that determines the size and species retained and is often strictly regulated. Specially designed netting panels, escape openings, or devices such as grids can also be incorporated into a trawl to enhance species and size selectivity.

3.1 BOTTOM TRAWLS

A bottom trawl is a cone-shaped net towed on the seabed and designed to catch fish living on or near the seabed.

While there is no separate category in the classification for the bottom trawl, those trawls listed in the subsections are all bottom trawls and bear similar characteristics in how and where they are operated. The groundgears of bottom trawls often consist of components such as heavy-duty ropes, chains, discs, bobbins and/or weights to ensure that seabed contact is maintained during fishing while minimizing the risk of damage to the net. Otter boards (used in single boat bottom trawls) also assist in keeping the net in contact with the seabed. The horizontal opening of the net mouth may be maintained by a rigid beam (beam trawl), by a pair of otter boards (otter trawl), or by towing the net between two boats (pair trawl). Floats and weights or a rigid frame often maintain the vertical opening of the trawl net. Two or more trawl nets may be rigged adjacently between the otter boards (twin or multi-rig trawls). One trawl may have more than one codend that splits the catch to reduce fish damage and improve fish quality, and/or to facilitate the handling of large catches. Bottom trawls can be towed from the stern or from outriggers; in the latter case, an even number of trawls are towed to balance the load.

The bottom trawl is one of the most versatile gear types, capable of operating over many types of seabed and at depths in excess of 1000 m. However, the bottom trawl has also become the subject of controversy, in part due to its poor selectivity, high discards and potential physical impact to the benthos. A recent report by FAO (Perez Roda *et al.*, 2019) revealed that bottom trawls (including those targeting shrimps and prawns) generated 4.2 million tonnes of discards, which is 45.5 percent of total annual discards for all fisheries between 2010 and 2014 (9.1 million tonnes). The estimated discard rate for all bottom trawls combined was 21.8 percent of their total landings. Consequently, great effort has been made on technologies and practices to reduce the unwanted catch of fish and other animals, some of which are now being implemented in fisheries around the world (e.g. Eayrs, 2007; Graham, 2010).

Bottom trawls have been reported to modify the physical characteristics of the seabed and may impact benthic species and ecosystems (Jones, 1992; NRC, 2002; Hiddink *et al.*, 2017; Amoroso *et al.*, 2018). The extent of seabed disturbance, ecosystem impact and resilience from bottom trawl fishing is likely to be area- and species-specific, and requires further research (Kaiser *et al.*, 2016; Rijnsdorp *et al.*, 2016). Measures to reduce

the impact of bottom trawls on the seabed, including best practices for managing impacts through spatial and temporal closures, modifications to the fishing gear and its components, have been recommended by numerous researchers (e.g. He, 2007; He and Winger, 2010; McConnaughey *et al*., 2020).

3.1.1 Beam trawls

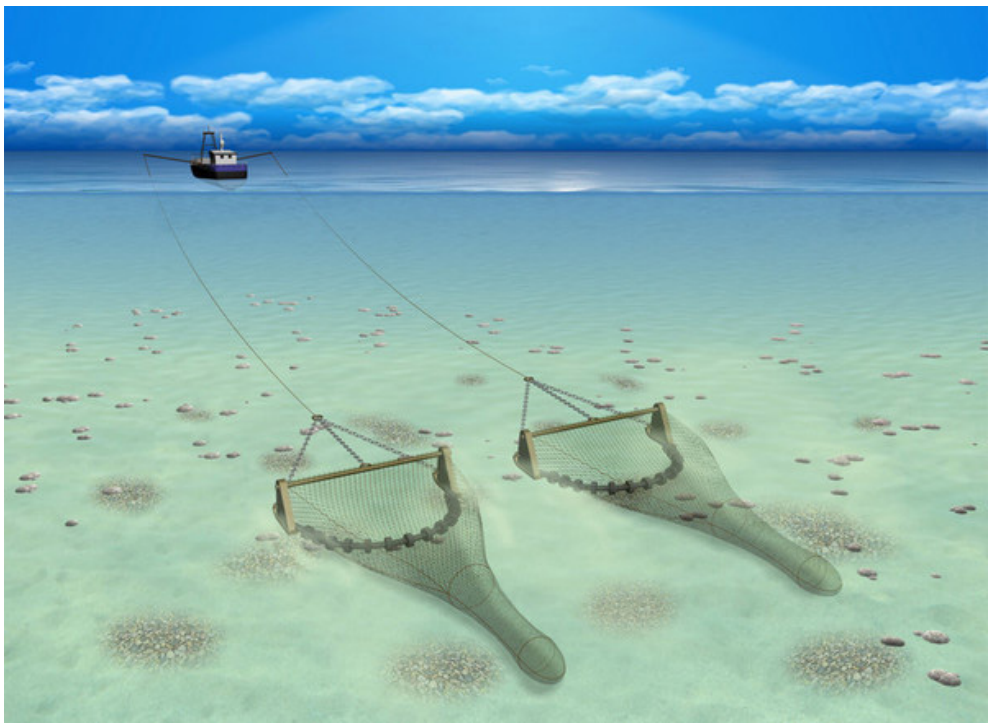
A beam trawl is a trawl whose horizontal spread is maintained by a rigid beam across the net mouth.

The beam trawl consists of a heavy steel beam, usually supported by beam heads, with wide shoes at the bottom to slide over the seabed. Beam trawls are usually towed on the seabed, often targeting fish that live on or near the seabed such as flatfish and shrimp. However, beam trawls can also be mounted on beams extended from the side of a boat and held just above the surface, such as skimmer trawls used in the Mid-Atlantic and Gulf of Mexico inshore waters of the United States of America (Hein and Meier, 1995). Skimmer trawls often fish the entire water column from surface to the bottom.

The beam is commonly made of wood, bamboo or metal, and may be of any length that can be handled on-board and able to withstand the stress during towing. The height of headrope is usually the same as that of the beam. In some cases, the beam may be mounted above the shoes on extension poles to provide an increased vertical net opening.

One beam trawl can be towed from the stern of the vessel, or alternatively two or more beam trawls may be towed from outriggers (Figure 11). Regardless of how many beam trawls are towed behind a boat they are classified as "beam trawl", unlike otter trawls for which single (OTB 03.11), twin (OTT 03.12) and multiple trawls (OTP 03.13) are classified separately.

FIGURE 11
Two beam trawls (TBB 03.11) are towed behind a boat on its outriggers



Source: Seafish, 2021.

Consistent bottom contact is essential for the successful fishing of benthic species, which is often achieved by heavy weight of the shoes and beam, as well as chains attached to the beam or on the shoes. These chains run ahead of the groundgear and act as tickler chains to stir up fish burrowed into the seabed. Some beam trawls are towed at very high speeds (up to 7 knots) to cover the ground and to reduce the chance of fish escaping; therefore, fish within the path swept by the net mouth are vulnerable to capture.

Beam trawls sometimes resemble towed dredges (DRB 04.1). One example is the Italian Adriatic Sea Rapido trawl which has a metal frame and teeth at the front – characteristic of a dredge – but it also has a cone-shaped net, which is characteristic of a trawl. The Rapido trawls and other similar gears in Mediterranean are classified as "beam trawls" in the current regional gear classifications (Sala, 2013). Skimmer trawls (a beam trawl) resemble boat-mounted stow nets (FSN 08.4) in the trap category. The difference is that skimmer trawls are towed on the side of the boat with the boat steaming forward, while in boat-mounted stow nets, the boat is usually anchored to the seabed.

One development of the beam trawl uses electrical pulses to stimulate target species on the seabed. Commercial application of electrical pulses flourished in the Chinese shrimp beam trawl fisheries in 1980s and 1990s, but the practice was subsequently banned in 2000 owing to an inability to control illegal increases in electrical outputs (Yu *et al.*, 2007). In European fisheries, the European Union declared the use of electricity in fishing to be illegal in 1988, and reaffirmed the ban in 2018 (ICES, 2020). However, currently the Netherlands and some other European Union members can issue licences for flatfish pulse beam trawling for up to 5 percent of their fleet.

3.1.2 Single boat bottom otter trawls

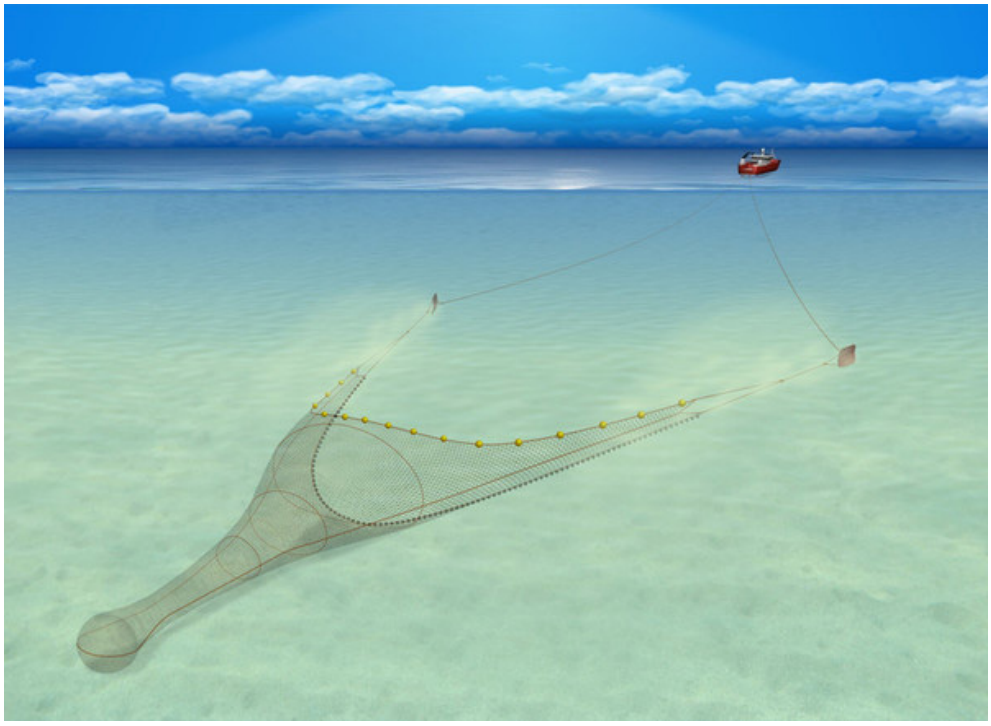
A single boat bottom otter trawl is one cone-shaped trawl towed on the seabed by one boat, with its horizontal spread maintained by a pair of otter boards.

This trawl is the most common type of trawl and is often referred to as "bottom otter trawl", "otter trawl", or "bottom trawl". Otter trawls were developed from beam trawls in late 1800s when steam power was first used on boats (Graham, 2006). Otter boards (commonly called doors) were first connected to the wingends of a trawl, and then moved forward with bridles and/or sweeps connecting the wingends to the otter boards (Figure 12).

The trawl is spread horizontally by the otter boards. The net is held open vertically by floats along the headrope (also called headline) or simply by the height of the otter boards, while ground contact is maintained by a weighted groundgear (also called groundrope or footrope) which also protects the net from damage. The horizontal distance between the otter boards is referred to as the "doorspread", while the distance between wingends is referred to as the "wingspread". The height of the midpoint of the headrope above the seabed is referred to as the "headrope height". These are the important geometry parameters of an otter trawl. Depending on the species, fish may be herded into the path of the net by the otter boards and by the sweeps and bridles. The fished area (or swept area) can therefore be greater than the area swept by the net between the wings. Towing speed is generally between 2 and 4 knots, depending on the species targeted.

A single trawl can have more than one codend. A trawl with two codends side by side is usually called a trouser trawl and is often used for comparative fishing trials to evaluate species and size selection properties of different codends and/or species separation devices (e.g. deflector panels, large-mesh windows and/or a grid system) installed ahead of the codend. Multiple codends are also used to retain different species of different sizes, separated by species-selection devices; in this case, codends are often arranged one on top of the other and different mesh sizes are often used. Multiple codends in a trawl can also improve catch quality, or ease of handling when the catch is large.

FIGURE 12
A single boat otter trawl (OTB 03.12) in operation. The trawl is towed behind one boat and is expanded horizontally by a pair of otter boards



Source: Seafish, 2021.

As in other gears, numerous terms are used for the different parts of a trawl system in the literature and by the fishing industry around the world. Figure 13 provides the main components and their suggested terms for the bottom trawl.

The otter board is a characteristic component of an otter trawl, from which the name of the gear is derived. There is a variety of otter boards, from wooden rectangular boards to sophisticated cambered metal or composite boards designed to improve stability, efficiency or robustness (Figure 14).

Different types of groundgears are used for bottom otter trawls depending on the type and topography of the seabed and species targeted. Groundgears may include heavy metal bobbins for rough ground in deep water, rubber discs of various sizes for a softer seabed, a light chain wrapped on the fishing line, or even a bare fishing line with no protection when used over a smooth sandy bed in shallow waters (Figure 15).

Single boat bottom otter trawls are used everywhere around the world: from the shallow waters of an Australian river (less than 2 m deep) for school prawn (*Metapenaeus macleaya*) (Broadhurst *et al*., 2012), to the deep, cold oceans at depths of up to 600 m for northern shrimp (*Pandalus borealis*) in the North Atlantic (Garcia, 2007), and to the seamounts off New Zealand at a depth of more than 1000 m for Orange roughy (*Hoplostethus atlanticus*) (Clark and O'Driscoll, 2003).

FIGURE 13

Components and terms of a typical single boat bottom otter trawl (OTB 03.12). Details of examples of different types of otter boards and groundgear (footrope) can be seen in Figure 14 and Figure 15

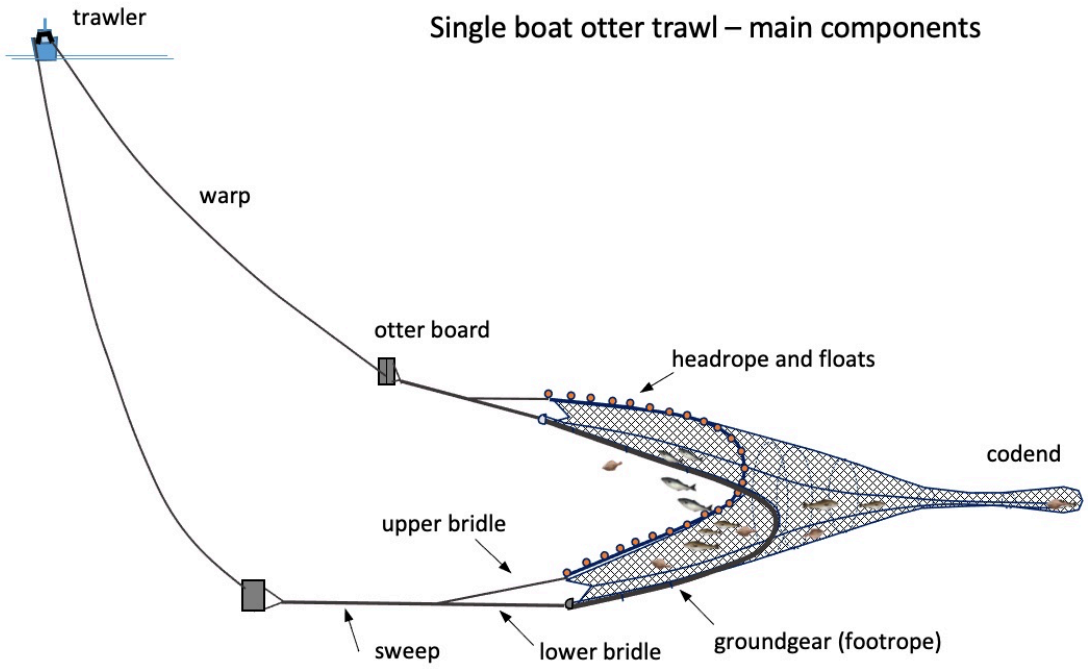
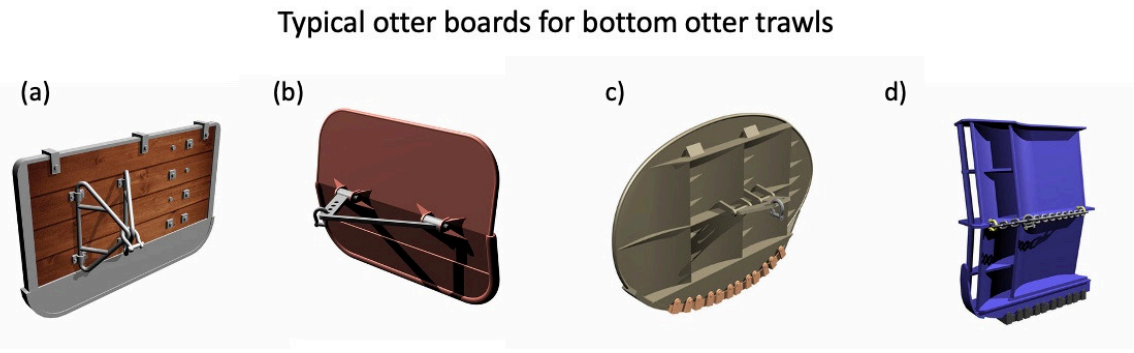


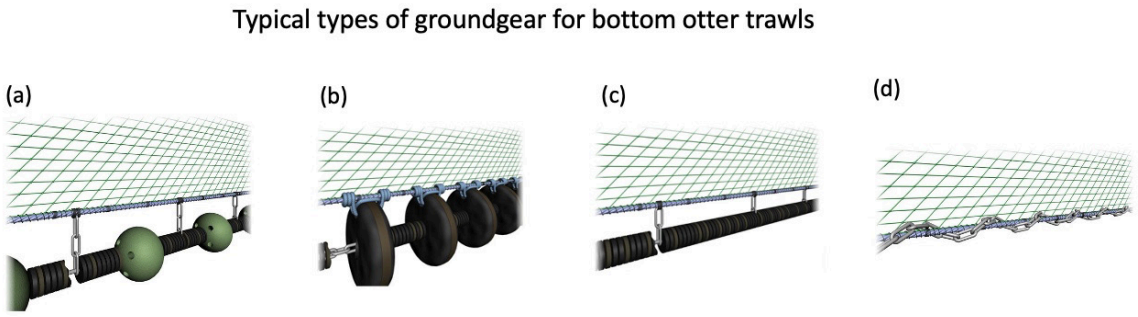
FIGURE 14

A representative selection of otter boards in use in single boat bottom otter trawls (OTB 03.12) around the world. (a) slotted cambered otter board wooden rectangular otter board, (b) V-shaped otter board, (c) slotted oval otter board, (d)



Source: Seafish, 2021.

FIGURE 15
A representative selection of groundgears in use in single boat bottom otter trawls (OTB 03.12) around the world (a) bobbin groundgear, (b) rockhopper groundgear, (c) rubber disc groundgear, (d) wrapped chain groundgear



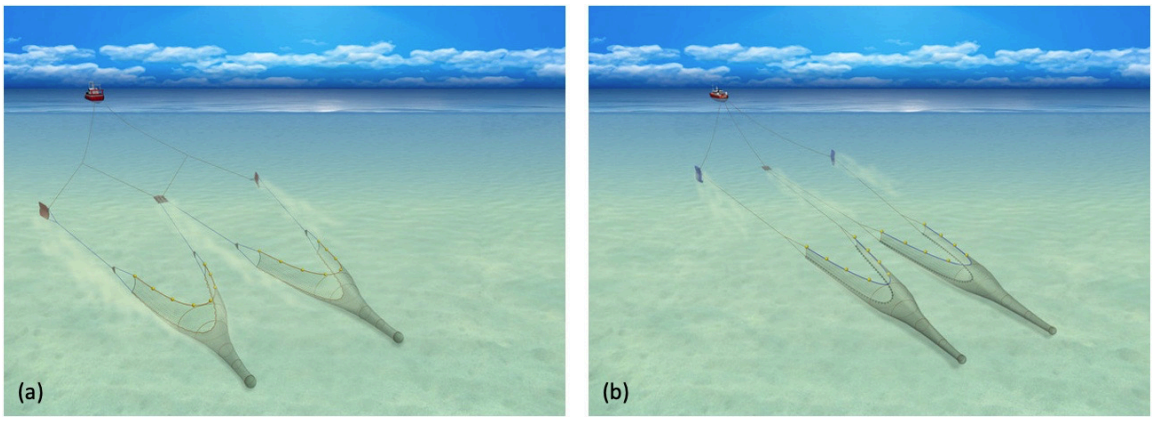
Source: Seafish, 2021.

3.1.3 Twin bottom otter trawls

Twin bottom otter trawls are two trawl nets towed over the seabed by one boat.

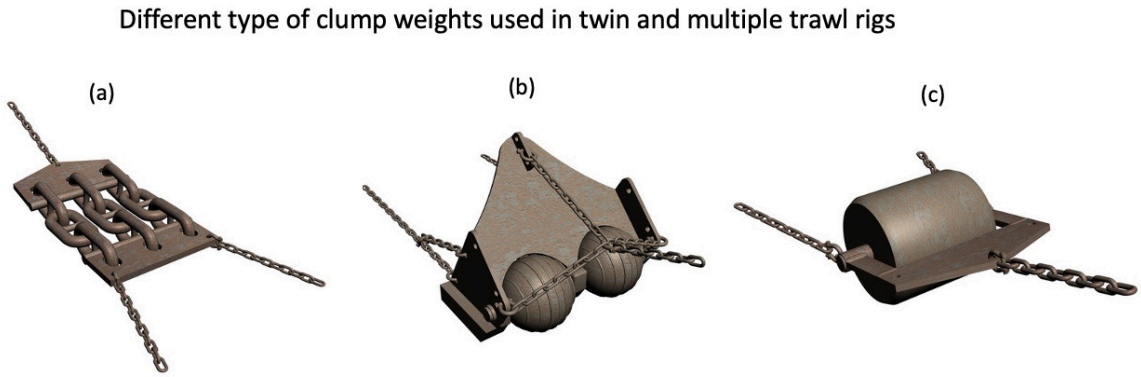
Twin bottom otter trawls are also called twin trawls and can be rigged as a two-warp system using a bridle arrangement (Figure 16a) or a three-warp system (Figure 16b). Regardless of variations, each trawl net is rigged between a central clump weight and one of the two otter boards. Different types of clump weights are used for twin trawls (Figure 17). In a similar manner to single trawls, sweeps and bridles connecting the otter boards (or clump weight) and the wingends of the nets can herd some species into the nets. In some cases, especially in shallow waters, one vessel may tow two completely separate trawls with its own otter boards, bridle systems and towing warps, usually from outriggers.

FIGURE 16
Two types of rigging for twin bottom otter trawls (OTT 03.13) (a) two-warp twin trawls, (b) three-warp twin trawls. In both rigging variations, the devices in the middle between the otter boards middle are clump weights, some of which are shown in Figure 17



Source: Seafish, 2021.

FIGURE 17
Different types of clump weights used in twin (OTT 03.13) and multiple (OTP 03.14) trawl rigs
(a) chain clump weight, (b) depressor clump weight, (c) roller clump weight



Source: Seafish, 2021.

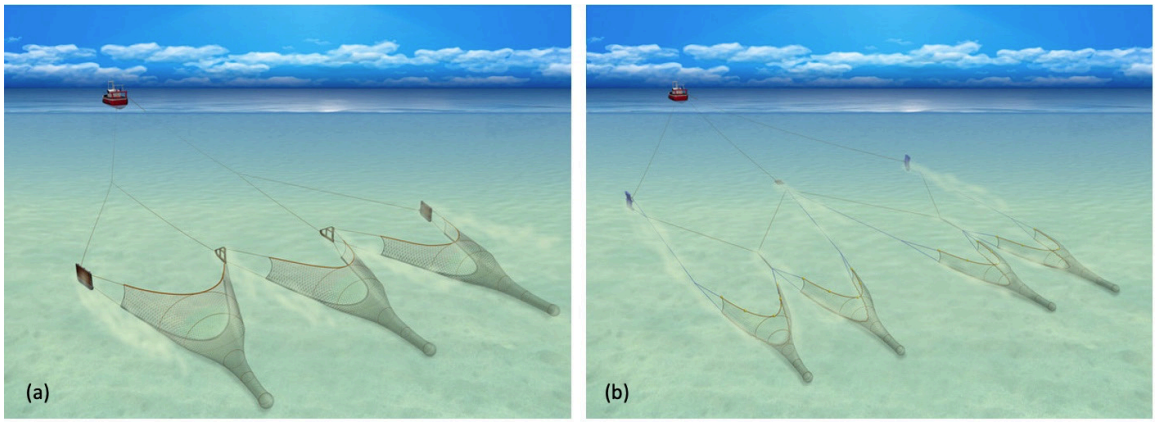
Twin trawls can increase the net's width while maintaining a low vertical opening, which is ideal for catching shrimps and prawns close to the seabed. Twin trawls are also useful for catch comparison experiments, allowing two different trawls, or two similar trawls with certain modifications (e.g. different codends) to be compared efficiently.

3.1.4 Multiple bottom otter trawls

Multiple bottom otter trawls comprise more than two trawl nets towed over the seabed by one boat.

Multiple bottom otter trawls are also called multi-rig trawls, which are rigged between two or more otter boards and clump weights or sleds (sledges). A triple-rig trawl system typically utilizes two otter boards and two sleds, which open the three nets horizontally (Figure 18 a). A quad-rig system, however, usually comprises two pairs of nets, typically rigged as a three-warp system (Figure 18 b). However, different rigging variations are used, including two-warp, three-warp and four-warp systems, and two-board and four-board riggings. The trawls can be towed from the stern or from outriggers.

FIGURE 18
Two types of multiple bottom otter trawls (OTP 03.14)
(a) Two-warp triple trawls (triple rig), which include two skids; (b) three-warp quad trawls (quad-rig), which include three clump weights between the adjacent trawls



Source: Seafish, 2021.

Multi-rig trawls aim to improve the performance of the twin trawl by providing a much wider total horizontal spread to produce a higher catch of species close to the seabed, such as shrimp and other crustaceans. Multi-rig trawls are also used for comparative fishing, as more than two different trawls can be compared simultaneously.

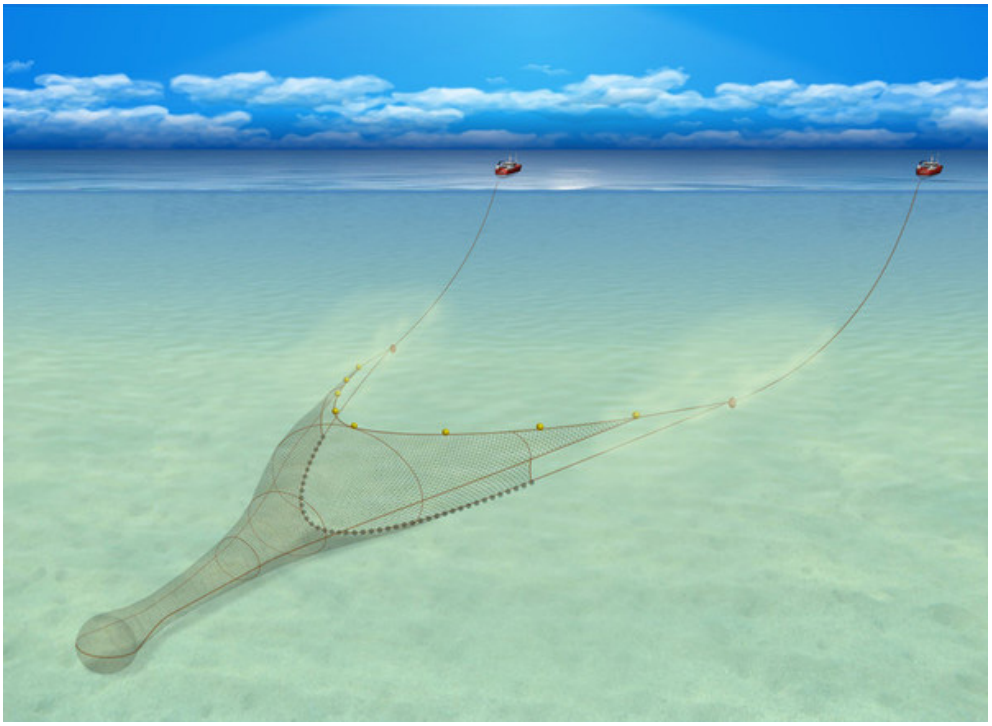
3.1.5 Bottom pair trawls

A bottom pair trawl is a trawl towed over the seabed by two boats, which maintain the horizontal spread of the net during fishing (Figure 19).

The design of the trawl net is similar to a single boat bottom otter trawl net but is typically larger than that for similar vessel sizes by virtue of the higher power available from two boats. Long towing warps are sometimes used as sweeps in front of the wings to increase the fished area of the trawl through herding and hence the catch efficiency for some species.

Bottom pair trawls can sometimes be confused with the pair seines in the boat seine category (SV 02.2). The main difference is that pair trawls catch fish through towing for a longer period of time while pair seines catch fish mainly through encircling the fish with heavy seine ropes while towing for a short time period. The shape of a pair seine changes constantly during fishing, while that of a pair trawl is more or less stable after the net starts to fish after setting and when the boats maintain their horizontal separation.

FIGURE 19
A bottom pair trawl (PTB 03.15) towed between two boats



Source: Seafish, 2021.

3.2 MIDWATER TRAWLS

A midwater trawl is a cone-shaped net towed in midwater by one or two boats to catch pelagic or semi-demersal fish in the water column.

Midwater trawls are also called pelagic trawls whose components are not intended to have contacts with the seabed while fishing. The target species are often schooling species such as Clupeids and scombrids, and catch rates are often very high. Towing speed usually ranges from 3 to 5 knots, but 6 knots may be required for faster swimming species. Midwater trawl nets are usually much larger than bottom trawl nets, especially their vertical opening. The front part of the net is usually made with very large meshes or ropes to reduce drag, but still herd the targeted fish. The vertical opening of a midwater trawl is often maintained with weights attached to the lower wingends, which are often called clump weights.

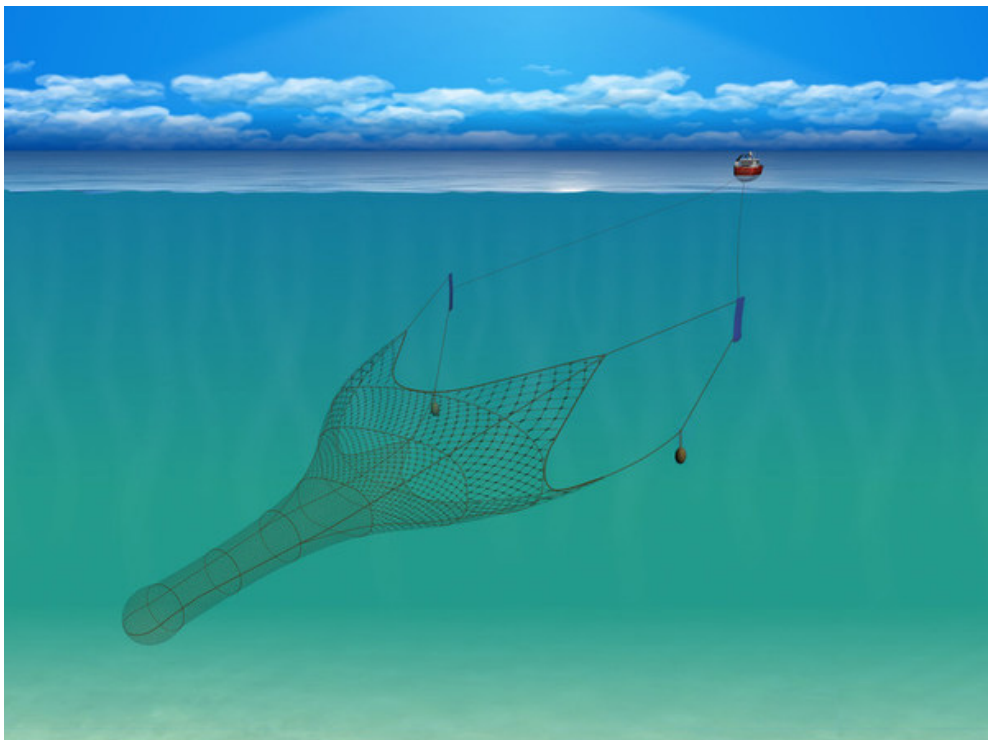
As fish tire, they fall back and are overtaken by smaller meshes in the aft sections of the net and the codend. The codend may be designed to hold a large catch, with circumferential strengthening ropes to prevent bursting when the fish reach the surface with expanded swim bladders.

Detecting schools of fish in midwater requires the use of an echo sounders and/or scanning sonars. Aiming the trawl to intercept the school requires the use of a net sounder (or called "netsonde") attached to the trawl's headrope in order to determine the position of the net relative to the depth of fish in real time. Careful adjustment of towing speed and/or the length of warp allows the boat operator to adjust the depth of the net to intercept the school. Midwater trawls may be towed by one or two boats, as described below.

3.2.1 Single boat midwater otter trawls

A single boat midwater otter trawl is a trawl that is towed in midwater by one boat using a pair of otter boards to spread the net horizontally (Figure 20).

FIGURE 20
A single boat midwater otter trawl (OTM 03.21) in operation



Source: Seafish, 2021.

Otter boards used for midwater trawls are usually of high hydrodynamic efficiency using cambered, slotted and high aspect ratio designs. Upper bridles are usually connected directly between the top of the otter boards and upper wingends, while lower bridles are connected between the bottom of the otter boards and lower wingends.

Single boat midwater otter trawls are widely used around the world for catching schooling pelagic species. Some important fisheries include: the midwater trawl fisheries for Alaska pollock (*Gadus chalcogrammus*) in the North Pacific; for Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) in the Northeast Atlantic (particularly in the Baltic Sea), as well as in the northeast United States of America; and for Antarctic krill (*Euphausia superba*) in the Antarctic.

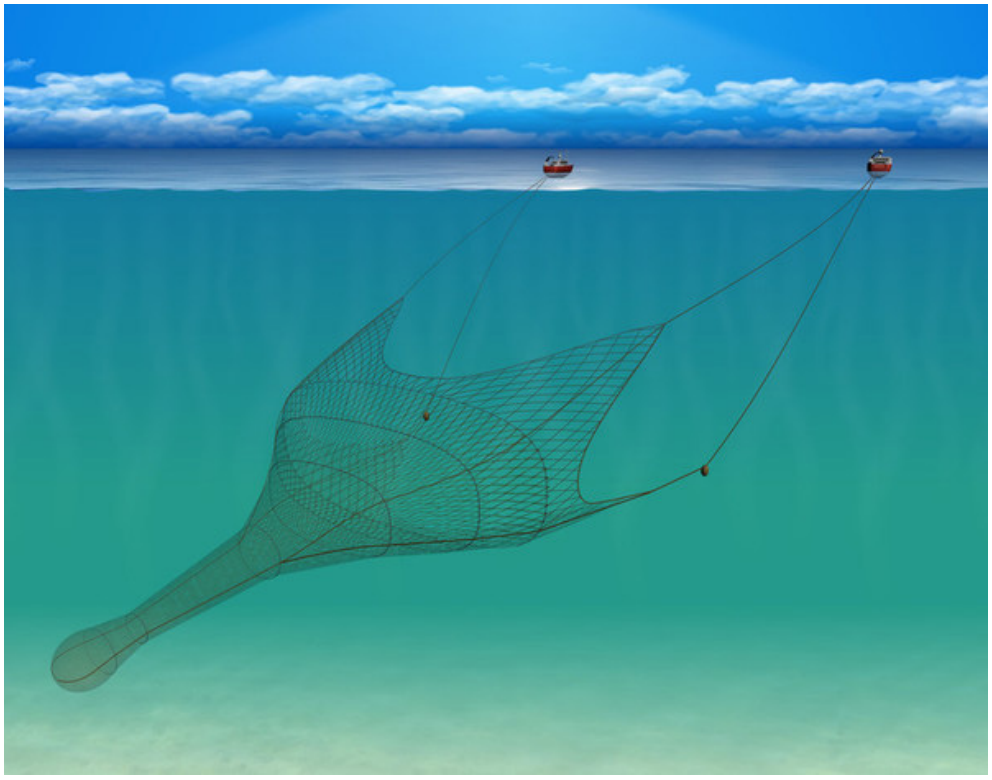
3.2.2 Midwater pair trawls

A midwater pair trawl is a trawl towed in midwater by two boats, whose distance apart determines and maintains the horizontal spread of the net (Figure 21).

Midwater pair trawls may be rigged with one towing warp from each boat and a bridle arrangement, or two towing warps from each boat connected to the upper and lower wingends as shown in Figure 21. The trawl's vertical opening is achieved using weights at the wingends, which are called clump weights. The net depth is controlled by the towing speed and/or the length of towing warps. Midwater pair trawls can also be fished near the surface. In this case, the depth of net may be controlled by attaching two ropes to the trawl or its towing warps, which lead to two floats on the surface (Gabriel *et al*., 2005).

Midwater pair trawls target the same species as the single boat midwater trawl, but midwater pair trawls are particularly useful for species near the surface. Further information on pair trawling may be found in Thompson (1978).

FIGURE 21
A midwater pair trawl (PTM 03.22) with two warps from each vessel



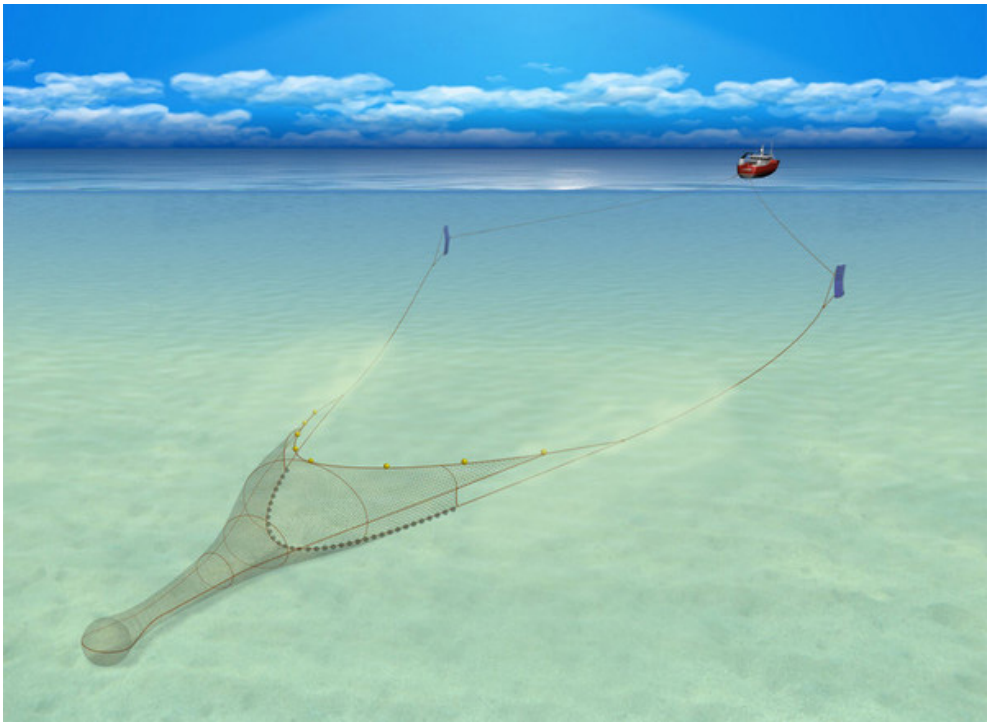
Source: Seafish, 2021.

3.3 SEMIPELAGIC TRAWLS

A semipelagic trawl is a trawl that has either the trawl net or the otter boards touching the seabed, but not both.

A semi-pelagic trawl is a hybrid trawling system between a midwater trawl and a bottom trawl for catching fish off the seabed. If the system is configured with the otter boards off the seabed, efficient pelagic otter boards with a high aspect ratio are often used, as shown in Figure 22. If the trawl system is designed to have the trawl net off the seabed while the boards are on the bottom, the net's groundgear may be lightened (He, 2007). Otherwise, the trawl and the otter board resemble the single boat bottom otter trawl.

FIGURE 22
One type of semipelagic trawl (TSP 03.3) with the otter board off the seabed while the trawl groundgear is on the seabed



Source: Seafish, 2021.

4. Dredges

A dredge is a cage-like structure often equipped with a scraper blade or teeth on its lower part, either pulled or towed to dig animals out of substrate and lift them into the cage or bag.

As dredges are in heavy contact with the substrate, the bottom part of the dredge, sometimes the entire cage, is made of metal rods or chain mesh to withstand chafing with the seabed; however, mesh bags made of synthetic materials are also used. Dredges may be operated either by hand, wading in the water or from a small boat in shallow waters, or towed behind a boat in deeper waters. Complex mechanized systems using hydraulic equipment (water jets) to dislodge the target species from the seabed may also be employed in dredges. Common target species include molluscs such as mussels, oysters, scallops and clams.

Two types of dredges may be operated from a large boat, towed dredges or mechanized (hydraulic) dredges. Towed dredges are towed steadily across the seabed and may include a series of small dredges attached to a single towing bar at the end of a towing wire. Hydraulic dredges use extensive accessory gear such as hoses and pumps and are either towed across the seabed slowly by boat or by winching a warp attached to an anchor. A review of dredge fisheries and technologies was compiled by Beentjes and Baird (2004).

Dredges penetrate and alter physical characteristics of the seabed and may impact benthic fauna. The extent of damage may depend on the type of gear and the environmental and physical conditions of the area. Many research projects have investigated the impact of dredging and the means to reduce such impact (Caddy, 1973; McLoughlin *et al.*, 1991; NRC, 2002; Gaspar and Chícharo, 2007). The direct and indirect effects of dredging on molluscs hit by the dredge or subject to repeated disturbance by dredges can suffer high levels of immediate or delayed mortality (McLoughlin *et al.*, 1991).

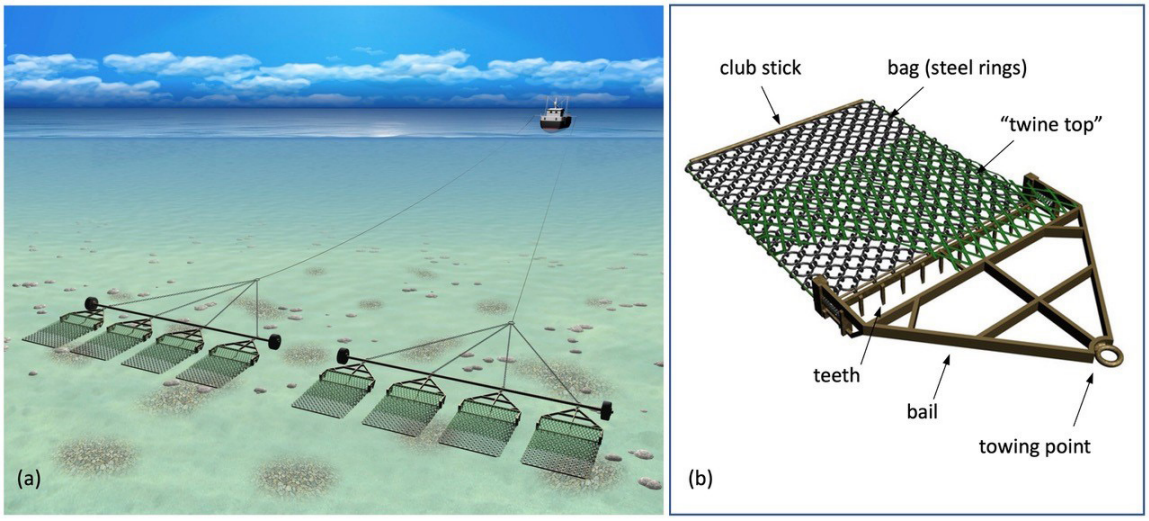
4.1 TOWED DREDGES

A towed dredge is a cage-like structure made of a robust metal frame that is towed behind a boat.

The towed dredge may or may not have teeth along the lower edge of the frame, which are usually referred to as the cutting bar or tooth bar. The basket-like bag is usually made of interlocking metal rings, chains, nets, or synthetic netting attached to the frame. Common targets are clams, oysters and scallops. Towed dredges may have wheels on the side of the frame to help move the dredge along the seabed. Depending on the power and size of the boat and the depth fished the number of dredges may vary from a single dredge towed behind the boat, to four dredges towed from each side of the stern (as seen in Figure 23a), or as many as 18 dredges towed from the outriggers on each side. In the latter case, the individual small dredges are connected to a towing bar which is attached by bridles to a single towing warp. The number of dredges or the size of dredge are often limited by legislative restrictions.

Some large dredge fisheries include the Japanese scallop (*Patinopecten yessoensis*) fishery, primarily from Hokkaido (Japan) which produced about 300 000 tonnes annually in the first decade of this century (Kosaka, 2016), and the Atlantic sea scallop (*Placopecten magellacnicus*) fisheries in the New England and mid-Atlantic regions of the United States of America, which landed about 280 000 tonnes of scallops annually between 2002 and 2011 (Stokesbury *et al.*, 2016). The American offshore scallop dredges are large and heavy, measuring around 4.5 m in width and weighing about one tonne. Two dredges are usually towed from the stern of 18 to 30 m vessels at around 5 knots (Stokesbury *et al.*, 2016).

FIGURE 23
Eight dredges (DRB 04.1) on two beams towed behind a boat (a); an enlargement, with annotations, of a typical towed dredge with teeth (b)



Source: Seafish, 2021.

4.2 HAND DREDGES

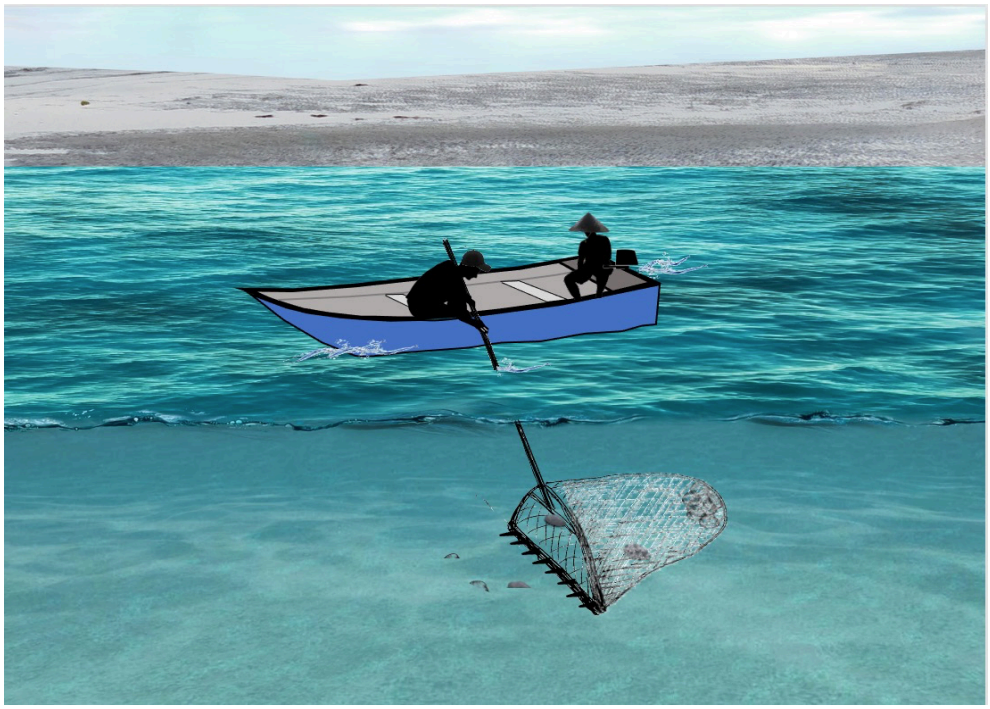
A hand dredge is a small and light hand-operated dredge with a handle and a metal frame which may have teeth on its lower edge.

A hand dredge usually has a frame attached with a bag, which is either made of synthetic netting or wire mesh. The hand dredge may be pulled manually by wading, or from a small boat in shallow waters (Figure 24). Typical target species are clams, oysters and mussels.

The hand dredge can sometimes be confused with the rake in the hand implements sub-class in the Miscellaneous gear category (MHI 10.2). The main difference between the hand dredge and the rake may be the steadier motion of "dredging" and the bag attached to the frame of the hand dredge.

FIGURE 24

A hand dredge (DRH 04.2) operated by a fisher from a small boat in shallow water



4.3 MECHANIZED DREDGES

A mechanized dredge is a large metal cage equipped with a cutting blade, which uses high-pressure hydraulic jet pumps to fluidize the substrate and wash out animals from the sediment and into the cage (Figure 25).

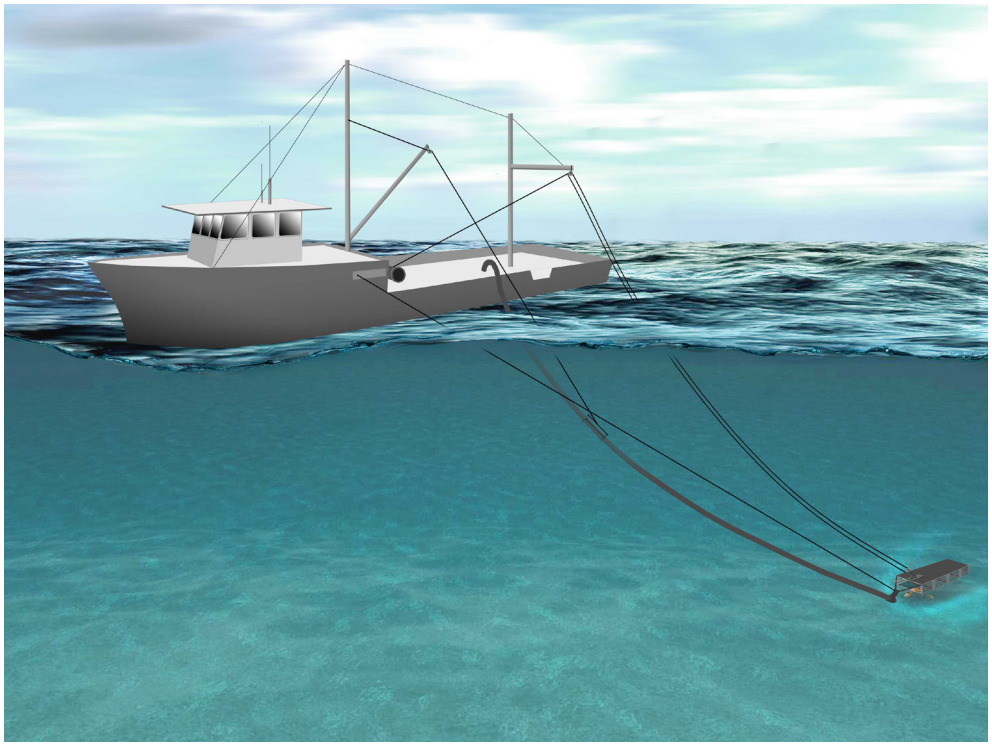
The mechanized dredge is therefore also called a hydraulic dredge. Molluscs such as mussels and clams are scooped up by the dredge located behind the water jets and may be delivered to the boat via a conveyer belt, by using a suction pump, or by bringing the cage-like dredge to the surface. The dredge may also be towed slowly during fishing, especially on large powerful vessels (Figure 25). In some operations, the boat may set a large anchor so that the boat can manoeuvre several sectors around the anchoring position.

Some important mechanized dredge fisheries include the Canadian east coast surf clam (*Spisula solidissima*) fishery and the Irish razor clam dredge fishery.

FIGURE 25

A mechanized hydraulic dredge (DRM 04.3)

A compressor onboard the vessel pushes high pressure water jet through a hose (thick line) to fluidize the substrate and wash out bivalves in the sediment, allowing the cage-like dredge to collect the animals (bottom right)



5. Lift nets

A lift net is a piece of netting mounted onto a frame that is lowered into the water to allow fish to enter the area above the net and is then lifted or hauled upward to collect the fish accumulated there.

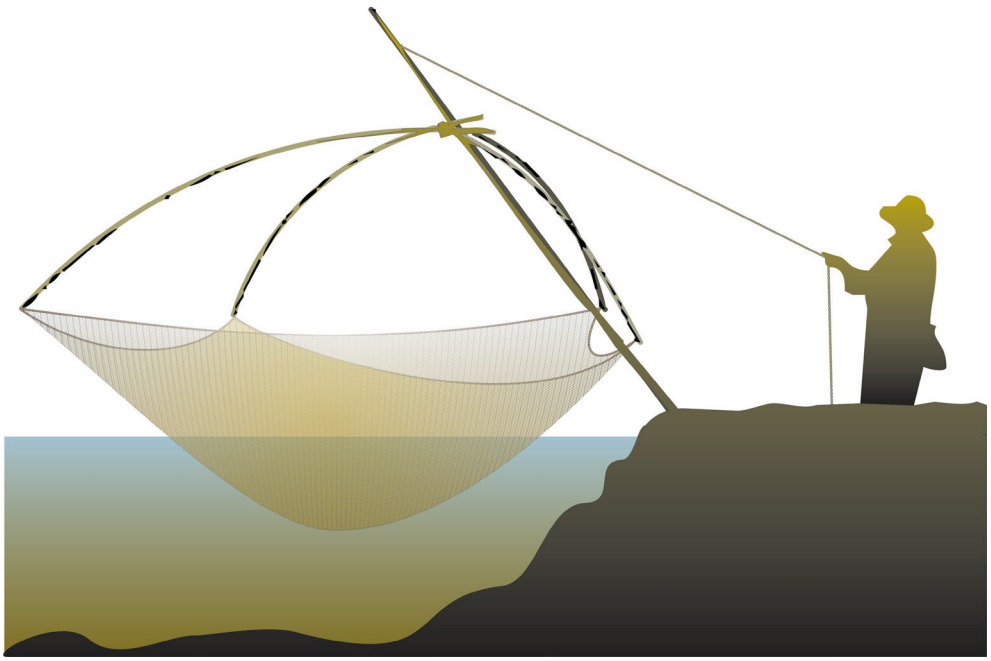
The net is either a series of simple horizontal sheets or a bag-shaped netting panel, like a funnel or cone with the opening facing upwards. The netting is often stretched over a frame of rods made of bamboo, wood, plastic or metal. The fish are often attracted over the net by lights or bait, or drift over the net with the current. These gears may be either small and portable and operated by hand or large in size and assisted by a winch or other mechanical device. They can be operated from shore, from a structure extended from the shore (e.g. a pier) or from a boat.

5.1 PORTABLE LIFT NETS

A portable lift net is a small rectangular-shaped net stretched on a frame and not fixed to a structure.

A portable lift net is usually supported by a rod and fished from a rock, shore, riverbank or pier (Figure 26). The gear is small, portable and tended, and not fixed to the shore or the structure so that it can be carried to different fishing spots. This gear is often used in recreational, artisanal and subsistence fisheries.

FIGURE 26
A portable lift net (LNP 05.1) operated by a fisher from the shore



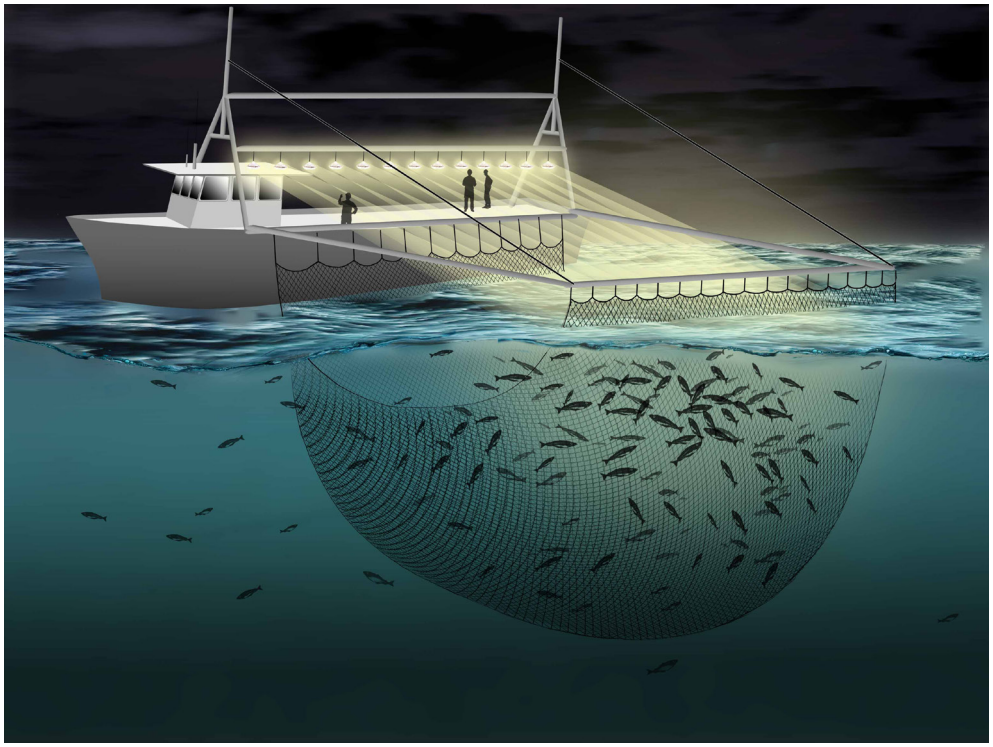
5.2 BOAT-OPERATED LIFT NETS

A boat-operated lift net is a rectangular net deployed from one or more boats at some depth to catch fish above by lifting the net.

A boat-operated lift net is usually large in size using beams extended from the boat. Lights are often used to attract and concentrate the fish at night (Figure 27). These gears include bagnets ("*basnig*"), blanket nets, and Japanese stick-held lift nets ("*bouke-ami*") (Sudirman and Nessa, 1992).

In addition to catching fish for human consumption, such as Pacific saury (*Cololabis saira*), boat-operated lift nets are primary fishing gears supplying live baitfish, mostly small clupeid and engraulid species, for tropical tuna pole-and-line fisheries. The success of these fisheries is often dependent on these nets to capture live baitfish in coastal waters the night before (Blaber *et al*., 1990; Lewis, 1990).

FIGURE 27
A boat-operated lift net (LNB 05.2) with light attraction



5.3 SHORE-OPERATED STATIONARY LIFT NETS

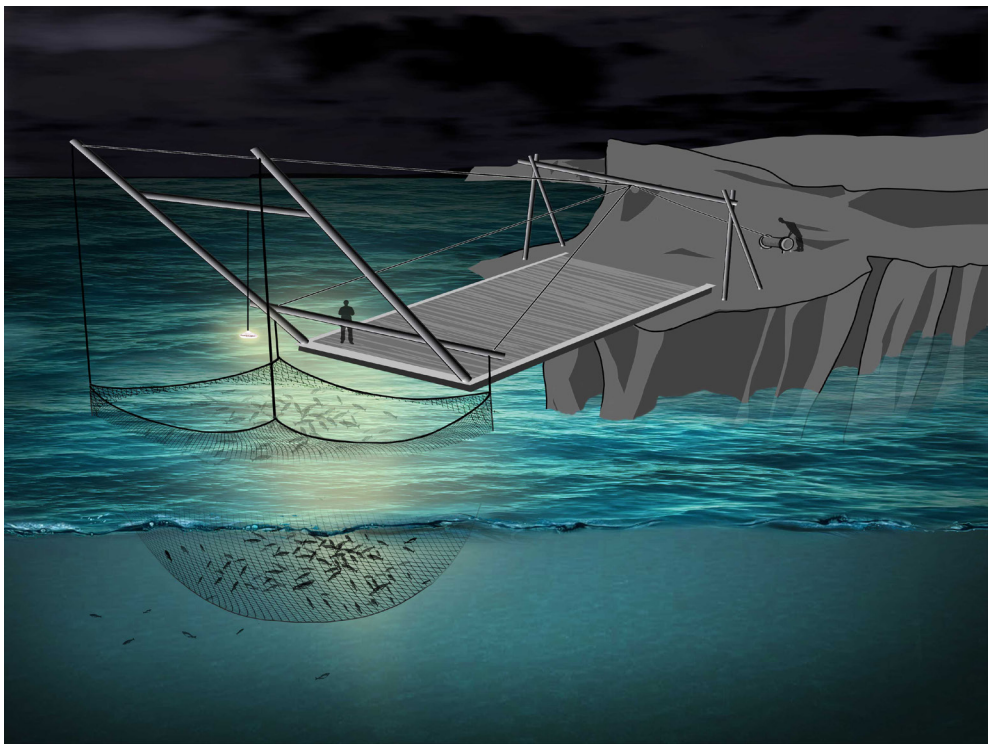
A shore-operated stationary lift net is a lift net operated from a stationary platform situated in coastal waters along the shore.

This type of lift net is often permanently or semi-permanently stationed on a riverbank, over a cliff, or on a structure such as a pier, tower or platform. The lifting system can be operated manually or mechanized using a hand-operated or powered winch depending on the size of the net. Artificial lights are often used to attract target species. Figure 28 illustrates a shore-based lift net for catching cuttlefish (*Sepiella maindroni*) over cliffs in Zhoushan, China (Feng *et al*., 1987).

Shore-operated lift nets are widely used in many Asia countries such as China, India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam (Krumme *et al*., 2013). Krumme *et al.* (2013) described a large-scale lift net in detail in the Hainan Province of China in the north of the South China Sea. The lift net is stationed some distance from the shore and operated by one fisher stationed in a wooden tower, which is also partially submerged at high tides. The fisher mechanically lifts the net and uses a small boat to get the catch from the net. According to a field survey conducted by the authors, there were 293 lift nets in that area alone in 2009.

FIGURE 28

A shore-operated stationary lift net (LNS 05.3) for catching cuttlefish (*Sepiella maindroni*) operated on a platform extended from a cliff. The operation is often carried out at night with the use of light



6. Falling gear

Falling gear is a net or a basket-like structure which is cast, pushed down or allowed to fall from above to catch fish underneath it.

The use of falling nets is usually restricted to shallow waters. However, some large-scale falling nets can operate in deep waters from a boat with the use of lights to attract and concentrate fish.

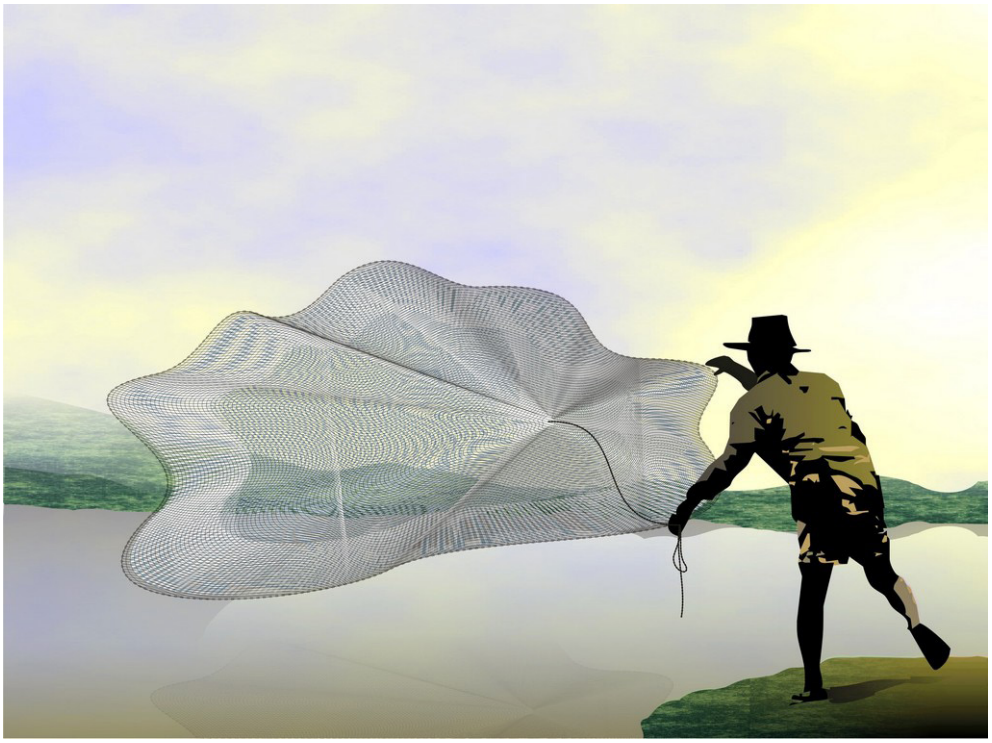
6.1 CAST NETS

A cast net is constructed from a series of tailored netting sections joined together to produce a cone-shaped net with weights and a drawstring attached to the perimeter and cast by a fisher to catch fish.

Netting at the funnel end in a cast net may be arranged such that the net hangs in a series of sculpted pockets to aid the retention of fish. More elaborate cast nets include brail lines that run from the lower edge and are held by the net thrower, which are slowly drawn together and form large pockets in the net. The line attached to the apex of the cone is used to assist the casting and retrieval of the net and allows the brail lines to be tightened.

A cast net may be cast from the shore, a bridge/pier, or from a boat. It has a disc-like shape when cast and as it touches the surface of the water (Figure 29). Weights around the perimeter of the net allow the net to sink quickly to prevent fish from escaping at the sides. The drawstring closes the bottom to prevent fish from escaping downwards. As the net is retrieved, fish bounded by the wall of netting can become trapped or enmeshed. Cast nets are often used in recreational, artisanal and substance fisheries.

FIGURE 29
A cast net (FCN 06.1) being cast by a fisher from the shore

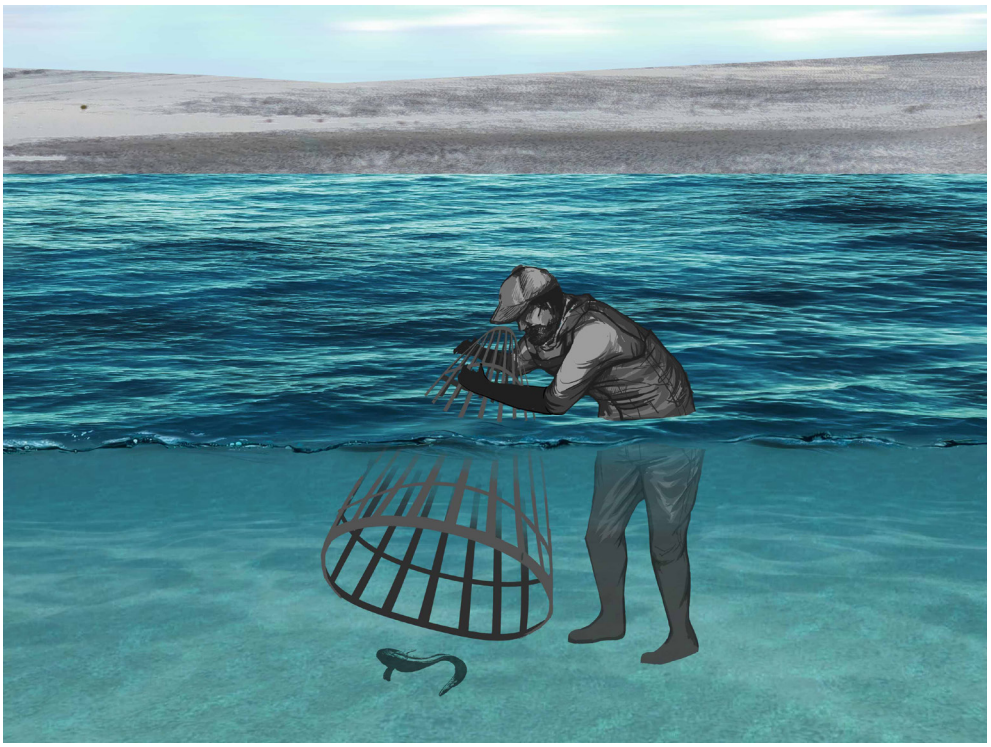


6.2 COVERED POTS/LANTERN NETS

A lantern net (or covered pot) is a cone- or pyramid-shaped rigid structure that catches fish by quickly falling over the top of the fish to prevent their escape.

The gear is generally hand-operated by fishers wading in water, as shown in Figure 30, or from a small boat in very shallow waters. The catch is often a single individual retrieved by hand through an opening in the top of the gear.

FIGURE 30
A lantern net (FCO 06.2) being pushed down by a fisher in shallow water



6.3 BOAT-OPERATED FALLING NETS

A boat-operated falling net is a cone- or pyramid-shaped net with weights and a drawstring on its perimeter that falls from the boat to catch fish underneath it.

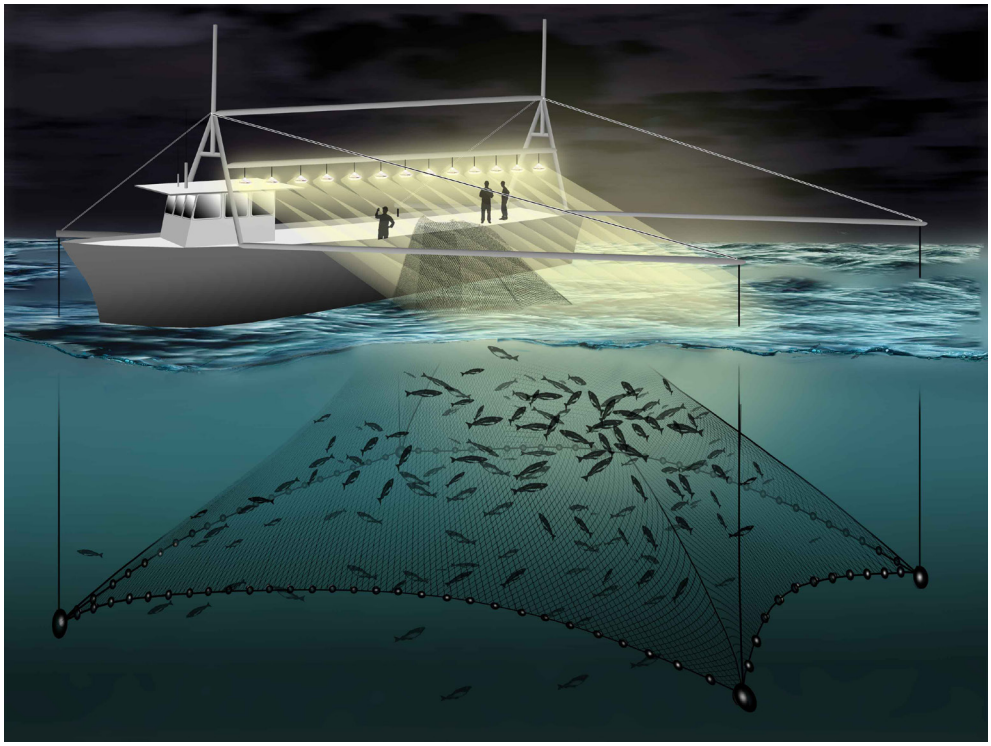
This type of falling net is usually large in scale and operated in deep waters. It is usually operated at night with the use of lights to attract target species (Figure 31). Once fish are attracted to the area under the net, which has been prepared on the side of the vessel, the net is quickly released and sinks with heavy weights on its perimeter to entrap the fish. A drawstring closes the bottom of the net when the net reaches beyond the depth of the fish, and the net is brought to the surface and the catch is either brought on-board or scooped to the deck.

A large number of falling nets of this type have been used in China and other Asian countries since the 1990s (Chen and Song, 2013; Zhao *et al.*, 2017). These falling nets can have a perimeter of more than 300 m and operated by vessels of around 40–50 m long. In some operations, 200–300 kW of lighting is used.

This boat-operated falling net is the opposite of a boat-operated lift net. As this type of falling net is not in a specific classification in the new ISSCFG (Table 1) but is significantly different from the above two types of falling gear in design, operation and scale, the catch from this type of net should be recorded and reported as "falling net (nei) – FG 06.9" before a specific gear type is added to the category in future revisions.

FIGURE 31

A boat-operated falling net with light attraction. This type of falling net is not in a specific classification in the 2016 ISSCFG (Table 1). The catch from this type of net should be recorded and reported as "falling net (nei) – FG 06.9"



7. Gillnets and entangling nets

Gillnets and entangling nets are long rectangular walls of netting that catch fish by gilling, wedging, snagging, entangling or entrapping them in pockets.

These nets are kept open vertically by floats attached to the head rope (or float line, or cork line) and by weights added to the footrope, but they can also be held open vertically by hanging the net onto stakes. These nets are usually fished in long fleets with a number of nets tied together to form a long string of nets (which may extend up to several kilometres) but they can also be used singly. Depending on their design, they may be used to fish at the surface, in midwater or near the seabed. They may be anchored to the seabed or allowed to drift freely with marker buoys or with the boat attached to it. Several types of net may be combined in one gear (for example, a trammel net combined with a gillnet). Fish are primarily caught by gilling and entangling, but also by snagging on the teeth or wedging near their maximum body thickness, or pocketed in trammel nets (Stewart, 1987; Gabriel *et al*., 2005; He, 2006).

Gillnets and entangling nets are an important and versatile gear type that contribute about 10 percent of global fish landings. With the introduction of synthetic materials in the 1950s and 1960s, and a subsequent reduction in prices, the use of gillnets made of synthetic materials has drastically increased. The increase in use is also attributable to the low visibility of monofilament twine, lightweight and rot resistance. Because gillnets and entangling nets are usually untended (without the presence of a boat), gear loss can be much higher than other tended gears, thus contributing to marine plastic pollution. Because abandoned, lost or otherwise discarded gillnets and entangling nets have the potential to continue catching fish and ETP species, more effective preventive and curative measures are needed to reduce their impact (Stelfox *et al*., 2016).

7.1 SET GILLNETS (ANCHORED)

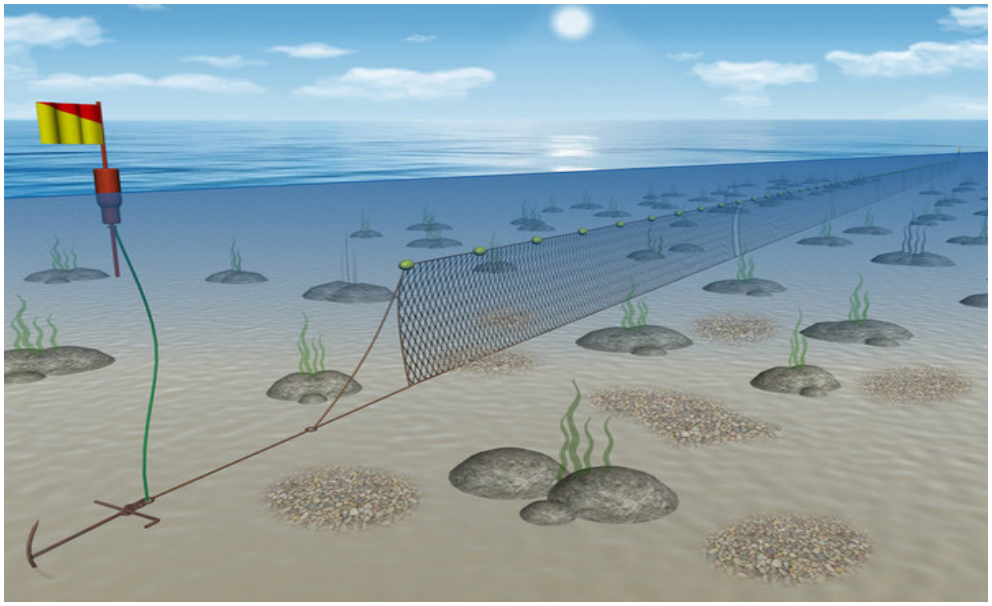
A set gillnet is a long, rectangular single-walled netting anchored or otherwise fixed to the seabed, catching fish when they come in contact with it (Figure 32).

The set gillnet is held open vertically in the water by a headrope, usually with floats, and by a footrope weighted with sinkers. Floatation and lead weights may be built into the ropes, which are often called floatrope and leadrope. The net is kept in position by anchors or other weights, usually at both ends, and marked on the surface with buoys and/or highflyers (Figure 33).

The set gillnet is the most common type of gillnet and is also referred to as the "bottom gillnet" or simply "gillnet". However, set gillnets can also fish in midwater or near the surface, especially in shallow waters. The most common type of netting material is monofilament nylon (PA), but multifilament or multi-monofilament netting is also used in some fisheries. The main capture mechanism is gilling, but it can also be wedging, snagging and entangling (He, 2006a; He and Pol, 2010).

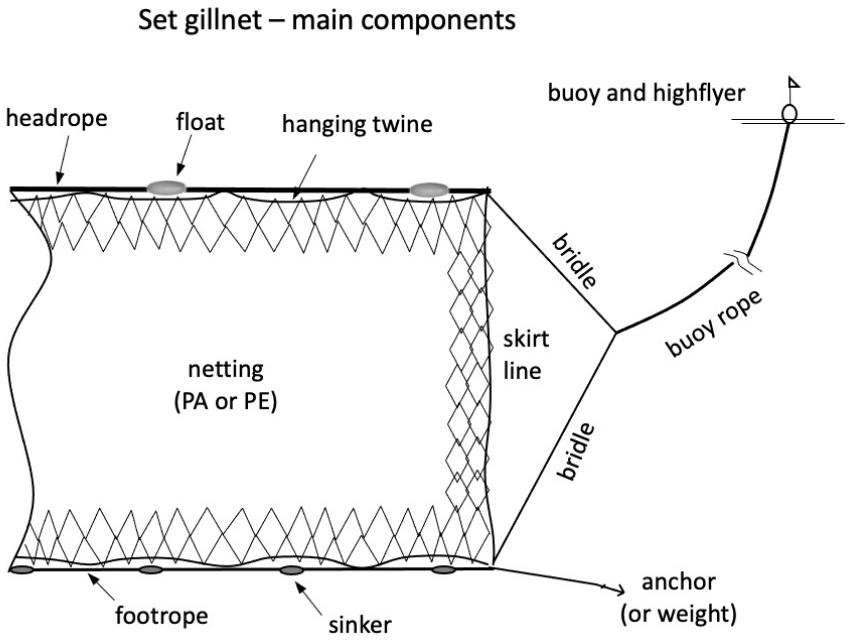
Gillnets are effective for catching a variety of fish species and are easy to operate. Gillnets can be highly size-selective, with the size distribution of the catch being largely dependent on its mesh size and hanging ratio. In gillnets the hanging ratio usually refers to the *horizontal* hanging ratio, which is the ratio of the length of rope to the stretched length of netting attached to it in the horizontal direction. For many set gillnets the typical hanging ratio is 0.5. However, in some flatfish gillnet fisheries, nets with low horizontal hanging ratios (e.g. 0.3) catch fish mainly by entangling, and are thus less size-selective.

FIGURE 32
A fleet of set gillnets (GNS 07.1) set on the bottom with anchors at each end, and buoys and highflyers on the surface



Source: Seafish, 2021.

FIGURE 33
Anatomy and components of a set gillnet (GNS 07.1)



While most gillnets have floats attached to the headrope to expand the net vertically, some gillnets do not have floats, such as those for Greenland halibut (*Reinhardius hippoglossoides*) in the deep waters off Labrador, Canada (He, 2006a), and for monkfish (*Lophius piscatorius*) and skates in Scotland (Galbraith and Rice, 2004). In these nets, large polypropylene ropes may provide some floatation to lift the headrope off the seabed, while leaving a large portion of the net on the seabed.

In some fisheries, vertical lines shorter than the height of the net are used to bring down the headrope in order to reduce the height of the net and produce a curved net shape. This type of net is called a "tie-down" net, and the lines are called tie-down lines (He, 2006b). This type of net is widely used for catching species such as monkfish in the eastern United States of America and has been reported to have lower bycatch of protected species such as Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) (Levesque *et al*., 2016).

Set gillnets are the most common type of gillnets and entangle nets; they are used all over the world for catching a variety of species, especially those on or near the seabed.

Set gillnets are also called "set-nets" in some regions, notably in Scotland (Galbraith and Rice, 2004), but they should not be confused with "stationary uncovered pound nets" (FPN 08.1) which are also often referred to as "setnets" or "set-nets" in Japan and other areas.

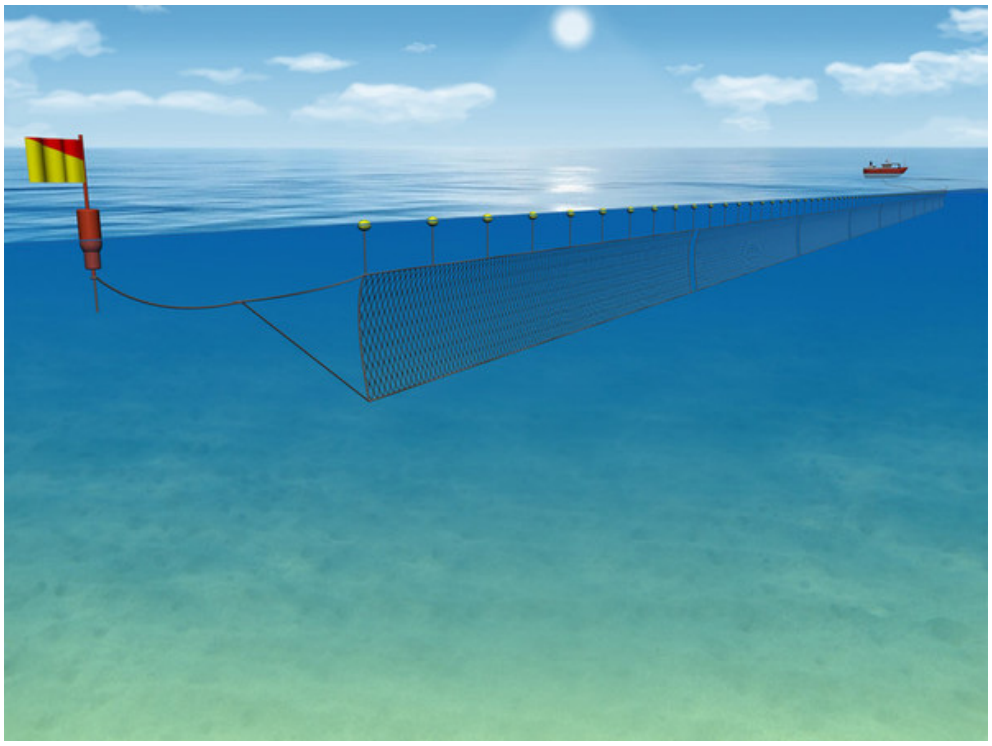
7.2 DRIFT GILLNETS

A drift gillnet is a type of gillnet that is not fixed to the seabed but allowed to drift with the current.

Drift gillnets (or driftnets) are usually fished in a fleet which can extend over a great distance in open waters. Drift gillnets usually fish on or near the surface but can be in midwater, with the length of buoy ropes controlling the depth of the net. The net is typically adrift with the vessel or a marker (buoy and highflyer) attached to one end of the gear (Figure 34). In large operations, the marker may be equipped with radio or satellite transmitters for easy location. The predominant method of capture is by gilling and the nets are thus highly size-selective for the target species. A fleet of drift gillnets can be over 10 km long and several fleets may be fished by a vessel; the total length of the net fished by one vessel may therefore stretch to tens of kilometres.

Drift gillnets have been reported as a concern for non-target species including ETP species such as marine mammals, seabirds and turtles (Northridge, 1991). As a consequence, the United Nations banned the use of large-scale driftnets (> 2.5 km long) on the high seas in 1991 (UNGA RES 44/225; UN, 1989). Subsequently, some regional and national authorities have implemented similar bans in their jurisdictions, such as the Southern Indian Ocean Fisheries Agreement (SIOFA CMM 2016/05; SOIFC, 2016) and the European Union (Technical Measure 2019/1241; European Union, 2019). However, the ban did not apply to drift gillnets of less than 2.5 km, which are commonly used in various small-scale fisheries around the world. Nevertheless, various authors have expressed concern regarding the levels of bycatch in such fisheries, including sharks, cetaceans and sea turtles (Sala, 2015; Nawaz, 2014; and Aranda, 2017).

FIGURE 34
A fleet of drift gillnet (GND 07.2)
with the buoy and highflyer in the foreground and the fishing vessel in the distance



Source: Seafish, 2021.

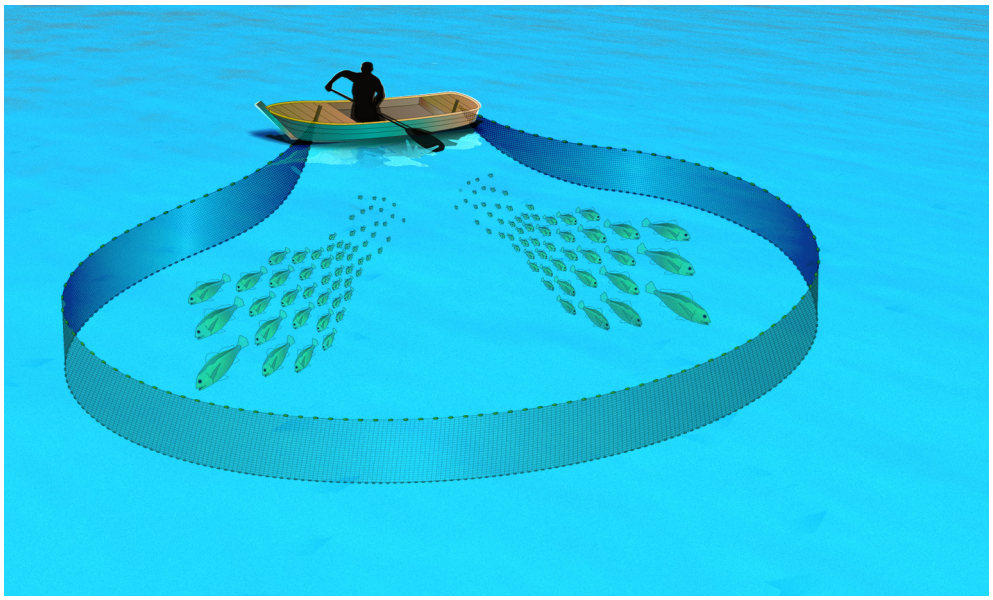
7.3 ENCIRCLING GILLNETS

An encircling gillnet is a long gillnet which is set in a circular shape around a fish aggregation, with noise or other means to drive the fish to the net so that they become gilled or entangled in the netting.

Encircling gillnets are generally used in shallow waters with the headrope on the surface and the footrope on the seabed. Sounds produced by knocking on the boat or visual stimuli are often used to drive the fish to the net (Figure 35). The development and changes in fishing practice of using encircling gillnets in Brazil have been described by Reis-Filho (2019).

The encircling gillnet is in some way similar in operation to the drive-in net (MDR 10.7): both drive fish towards the net with stimuli. However, the gear and catching mechanisms are different. The encircling gillnet is a long rectangular net and catches fish by gilling and entangling, while the drive-in net is a cone-shaped net with wings and retains fish in its codend.

FIGURE 35
Encircling gillnet (GNC 07.3).
The fisher hits his paddle on water to drive the fish to the encircling gillnets



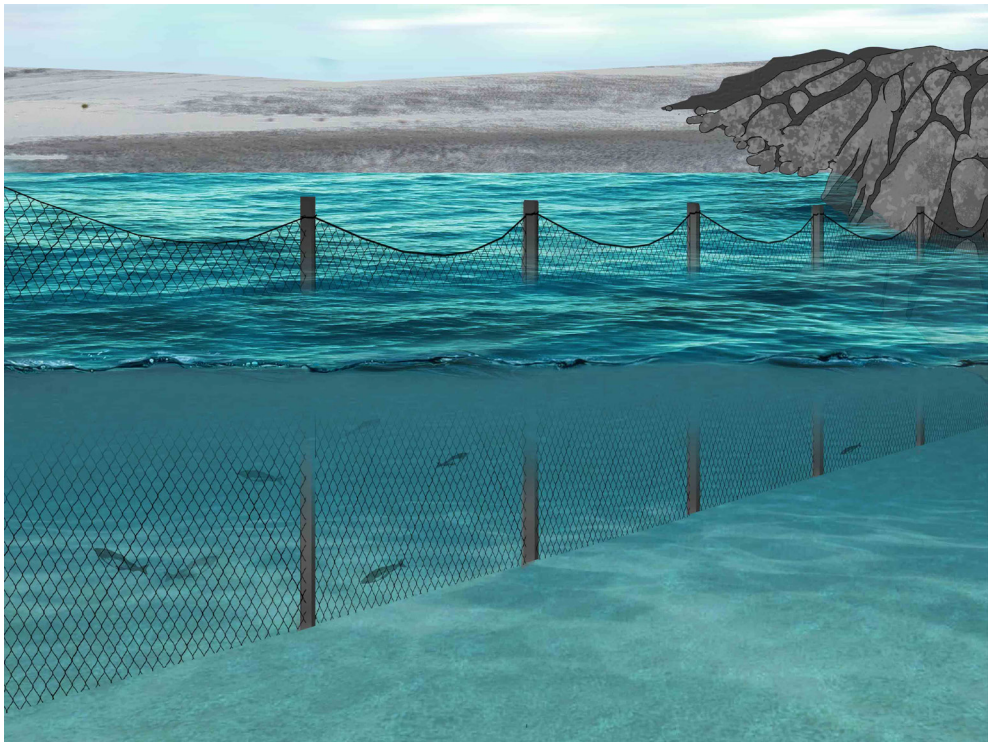
7.4 FIXED GILLNETS (ON STAKES)

A fixed gillnet (on stakes) is a long gillnet that is hung on stakes that are driven into the seabed (Figure 36).

Fixed gillnets are often set in coastal bays, and usually in tidal waters where there is a significant tidal range. The stakes may be piled when the nets are set or re-used from previous operations, which is usually at high tide after the fish have come into the bay. The fish are usually gilled in the net or concentrated near the bottom of the net at low tide and collected by hand or with a scoopnet.

The fixed gillnet should not be confused with the set gillnet (GNS 07.1). The fixed gillnet is hung on stakes, while the set gillnet is fixed on the seabed with anchors or other heavy items such as sandbags or concrete blocks. If bags and/or entrance structures are used together with the fixed gillnet, it becomes an "uncovered pound net" (FPN 08.1) or a "barrier, fence or weir" (FWR 08.5) in the "trap" category.

FIGURE 36
A fixed gillnet (on stakes) (GNF 07.4) set near a beach



7.5 TRAMMEL NETS

A trammel net is a gillnet that has three layers of netting, with two outer layers of large-mesh netting and one inner layer of slackly hung (i.e. with a low horizontal hanging ratio) small-mesh netting, either to entrap fish in a pocket or entangle them in the netting (Figure 37a).

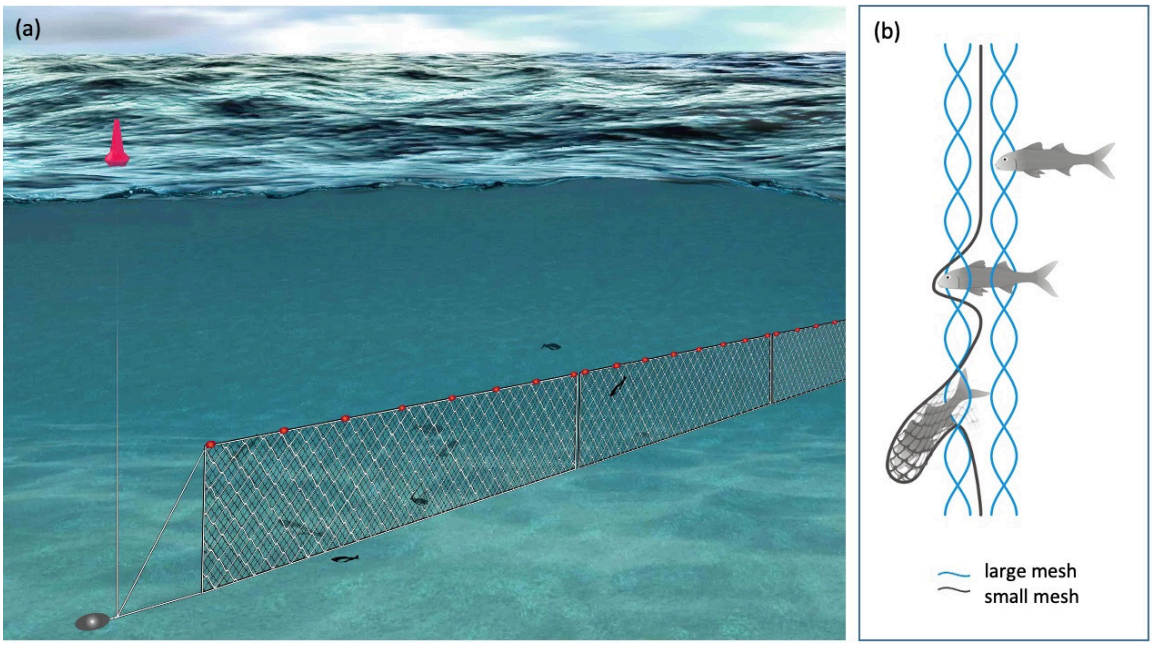
When a fish pushes the small-mesh netting through one of the outer layers of large-mesh netting, the netting forms a bag that can retain the fish (Figure 37b). Trammel nets are usually set on the bottom in a similar manner to set gillnets. However, the trammel net may be fished with a sweeping motion around a fixed anchor on one end, like the sweeping trammel net used in Japan (Purbayanto *et al*., 2000).

Trammel nets are widely used as a small-scale fishing gear all over the world for various species, including common sole (*Solea solea*) in southeast England (Ford *et al*., 2020), cramote prawn (*Melicertus kerathurus*) in Turkey (Gökçe and Metin, 2007), and squid (*Sepioteuthis lessoniana*) in Japan (Akiyama *et al*., 2004). The trammel net was the most important gear in the "gillnet and entangle net" category on the northern coast of Java, Indonesia in the 1990s, targeting various shrimp species (Purbayanto, 2005).

FIGURE 37

A trammel net (GTR 07.5) and its fish-catching mechanism

(a) The white netting indicates large-mesh outer layer nets, and the dark small-mesh netting indicates the inner layer net. (b) Fish catch mechanism. The black line represents the inner layer small mesh, while the mesh-like blue lines represent the two large-mesh outer layers. Fish are pocketed when the small mesh layer is pushed through one of the large-mesh layers

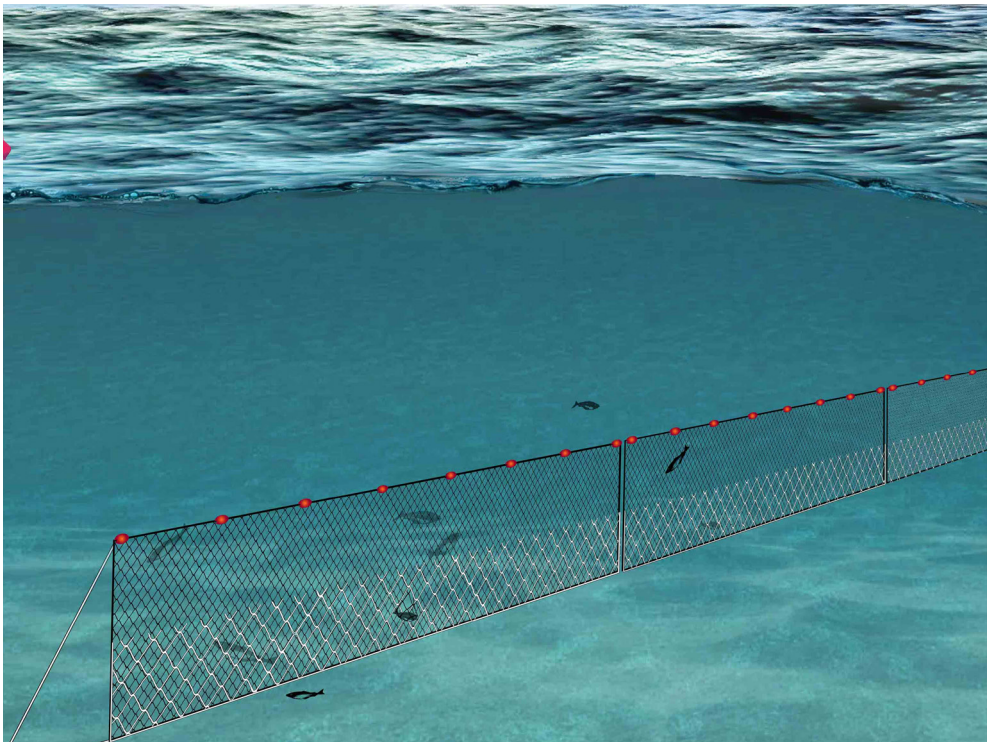


7.6 COMBINED GILLNETS-TRAMMEL NETS

A combined gillnet-trammel net is a bottom-set net consisting of a regular gillnet in the upper part to catch semi-demersal or pelagic fish, and a trammel net in the lower part to catch near-bottom fish (Figure 38).

The proportion and the relative position of gillnet and trammel net may be determined according to target species and their height above the seabed. The net is otherwise similar to the set gillnet (GNS 07.1) in terms of deployment and retrieval.

FIGURE 38
A fleet of combination gillnets-trammel nets (GTN 07.6). The bottom portion of the net (white/black) is the trammel net, while the top portion (black) is the regular gillnet



8. Traps

Traps are stationary structures of many shapes and sizes into which fish are guided, or pushed by the current, or drawn into the gear by bait or other attractants.

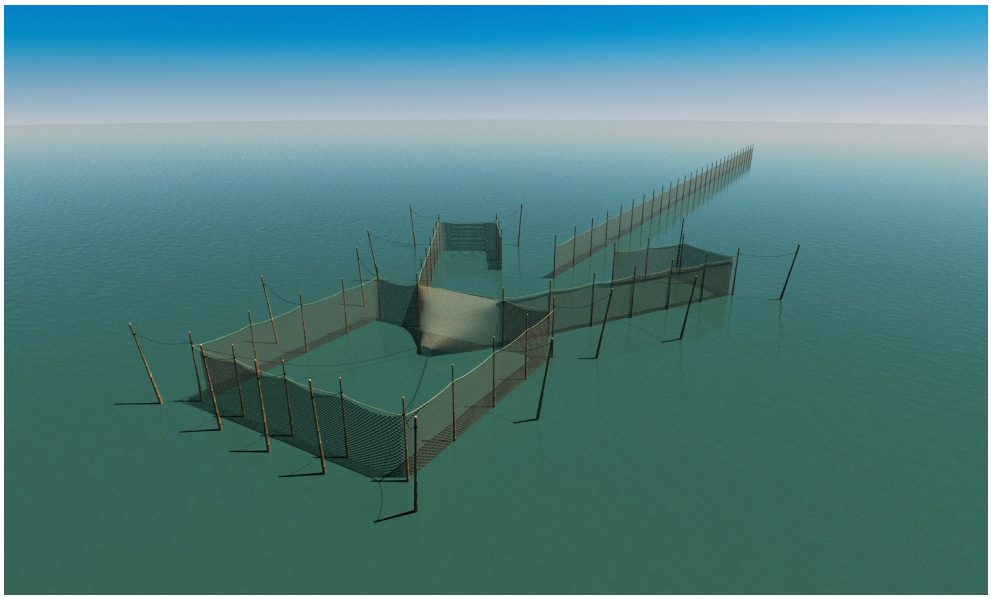
Traps usually consist of a fish-holding chamber or a codend-like bag into which the fish are held before hauling on to the boat. One or more funnels or non-return devices are often incorporated into the design to prevent fish from escaping once they have entered a chamber.

8.1 STATIONARY UNCOVERED POUND NETS

A stationary uncovered pound net is usually a large net divided into one or more chambers, anchored with a mooring system or fixed on stakes, intercepting and trapping fish during their migration or daily movement.

A pound net often has one or more long leaders placed across the path of migrating fish to intercept or guide them towards one or more holding chambers (also referred to as the "pound", "bag" or "codend" depending on design and local tradition) (Figure 39). The chambers – except the final chamber where fish are held – may be open at the surface and closed at the bottom. However, the top can be covered if the upper edge of the net is not on or near the surface, and the bottom can be open if it is set on the bottom. The catch is retrieved by hauling the final bag or holding chamber onboard by one or more boats.

FIGURE 39
A typical pound net (FPN 08.1)



There is a vast range of pound nets with different names. Some notable pound nets include: Japanese set-nets, such as the one shown in Figure 40 (Inoue, 1988); Newfoundland cod traps such as the one in Figure 41 (He, 1993); Baltic salmon and whitefish traps and pound nets – often collectively called "trap-nets" – as shown in Figure 42a (Lehtonen and Suuronen, 2004; Fjälling, 2005); Alaskan salmon traps (Colt, 1999); and bluefin tuna traps (ICCAT, 2012). One development seen in the Baltic pound net is the bag's reinforcement with hoops and double netting to protect the catch from damage by seals (Suuronen *et al.*, 2006). A new design to raise the bag mechanically, using inflatable pontoons, was invented in Sweden, and the net was subsequently called a "pontoon trap" (Suuronen *et al.*, 2006; Hemmingsson *et al.*, 2008) as shown in Figure 42b. A review of large-scale traps used in some important trap fisheries was made by He and Inoue (2010), with a discussion on fish behaviour and conservation challenges.

FIGURE 40
A Japanese set-net, a type of stationary uncovered pound net (FPN 08.1)

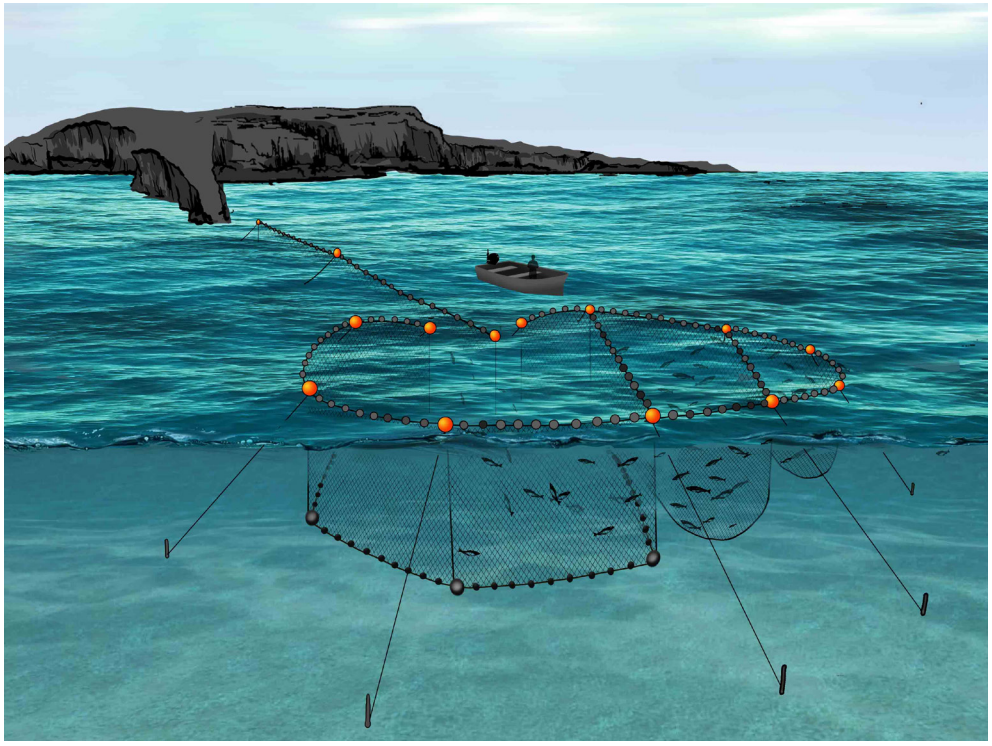


FIGURE 41
A Newfoundland cod trap, a type of stationary uncovered pound net (FPN 08.1)

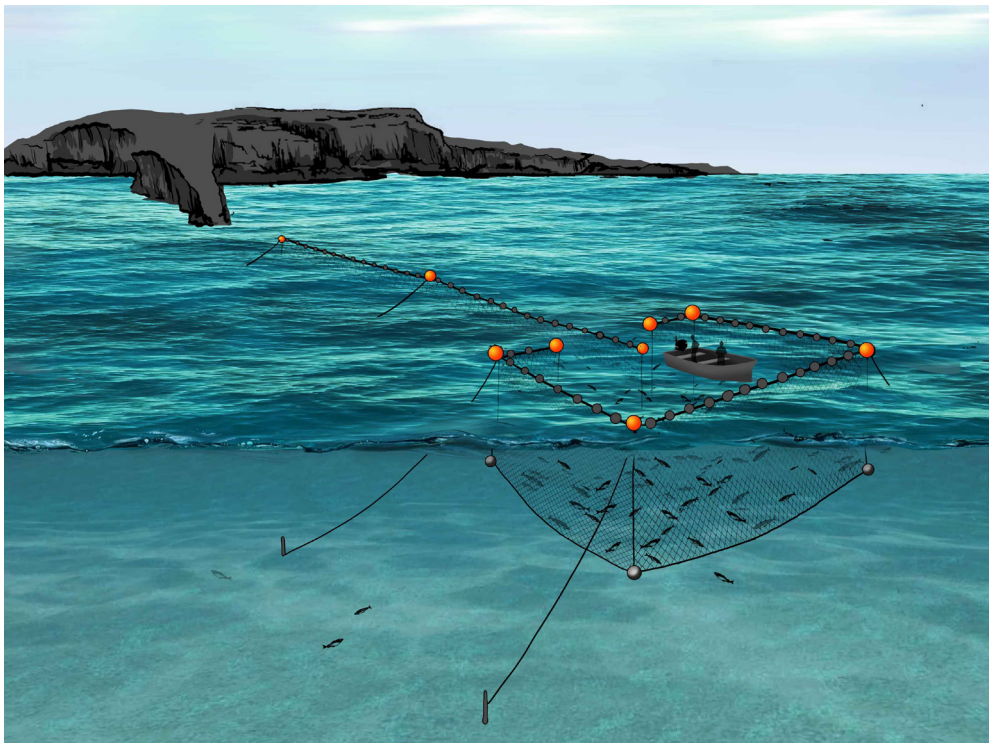
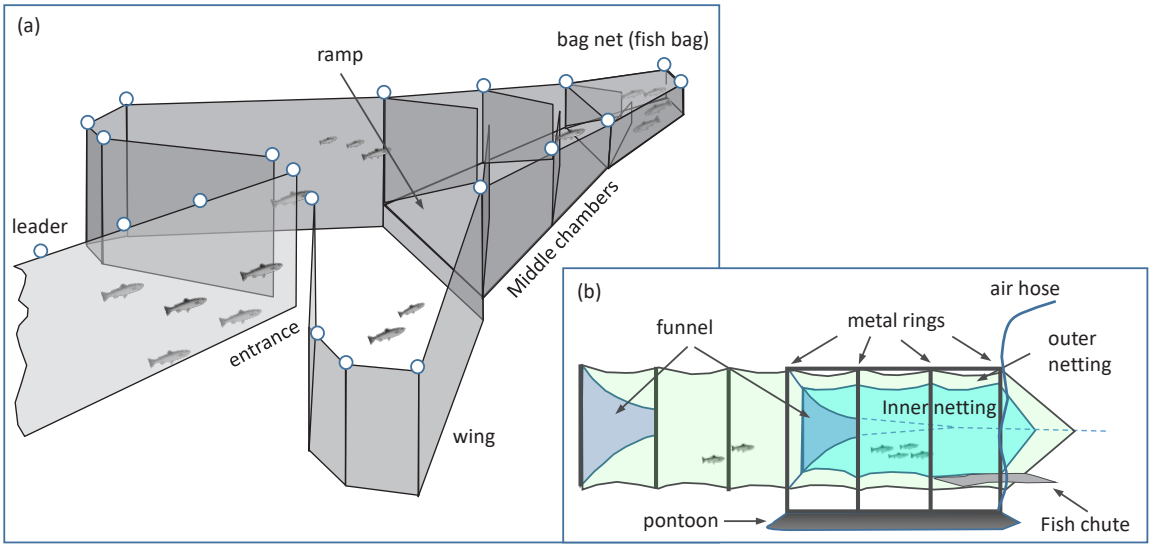


FIGURE 42
A typical Baltic trap-net, a type of stationary uncovered pound net (FPN 08.1)
(a) basic component of the trap-net, modified from He and Inoue (2010).
(b) Recently developed reinforced double-netting final chamber (also called the fish chamber) using pontoons to raise the chamber during hauling



8.2 POTS

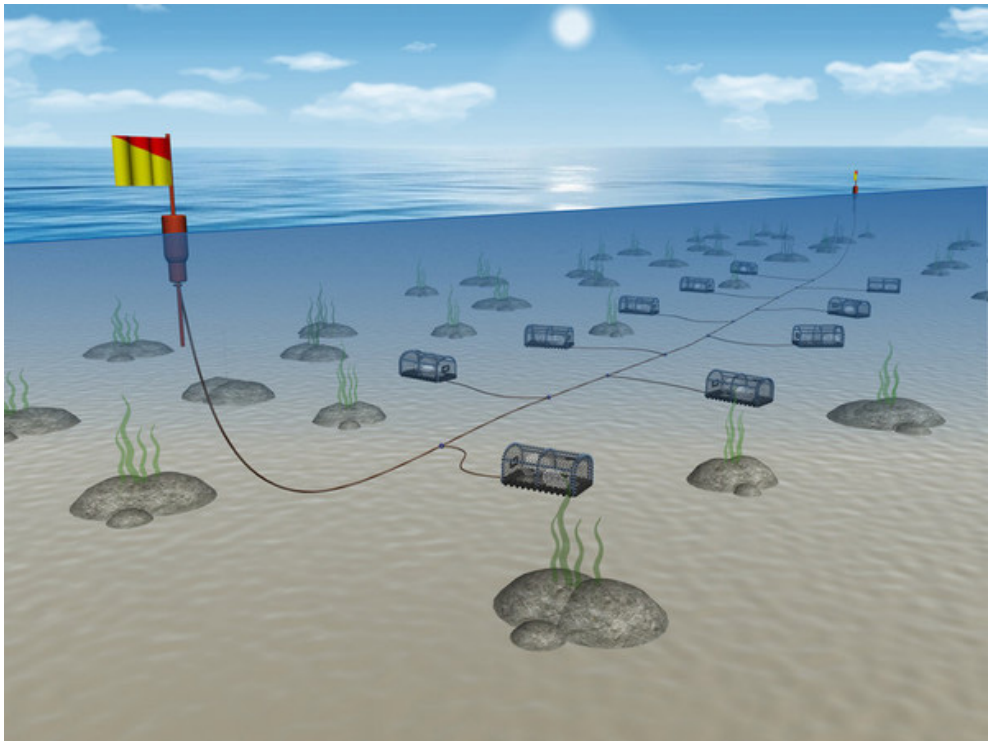
A pot is a small enclosure that attract fish through one or more entrances that allow the entry of fish but prevent or retard their escape.

Pots are usually set on the bottom with bait, singly or in a fleet of many pots, and connected by a rope to a marker on the surface (Figure 43). They can be hauled by hand or using a mechanized pot hauler. In addition to their cage- or beehive-like shapes, pots can be of any shape, and may be made from many materials. Traditional pots in Africa are made from wood while in Asia, bamboo and wicker are commonly used base materials. Natural objects such as large mollusc shells are also used as pots, especially for octopus (Gabriel *et al*., 2005).

The term "trap" is used interchangeably with pot in literature and by the fishing industry in many fisheries and in many locations. Smaller pots are also called "creels". In this gear classification, pot is a sub-category of trap

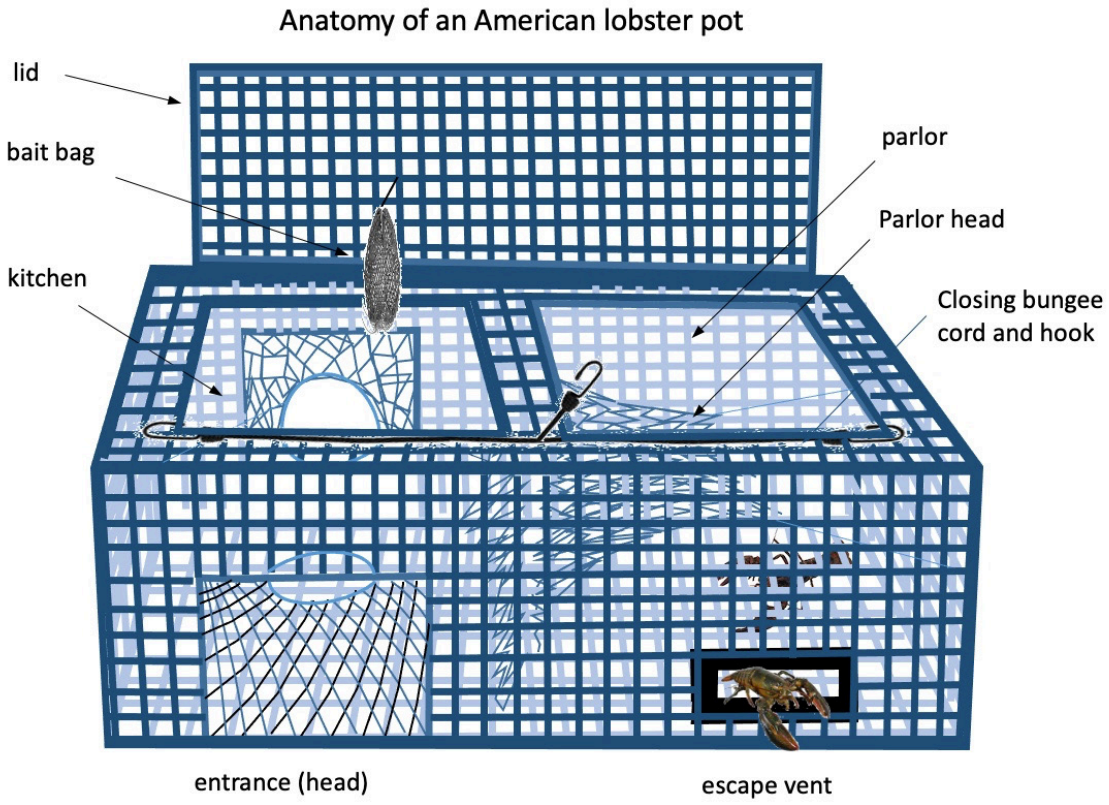
A typical pot includes one or more entrances (or heads), one or more chambers, a bait container, and a lid (or a side door) for accessing the catch and rebaiting. Many jurisdictions now require one or more escape vents (or escape panels), which often include degradable mechanisms, to allow small animals to escape. A typical American lobster (*Homarus americanus*) pot in use in the northeastern United States of America, including the names of its components, is shown in Figure 44. The pot is made from PVC-coated wire mesh.

FIGURE 43
A fleet of pots (FPO 08.2) set on the seabed



Source: Seafish, 2021.

FIGURE 44
A typical pot (PFO 08.1) for catching American lobster (*Homarus americanus*) in use in the north-eastern United States of America and eastern Canada, with the names of its various components



Pots are an important gear type, especially for crustaceans such as lobsters, crabs and shrimps. Major pot fisheries include the American lobster pot fisheries in the north-eastern United States of America and eastern Canada, the blue crab fishery in Chesapeake Bay (United States of America) and the swimming crab pot fishery in eastern China. A review of fish pots, focusing on their design, capture process and conservation, was made by Thomsen *et al.* (2010).

Similar to gillnets and entangling nets, pots are untended fishing gears and capable of catching fish and other animals without the presence of a vessel. As a consequence, gear loss is more common than with tended gears and contributes to the marine pollution burden and potentially ghostfishing (Smolowitz, 1978; Macfadyen *et al.*, 2009). Pots that are abandoned, lost or discarded, especially those that do not have an escape vent, have the potential to continue catching fish and self-baiting for an extended period. In many pot fisheries, biodegradable materials or devices are built into the pot in order to reduce its catching function after it has been abandoned, lost or discarded.

Given the large number of pots used in some fisheries, the vertical lines (buoy lines) of pots have become a serious problem due to their potential to entangle cetaceans (Hamilton and Baker, 2019). This is of particular concern for severely threatened species such as the North Atlantic right whale (*Eubalaena glacialis*). Research is needed on the means to reduce vertical lines in pot fisheries, including on devices that do not require buoy ropes for retrieving pots (ropeless fishing) (Myers *et al.*, 2019; FAO, 2021).

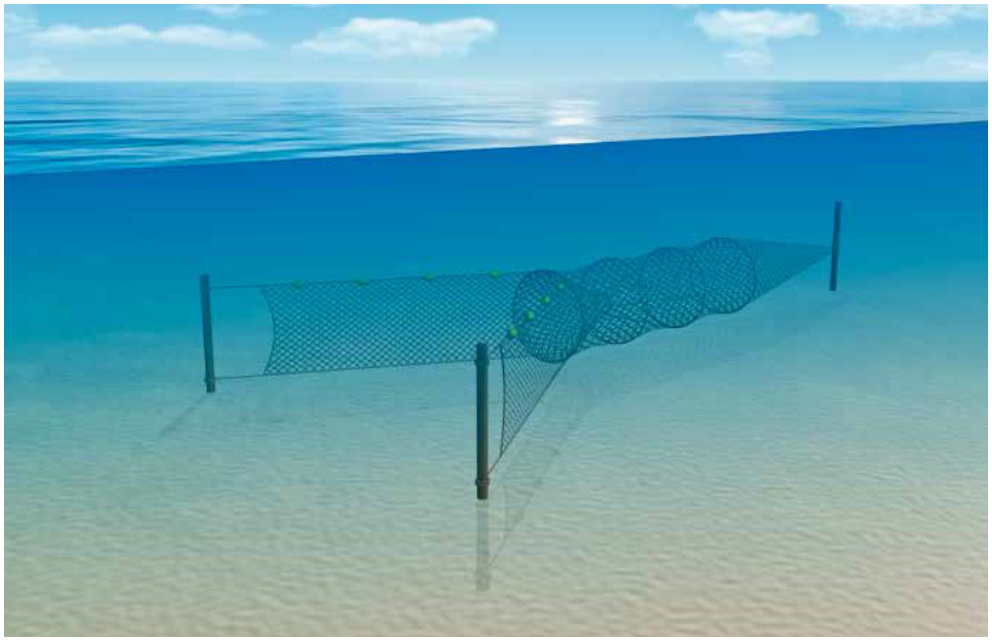
8.3 FYKE NETS

A fyke net is a rectangular, cylindrical or semi-cylindrical net mounted on rings or hoops, usually with wings and/or a leader, and fixed to the substrate with anchors, weights or stakes.

Fyke nets often incorporate multiple non-return devices in the design to prevent fish from escaping (Figure 45). Fyke nets are usually fished in shallow nearshore waters or in estuaries, rivers or lakes. Fyke nets may be used separately or in groups.

Fyke nets should not be confused with large-scale pound nets (FPN 08.1), especially the recently developed pontoon traps in the Baltic. Fyke nets are usually much smaller in size, and can be carried to different locations if desired, while pound nets are much larger and typically set for at least a season.

FIGURE 45
A fyke net (FYK 08.3)



Source: Seafish, 2021.

8.4 STOW NETS

A stow net is a cone- or pyramid-shaped net with the opening formed by a frame and set in an area with strong currents or large tidal flows to catch fish that drift into it.

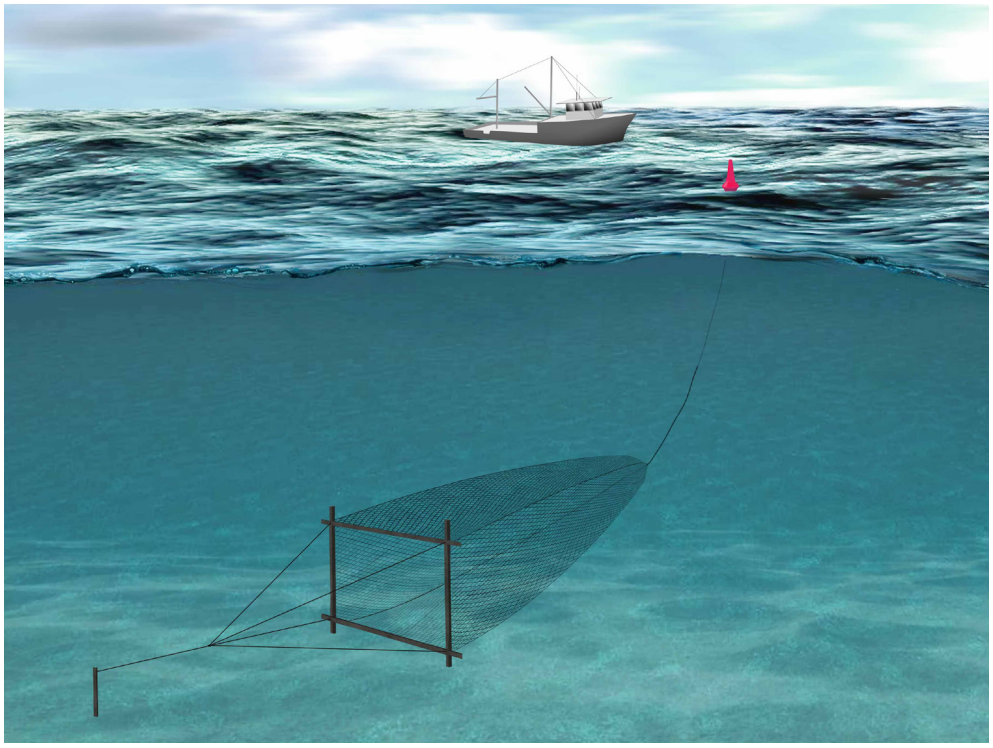
Stow nets may also use two or more beams, or sometimes spreading canvas and floats to maintain the opening in the front, but a rectangular frame as shown in Figure 44 is most typical. They are fixed by means of one or more anchors or stakes but may also be tied to an anchored boat. They are usually deployed in areas of strong currents, with their orientation determined by the direction of the current so as to catch fish that drift into the net with the current. Some stow nets are anchored to one point on the seabed and turn with the tide so that the mouth of the net is always facing the current, as shown in Figure 46. Several stow nets may be connected together. The gear can be used in rivers, estuaries or in the open sea.

Stow nets (*zhang wang* in Chinese) are widely used along the entire coast of China. In *China Atlas of Marine Fishing Gears* (Feng *et al*., 1987), 39 types of stow nets were described in detail, illustrating the variety, extent and importance of the gear for catching different species in China.

Some stow nets may have a similar shape and structure to a drive-in net (MDR 10.7). The main difference between the two is that a stow net catches fish when the fish drift into the net with the current, while the fish are "driven" into a drive-in net by swimmers, boats or noise.

Boat-mounted stow nets may be confused with skimmer trawls, which are classified as a beam trawl (TBB 03.11). Boat-mounted stow nets are held by an anchored boat, while skimmer trawls are carried forward by a steaming boat.

FIGURE 46
A stow net (FSN 08.4) with one anchoring point.
This style of anchoring allows the net to turn with the tide, thus always facing the current



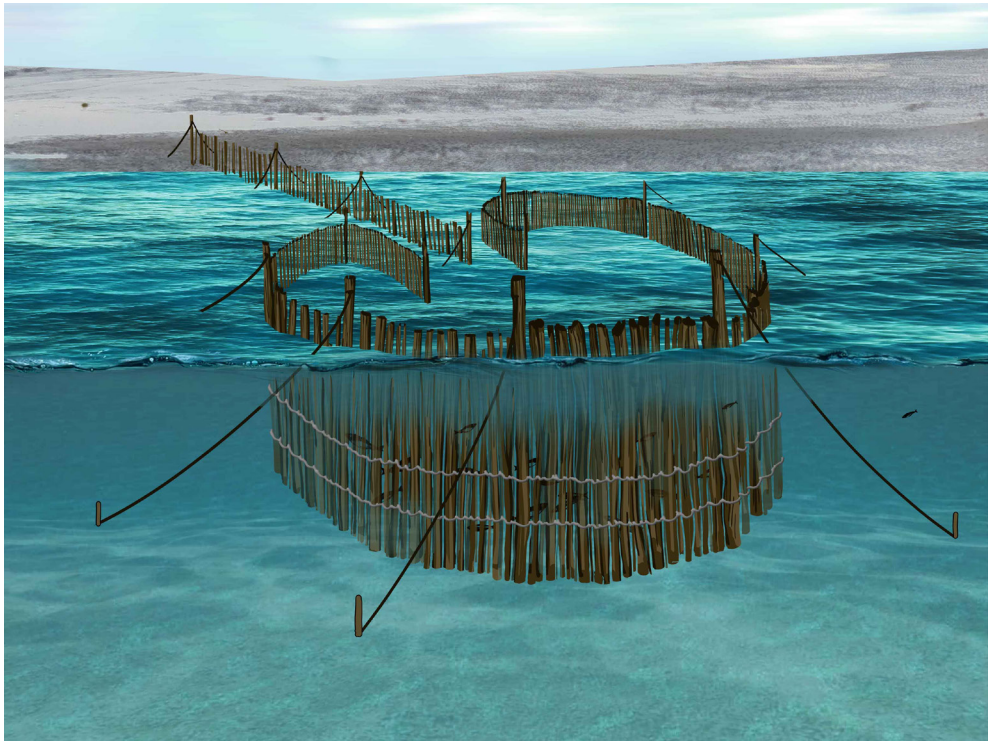
8.5 BARRIERS, FENCES AND WEIRS

Barriers, fences, and weirs are permanent or semi-permanent structures that entrap fish on a similar principle to pound nets.

These gears may be one of the oldest gear types and come in numerous forms. They are fixed to the substrate through stakes, branches, reeds, or stones, usually in tidal waters and generally have a narrow slit (doorway) leading to an enclosed holding chamber or chambers. From the doorway, a wall of fences (leader) often extends to the shoreline to guide the fish to the doorway.

Weirs are usually made from sticks, piles and netting, and can sometimes be confused with pound nets that also use piles and netting. The difference may be in the location they are used – weirs are usually installed in tidal waters, while pound nets are often deployed in deeper coastal waters. Traditional names of the gear in different localities may dictate the way they are referred to. Figure 47 illustrates a herring weir in Eastern Canada.

FIGURE 47
A weir (FWR 08.5) used for catching Atlantic herring (*Clupea harengus*) in coastal waters in Nova Scotia, Canada



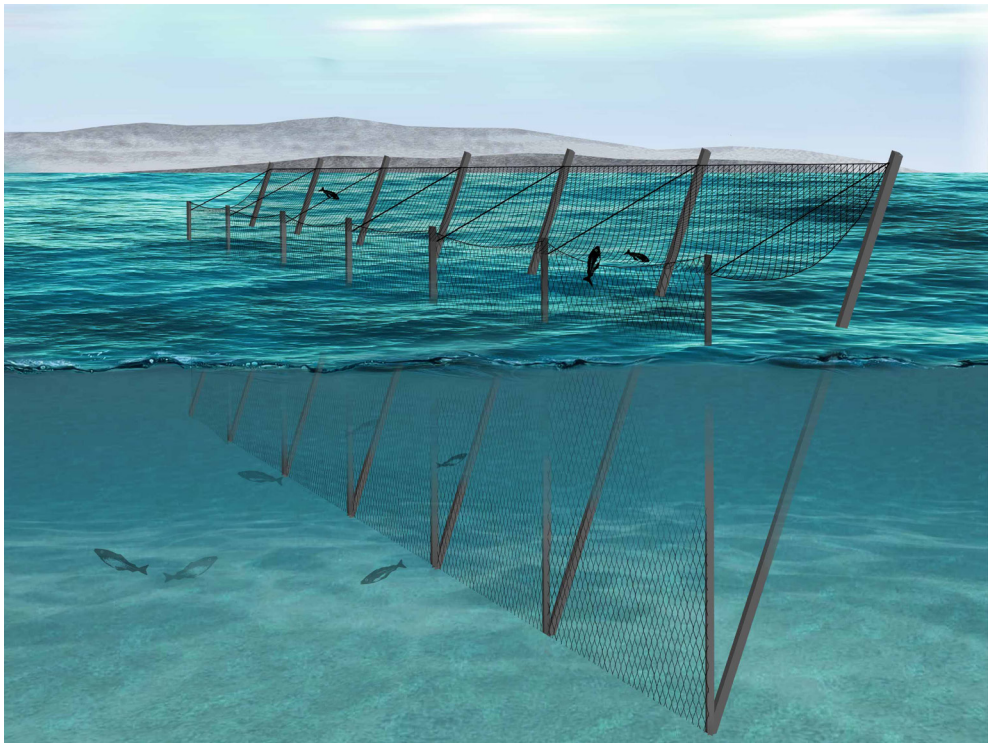
8.6 AERIAL TRAPS

Aerial traps are devices or structures that retain fish that have jumped out of the water.

When fish try to overcome a blocking net, a dam or a waterfall in rivers, they may jump and accidentally land in a net or any other device set for that purpose. The trap may be in the form of boxes, hoop nets, rafts, boats and nets ("veranda nets"). Fish are sometimes frightened by noise or light and induced to jump out of the water. Figure 48 illustrates an aerial trap (veranda net) installed in coastal waters or rivers in the Mediterranean area to catch fish jumping over the vertical blocking net (Gabriel *et al.*, 2005). The net may be in a straight line or in spiral shapes to trap the fish so that they are forced to jump. Regardless of the shape of the device that eventually retains the fish, if a fish is out of the water (in the air) when caught, the device is classified as an aerial trap.

FIGURE 48

Veranda net, a type of aerial trap (FAR 08.6) installed in coastal waters to catch jumping fish



9. Hooks and lines

Hook-and-line gears are those that use hooks (including jigs) and lines to catch fish.

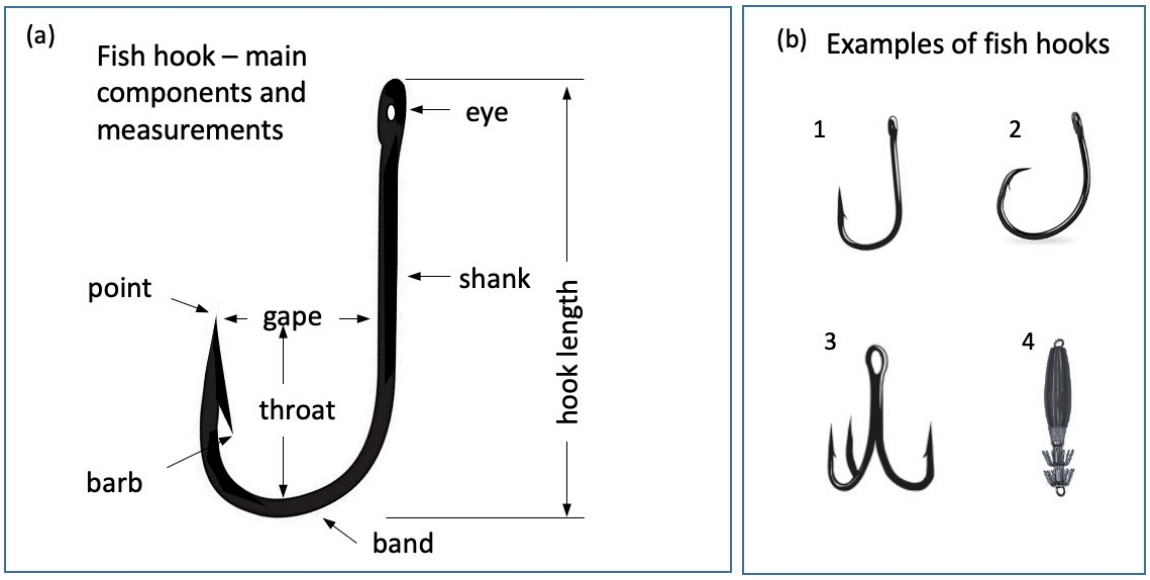
Hook-and-line gears catch fish by the mouth with baited hooks, or by penetrating their flesh (impaling, ripping or tearing) with unbaited hooks when they pass within the range of movement of the hook. Bait can include natural bait fish such as mackerel, herring and squid, or artificial lures such as rubber, plastic or feather.

Hook-and-line gears may be used with one hook or with a large number of hooks. They may be tended by a fisher or with a machine or may be left untended. For untended gears, they may be set on or near the bottom with anchors or weights, near the surface or in midwater drifting with the currents.

The hook is the most important element in the hook-and-line gear. To a large extent, the hook determines the success of capture. In the past, hooks were made of shells, animal bones, stone, wood, bamboo and metal. Today, most hooks are made from high-carbon steel, steel alloyed with vanadium, or stainless steel, depending on their application. Many hooks are covered with some form of corrosion-resistant surface coating.

Hooks may be barbed or barbless. Barbless hooks are used to reduce injury to the fish when hooked and to facilitate the easy release of the fish from the hook. The design of a fishhook is often tailored to the morphology of the fish's mouth and its behaviour, and/or the fishing technique (manual or automated), which results in a wide array of shapes and sizes (Figure 49).

FIGURE 49
Terms used to describe a hook (a) and examples of different types of hook (b)
1. J-hook, 2. circle hook, 3. treble hook, 4. squid jig



9.1 HANDLINES AND HAND-OPERATED POLE-AND-LINES

Handlines and hand-operated pole-and-lines include all hook-and-line gears that are operated and/or tended by a fisher.

Handlines and hand-operated pole-and-lines may be operated from the shore, on ice, or from a boat, either with hook(s) attached to a line or with an additional pole.

Handlining is carried out with one or more baited (natural or artificial) hooks attached to a single line. Fish must take the bait to be captured. The hand-operated jigging line is a type of handline which does not use natural bait but is operated with a fish-shaped lure. The most important characteristic of jigging is that the jigs are moved in a certain pattern to attract and hook the fish. During jigging, the fish may be caught by the mouth or on their body. Manual hand reels are also used to reduce manual labour when fishing in deep waters.

Hand-operated pole-and-lines use similar lines and hooks, and a pole; and usually a reel is used to help manoeuvre and retrieve the line. The pole assists the fisher to cast the hook a greater distance, which is especially important when fishing from the shore. Reels help retrieve the line so that they do not become entangled.

Pole-and-lines are the most important recreational fishing gears operated in most riverine, lacustrine and estuarine waters, but they are also important commercial fishing gears. One important commercial pole-and-line fishing practice is the tuna pole-and-line fishing in tropical waters, especially for skipjack tuna (*Katsuwonus pelamis*). Skipjack pole-and-line fishing may use live bait (chum), enhanced with water spray to induce an elevated feeding response (Ben Yami, 1980; Gillet, 2006). In this fishery, barbless hooks with or without feather lures are fished from the deck of the vessel, as illustrated in Figure 50. Live baitfish are typically captured by a boat-operated lift net (LNB 05.2), especially the Japanese-style stick-held lift net (*bouke ami*) in coastal waters the night before (Lewis, 1990). Purse seines are also used for catching live baitfish, which may be held in cages for days before they are used with pole-and-lines. The success of tuna pole-and-line fishing is largely dependent on the availability and sustainability of baitfish (IPNLF, 2012).

When handlines or pole-and-lines are towed behind a boat, whether with or without a pole, they become trolling lines (LTL 09.5).

FIGURE 50

Hand-operated pole-and-lines (LHP 09.1) fishing for skipjack tuna (*Katsuwonus pelamis*) with live bait chum and water jets. Water jets come from the stern of the boat (underneath the fishers)

9.2 MECHANIZED LINES AND POLE-AND-LINES

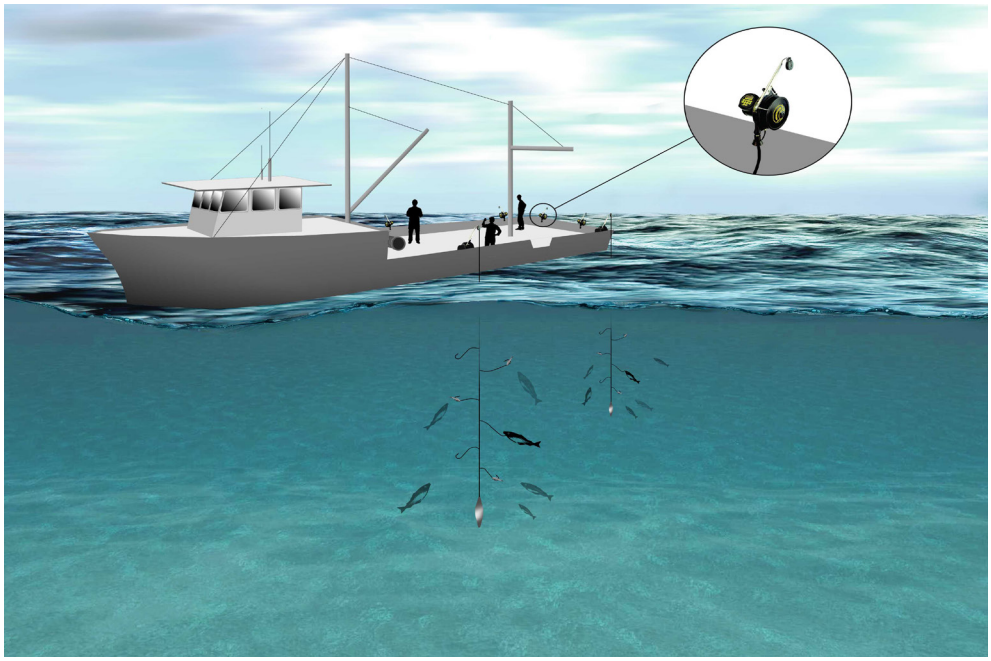
Mechanized lines and pole-and-lines are hook-and-line gears that are actively operated mechanically using powered reels or drums, either with hook(s) attached to a line, or with an additional pole.

Hooks with lines or pole-and-lines may be mechanized, with the movement (depth of set, type of retrieval action and speed) of the line or the pole being automated, in addition to automatic retrieval when a tension sensor detects fish being caught (Figure 51). Likewise, mechanical controls are also applied to jigging, especially for offshore squid jigging that utilize automatic jigging machines and light attraction. Mechanized lines and pole-and-lines are usually used on a boat, and several units may be tended by each fisher.

Automatic (mechanized) squid jigging which started around 1960s in Japan is now popular around the world (FAO, 1992; Arkhipkin *et al.*, 2015). Squid jigging vessels use lights to attract squid to shallower depths at night to facilitate jigging. Some large squid jigging vessels can operate 50 jigging machines, each with up to 50 jigs. Light power used in these vessels can reach 300 kW (Arkhipkin *et al.*, 2015). China is one of the main countries that has engaged in squid jigging in offshore waters in recent years, with about 400 offshore vessels landing about 300 000 tonnes of squid in the early 2000s (Chen *et al.*, 2008).

There are concerns about using an excessive amount of power for lights during jigging. In the last decade, more and more energy-efficient light-emitting diode (LED) lights have been used instead of or in combination with metal halogen lights (Matsushita *et al.*, 2012).

FIGURE 51
Mechanized lines (LHM 09.2) fishing from a boat



9.3 LONGLINES

A longline is a type of hook-and-line gear where hooks are connected to branch lines which are then attached to a long horizontal mainline at certain intervals.

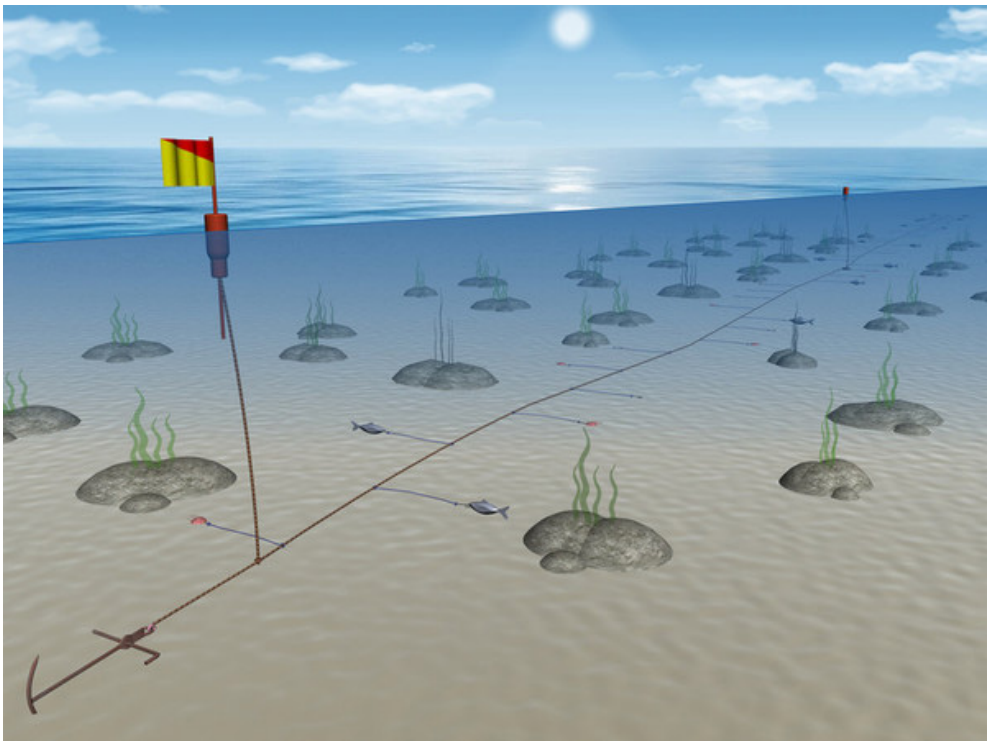
Longlines are usually baited and set in open water untended for a period of time. The number of hooks and the length of the mainline depend on the scale of the operation and the area of fishing grounds, ranging from a few hundred metres in coastal set longlines to more than 80 km in large-scale drift (pelagic) longlines. The basic longline gear units include the mainline, the branch line snood (or branch line or gangion), the hook and the bait. Hooks and branch lines can be attached to the mainline through conventional knots or through the use of mechanical crimps or clamps, which often incorporate swivels.

Longlines may be hauled by hand or by powered reels or drums. The baiting of hooks may be done manually or by a machine. Bjordal and Løkkeborg (1996) provided a comprehensive description and in-depth analysis of world longlining technology and fisheries.

Major conservation issues for longlines include the unintended catch of endangered, threatened and protected fish and other animals, including sea turtles and seabirds (Watson and Kerstetter, 2006; Gilman *et al.*, 2006; Løkkeborg *et al.*, 2010; Anderson *et al.*, 2011). Mitigation measures for reducing seabird catch in longline fisheries include bird-scaring lines (tori lines), weighted snoods, hook pods and night setting (Løkkeborg, 2008; Melvin *et al.*, 2014). Mitigation measures for reducing sea turtle catch in longlines include the type and colour of bait, the type of hook, and the setting depth (Gilman *et al.*, 2006; Swimmer *et al.*, 2017). In 2009, as a part of its Technical Guidelines for Responsible Fisheries series, FAO published *Best practices to reduce incidental catch of seabirds in longline fisheries* (FAO, 2009); the Organization has also developed guidelines for reducing sea turtle mortality in fishing operations (FAO, 2010).

FIGURE 52

A fleet of set longlines (LLS 09.31) deployed on the bottom for catching demersal fish



Source: Seafish, 2021.

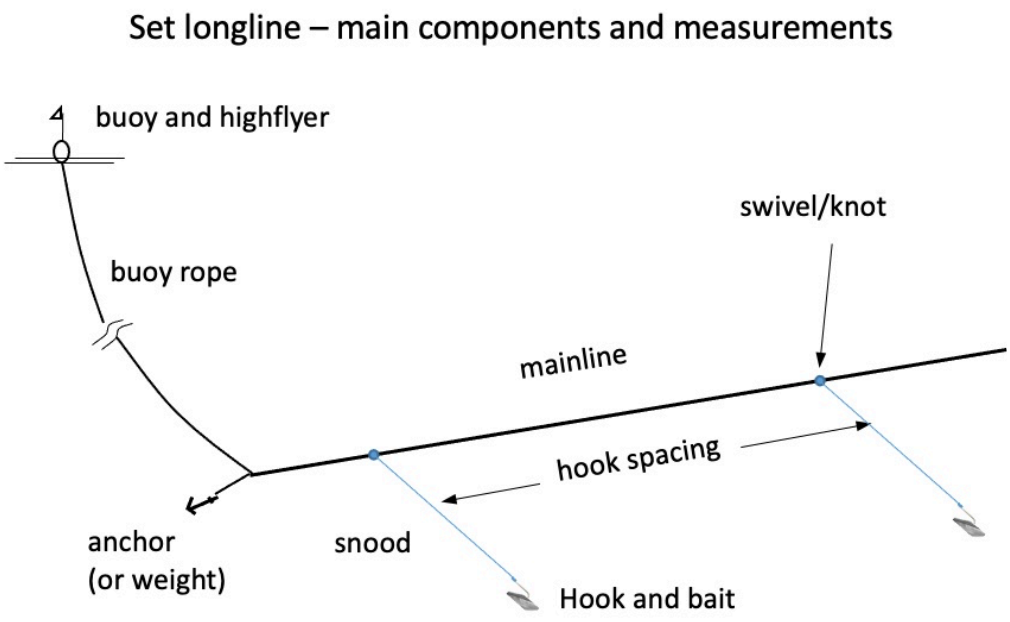
9.3.1 Set longlines

A set longline is a longline gear that is anchored or otherwise fixed to the seabed at either end of the mainline.

Set longlines usually fish on or near the bottom; they are therefore also called bottom longlines or demersal longlines in the literature (Figure 52). However, set longlines can also have the mainline and hooks off bottom, or near the surface in shallow waters. A typical set longline includes a mainline either lying on the seabed or floating off the seabed, snoods (with a hook and bait) attached to the mainline at regular intervals (usually 1–2 m), an anchor or weight at either end of the string of the longline, and a buoy line coming up to the surface where a marker indicates location and facilitates hauling (Figure 53).

The set longline is the main type of longline that catches a variety of bottom-dwelling species all over the world. In the north Atlantic, many bottom-dwelling species such as Atlantic cod, Atlantic halibut, haddock, tusk and ling are caught by set longlines. In east and southeast Asia, longlines are often used to target snappers, groupers, tilefish and conger eels. In southern oceans, longlines are used for catching Patagonian toothfish.

FIGURE 53
Basic components of a set longline (LLS 09.31)

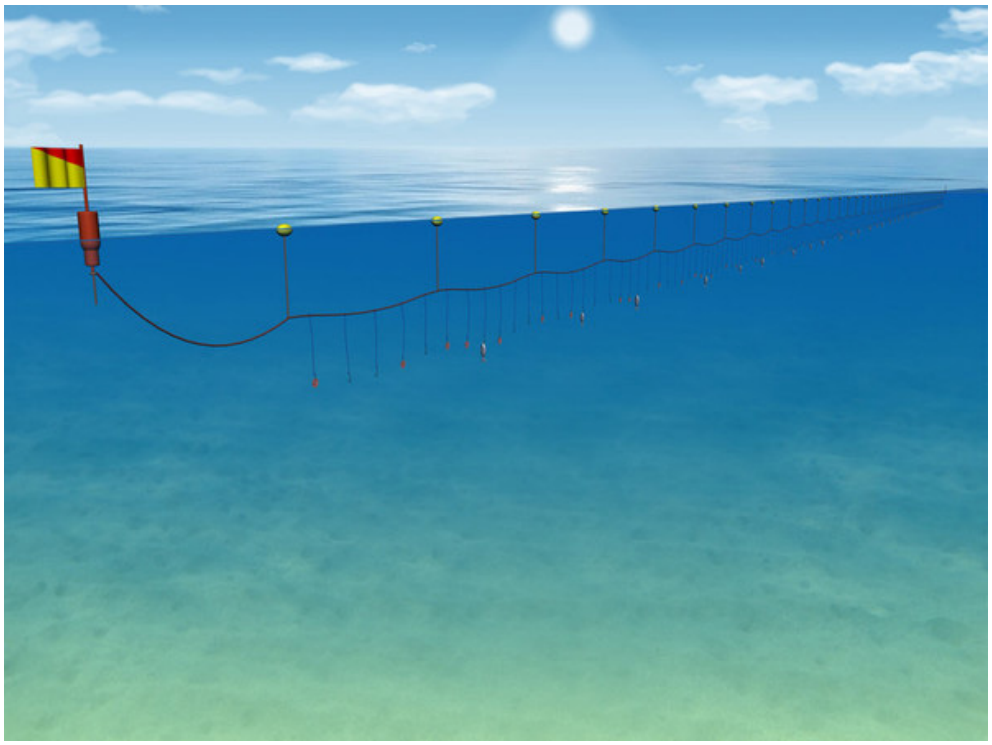


9.3.2 Drifting longlines

A drifting longline is a type of longline that is not fixed to the seabed and drifts passively with the current, usually with the boat (also drifting) attached at one end of the longline.

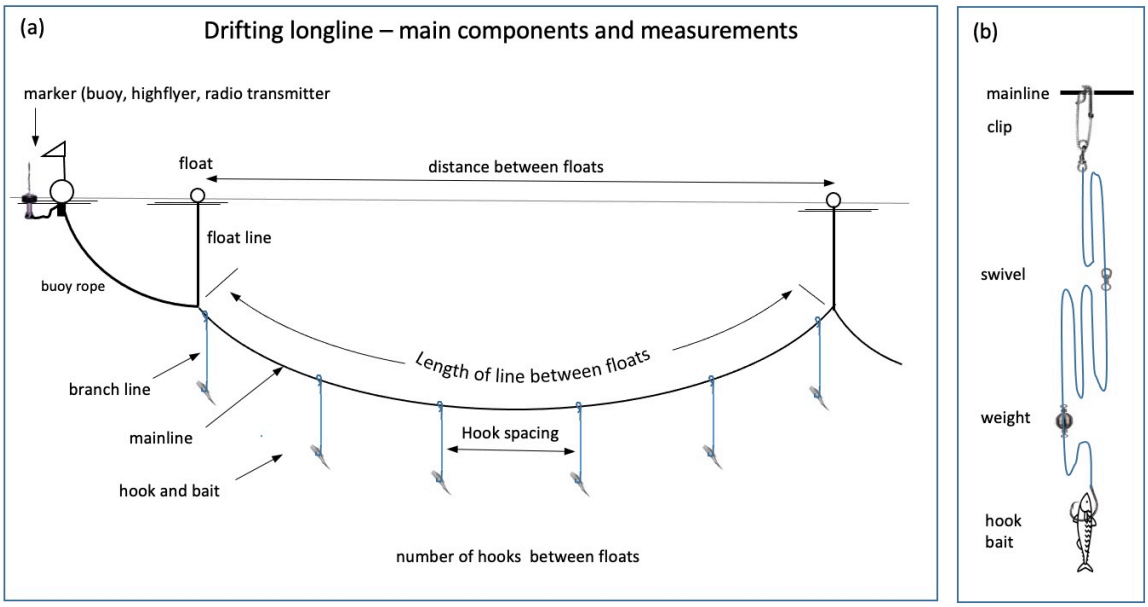
Drifting longlines usually fish near the surface or in the water column; therefore, they are also known as pelagic longlines (Figure 54) and are often fished in offshore waters. They target pelagic species such as billfishes and tuna, and other large pelagic species. The depth where fish reside may be species-specific, and changes diurnally, as well as with environmental conditions such as temperature. The depth of the hooks therefore influences catch rates and species composition and is controlled in a number of ways including: the length of line between floats, the length of float line, the length of branch line, and the depth of mainline catenary (determined by the length of mainline relative to the distance between the nearest floats). Branch lines in drifting longlines are often more than 10 m long, and may include a clip, one or more swivels and a weight (Figure 55). In large-scale operations in open oceans and archipelagic seas, radio or satellite buoys are often used at intervals along the mainline to monitor the position of the gear (Bjordal and Løkkeborg, 1996; Watson and Kerstetter, 2006).

FIGURE 54
A fleet of drifting longlines (LLD 09.32) set near the surface



Source: Seafish, 2021.

FIGURE 55
Basic components and terms used to describe a drifting longline (LLD 09.32)



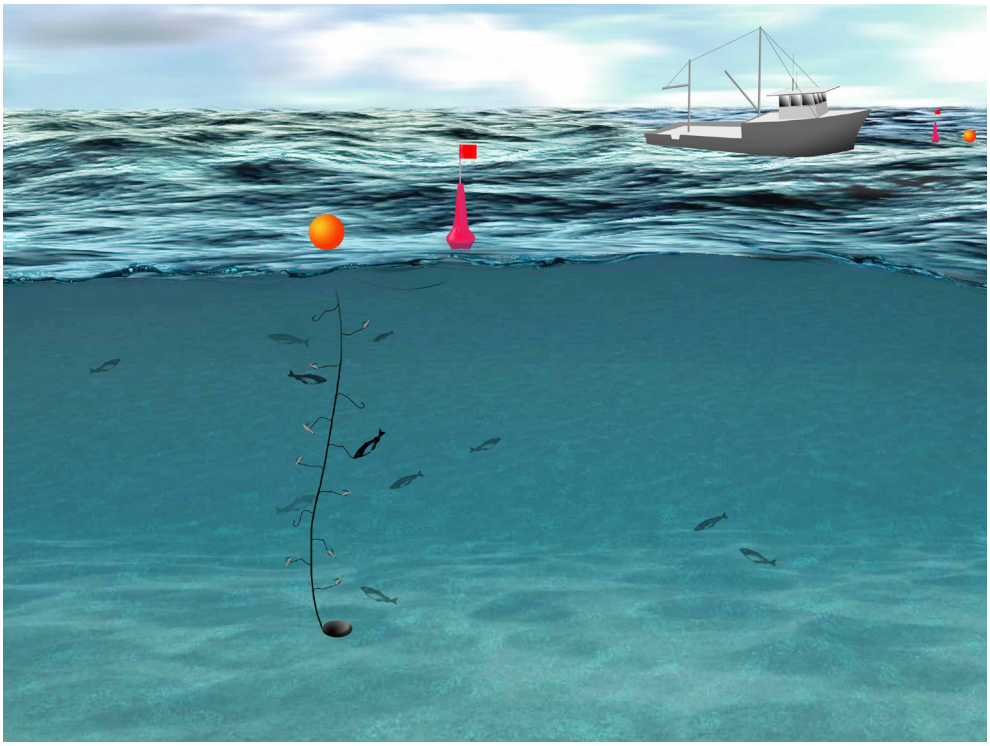
9.4 VERTICAL LINES

A vertical line is a line set vertically with one or more baited hooks attached.

Vertical lines are also called drop lines or buoy gears. A buoy is usually attached to the line at the surface to indicate position, but the line can also be attached to the boat. A weight is attached to the bottom end of the line. The weight can be on the seabed to secure the position of the line, as shown in Figure 56, or rigged to drift in the water without attaching to the seabed. In the latter case, a conspicuous highflyer with a radar reflector or a radio beacon is attached to the surface buoy to facilitate relocating the gear. Swivels are usually used for attaching branch lines to the mainline. Several lines are often deployed in a small, concentrated area such as a sea mount, or around an FAD (Preston *et al.* 1998). The lines may be operated manually or mechanically using powered reels or drums. Several vertical lines may be attached to a horizontal line to keep the lines together. Preston *et al.* (1998) provides a comprehensive manual on the gear and the operational methods of vertical lines, with a particular focus on their use in the Pacific Islands.

FIGURE 56

A vertical line (LVT 09.4) set in coastal waters fishing from the surface to the bottom

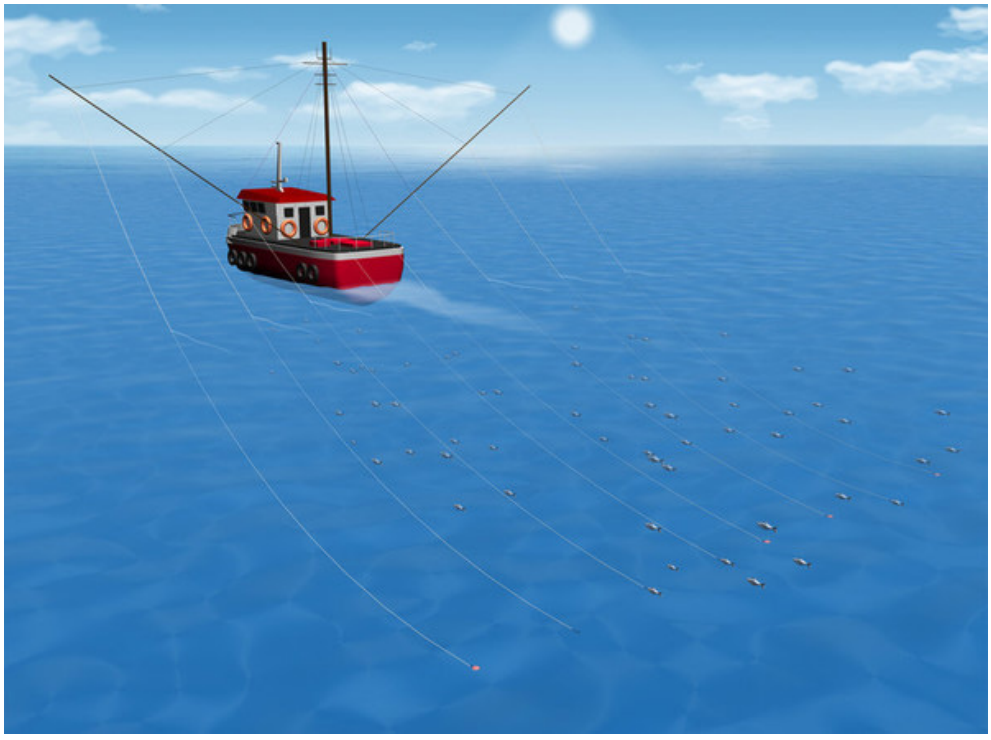


9.5 TROLLING LINES

A trolling line is a line with one or more baited hooks (or lures) towed behind a boat.

The boat may tow many lines, often from outriggers (Figure 57) or a single line hand-tended by a small crew in a dinghy (Preston *et. al*., 1987). The lines may be near the surface or some distance below the surface depending on where in the water column the fish aggregate, which can be adjusted by the amount of weight on each line, the length of the line and the towing speed. Outrigger poles extending from the sides of the boat may be used to increase the number of lines that can be trolled simultaneously. The towing (or trolling) speed depends on the target species. The handling of trolling lines, including the removal of fish from the hooks, may be done manually or automatically with mechanized systems. Preston *et al*. (1987) provides a comprehensive manual on the gear and operational methods of trolling lines, with a particular focus on their use in the Pacific Islands.

FIGURE 57
Trolling lines (LTL 09.5) towed behind a boat using outriggers



Source: Seafish, 2021.

10. Miscellaneous gear

Miscellaneous gears include all other gears not included in other categories. There are a variety of other gears in world fisheries, especially in small-scale and artisanal fisheries, in addition to those described in the nine main categories above.

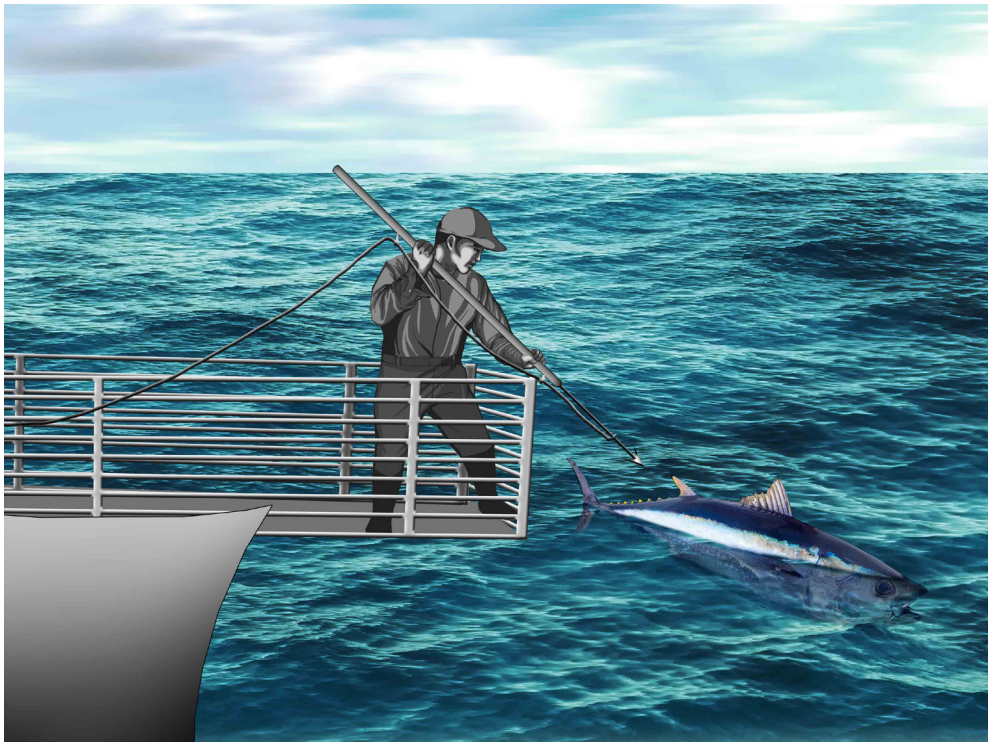
10.1 HARPOONS

A harpoon is a spear-like gear with a long shaft and a detachable sharp point that is secured by a line to retrieve the catch.

A harpoon may be pushed or thrown manually (Figure 58) or fired (shot) from a cannon or a gun. The point of the harpoon is designed to separate from the shaft when it penetrates an animal. The point may have one or more barbs to secure itself in the flesh of the animal. Barbs may be fixed or moveable (retractable).

Harpooning is a traditional method for catching large pelagic predatory fishes such as swordfish and tuna in Canada, Italy, Japan and the United States of America (Sakagawa, 1989; Decker, 2017). When a fisher spots a fish, the harpoon is manually thrust into the animal and hauled onboard. Harpooning is an environmentally responsible fishing method as fishers can visually identify the size and species of a targeted fish before killing it; this method therefore usually does not result in the bycatch of unwanted marine life. In Canada harpooning for swordfish (*Xiphias gladius*) occurs primarily along the edges of Georges and Browns Banks, and targets mainly the large female swordfish swimming in surface waters during the day.

FIGURE 58
A fisher holding a harpoon (HAR 10.1) from the bow of a vessel and ready to strike a bluefin tuna



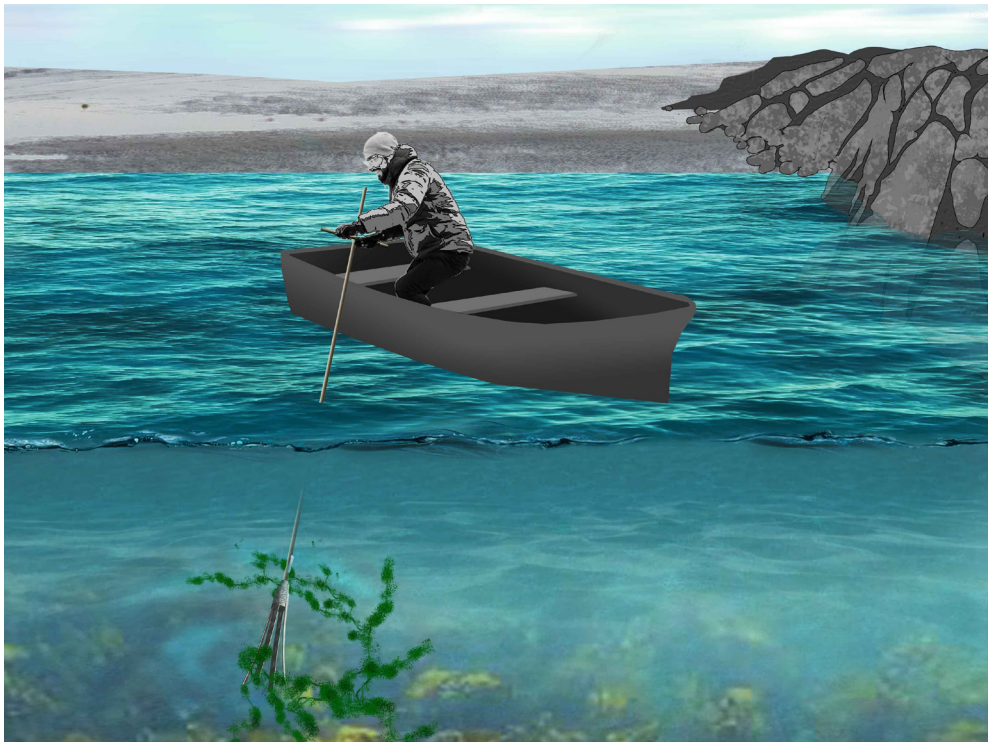
Harpooning was also a primary gear for whaling in the nineteenth and early twentieth century, until a moratorium on commercial whaling was called by the International Whaling Commission (IWC) in 1982.

10.2 HAND IMPLEMENTS (WRENCHING GEAR, CLAMPS, TONGS, RAKES, SPEARS)

Hand implements are gears that are operated by hand in shallow waters either from a boat or by wading in water. They are small-scale fishing gears often used recreationally or in subsistence fisheries. They include wrenching gear, clamps, tongs, rakes, and spears among others.

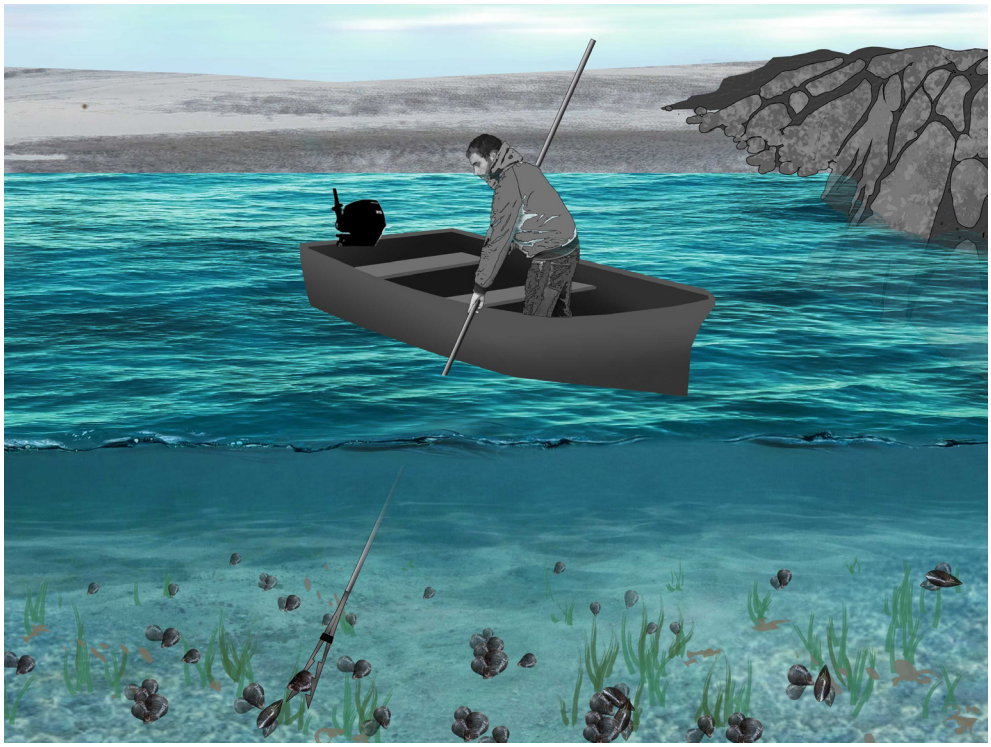
Wrenching gear. A wrenching gear (Figure 59) is used for harvesting sessile seaweeds, either by divers, by wading or by operation from a boat in very shallow waters. The fishers twist the gear to entangle seaweed so that they can be harvested.

FIGURE 59
Hand implements (MHI 10.2) – wrenching gear harvesting seaweed



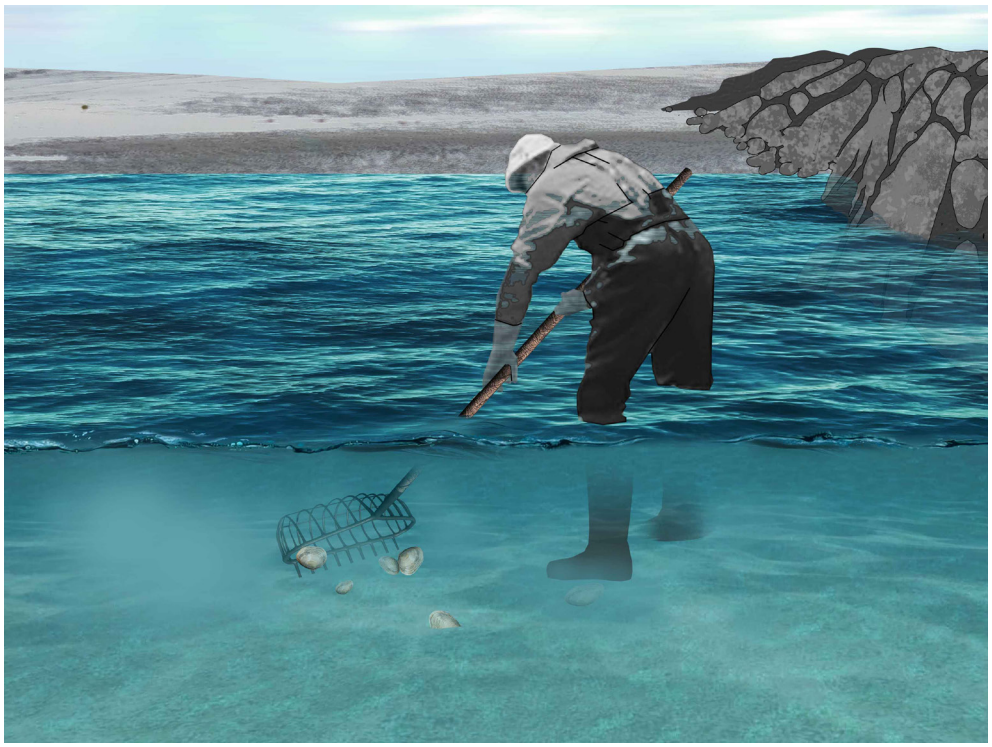
Clamp. A clamp is a form of grappling or wounding gear comprised of a hand-operated stick split at one end to form at least two prongs (often three). When a target such as a trochus or shell is sighted, the operator pushes the gear so that the prongs clamp the animal between them (Figure 60). To provide more grip on the prey, barbs may be built into the clamping branches. Tension in the prongs is maintained by tightly wrapping the section where the prongs split from the main branch with twine or rubber bands. Clamps are well known in many parts of the world, especially for taking shellfish out of the water without damage. Clamps can also be used for catching fish. In this case stronger implements made of steel or iron, similar to multi-pointed spears, are used and the fish is usually damaged in the process.

FIGURE 60
Hand implements (MHI 10.2) – clamp harvesting mussels



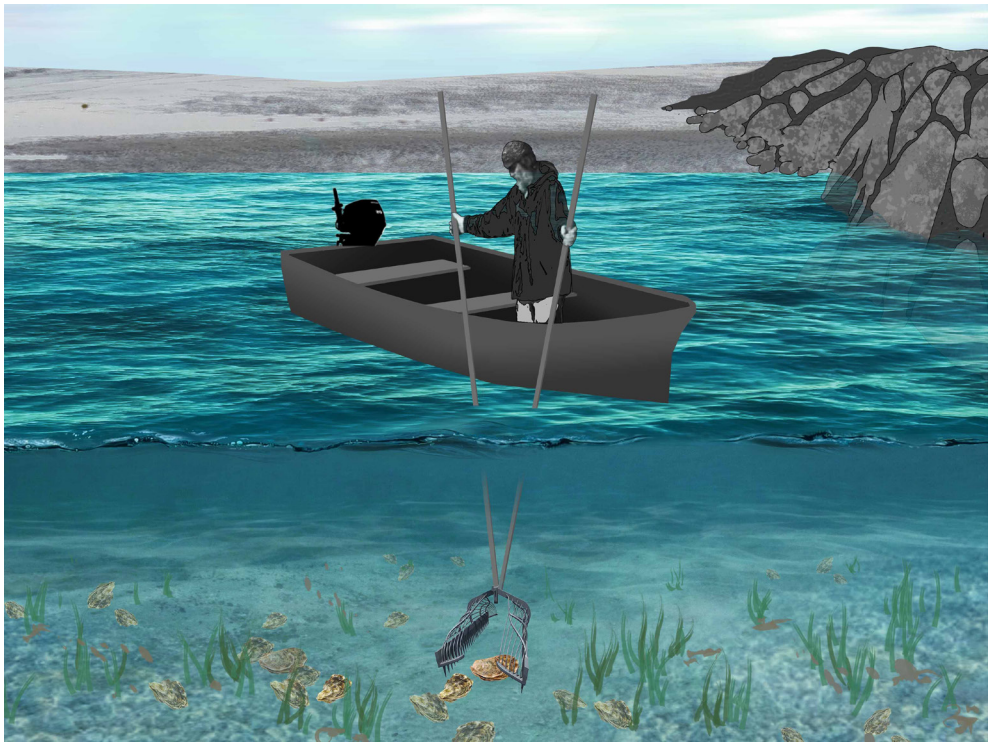
Rakes. Rakes are used to dig out infaunal animals such as clams that are hidden underneath the surface of the seabed (Figure 61). To help collect the catch, the teeth of a rake may be bent, or a wire-mesh or netting collection bag may be attached to the rake. The main difference between a rake and a hand dredge (DRH 04.2) is that a hand dredge usually has a bag, and is often "dragged" steadily, while a rake does not usually have a bag.

FIGURE 61
Hand implements (MHI 10.2) – rakes harvesting clams



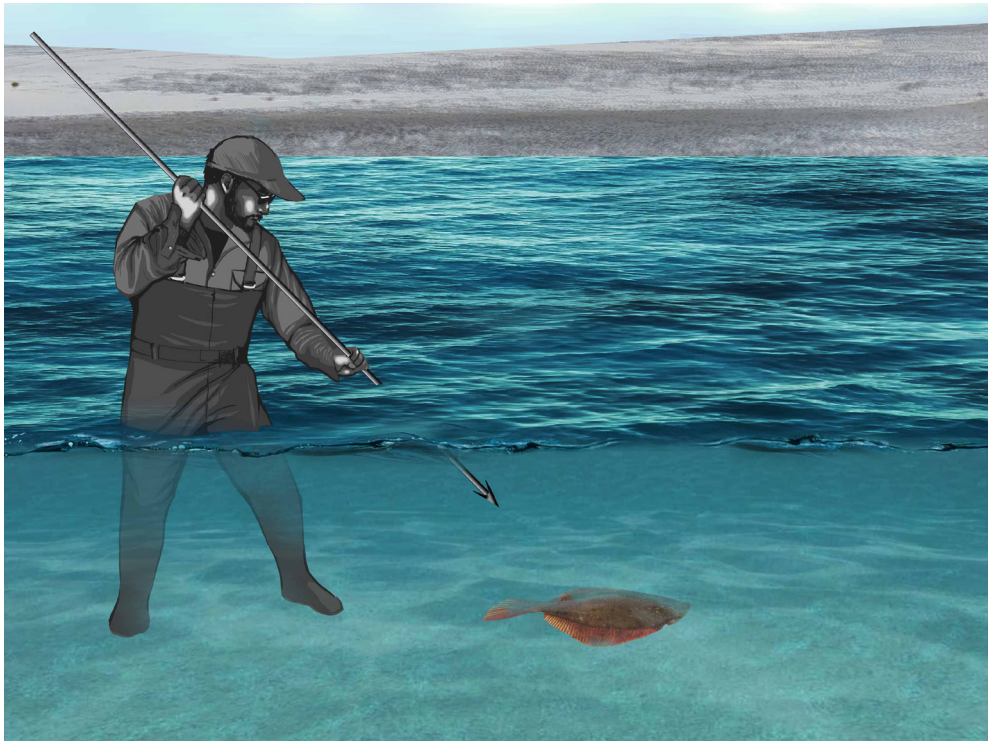
Tongs. Tongs consist of a pair of rakes or rake-like baskets attached to two long handles joined together like scissors (Figure 62). They are mainly used for collecting infaunal and epifaunal animals such as mussels, clams and oysters.

FIGURE 62
Hand implements (MHI 10.2) – tongs harvesting oysters



Spears are pointed tools with a handle that are used to harvesting an animal by piercing (Figure 63). They can range from simple pointed bamboo or wood sticks to more complicated multipronged metal spears. Spears are usually thrown or forced by hands, and can be used from the shore, on-board or by divers. The major difference between a spear and a harpoon is that the metal tip of the harpoon is usually detached from the handle and a line tied to the tip secures the fish to the boat.

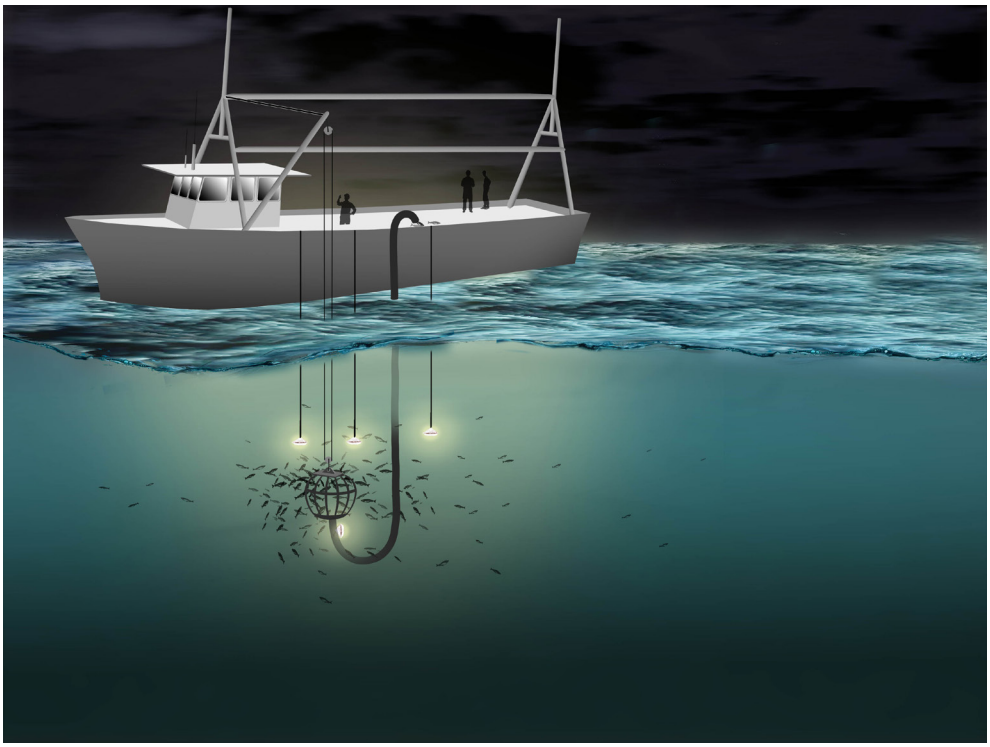
FIGURE 63
Hand implements (MHI 10.2) – spear piercing a fish



10.3 PUMPS

A submersible pump may be used to harvest dense concentrations of fish, usually small pelagic species. In most instances this gear is used at night and the fish are attracted and concentrated by the use of artificial lights (Figure 64) or other means. Pumps for harvesting fish and other animals directly should not be confused with the pumps used to land fish that have already been caught by, for example, purse seines, in which case the pump is used as auxiliary equipment.

FIGURE 64
A pump (MEM 10.3) for harvesting small pelagic fish that are concentrated by light



10.4 ELECTRIC FISHING

Electric fishing uses intermittent electric pulses to stun the fish or otherwise modify its behaviour (e.g. by involuntary muscle contraction) so that it becomes more vulnerable to capture. Once stunned, auxiliary gears such as scoopnets are used to collect the fish. In this case, the catch is attributed to electric fishing, not to scoopnets. Electrical fishing is more commonly used in a freshwater environment, especially in small and shallow waters such as creeks and ponds (Figure 65). It is a common tool for fish sampling for biological research and resource surveys. Electric fishing should not be confused with some gears such as beam trawls that use electric pulses to enhance the capture of certain target species such as shrimps and flounders. In this case, the landing is attributed to the main gear (e.g. beam trawl), not to electric fishing.

FIGURE 65

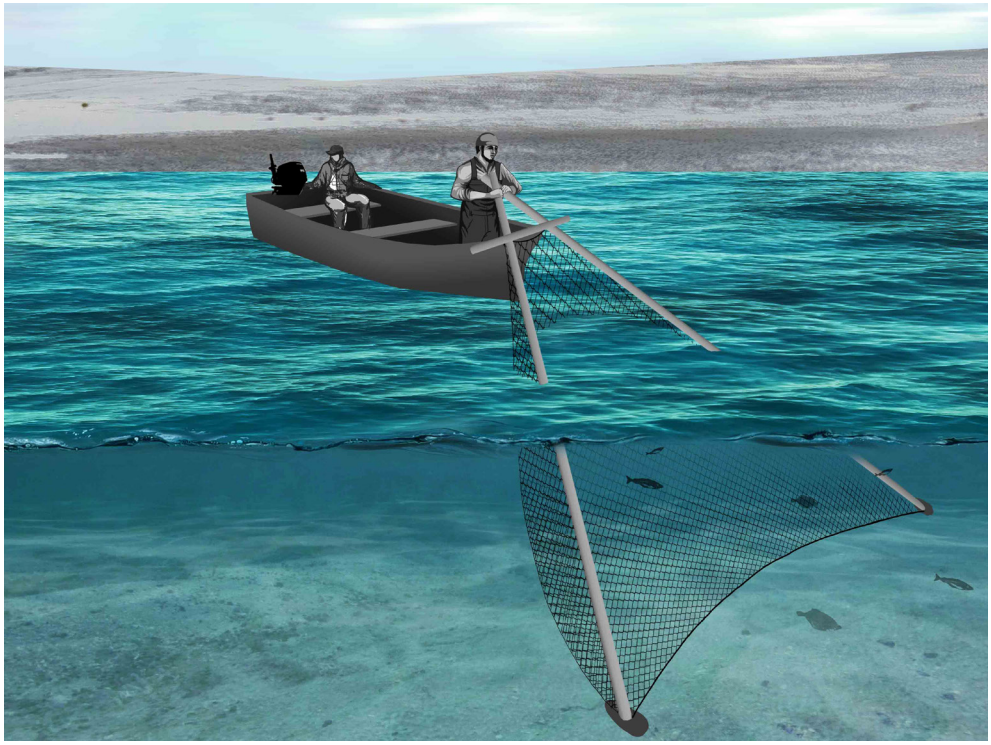
A fisher uses electric fishing equipment (MEL 10.4) for stunning fish in a freshwater stream. In his backpack is a pulse generator and battery

10.5 PUSHNETS

A pushnet is a bag-shaped net, with two sides fixed to scissor-like crossed poles and pushed by a fisher wading in water or from a boat in shallow waters (Figure 66). In the past the poles have been made from bamboo and wood, but plastic, aluminium or steel poles are now common. To help the net glide smoothly over the seabed, shoes or runners may be used at the end of the poles.

Motorized pushnet fishery has been developed in many southeast Asian countries, especially in the Philippines and Thailand (Suuronen *et al*., 2020). The gear is used to catch many species in shallow waters, especially shrimp, but larger boats with engines of up to 400 Hp can fish down to 20 m deep. The net is fixed on crossed poles to keep it open. The poles of small pushnet boats are 6–15 m long but large pushnet boats can use poles of up to 44 m. While most pushnet boats are relatively small (< 10 GT), some larger boats can be more than 60 tons. Although the gear is banned in Thailand there are still many pushnets in operation (Suuronen *et al*., 2020).

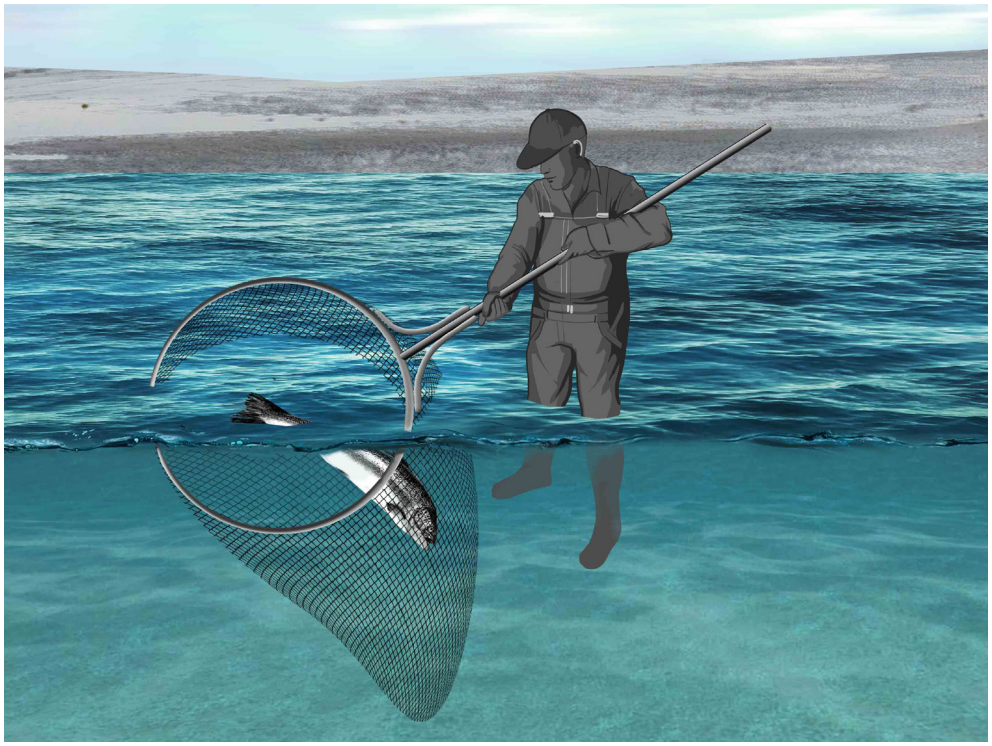
FIGURE 66
Pushnet (MPN 10.5) operated from a boat in shallow water



10.6 SCOOPNETS

A scoopnet is a small net bag used to scoop or sieve the catch from the water (Figure 67). The net is usually operated by hand, by one or more people. The net may be held open by a metal, plastic or wooden frame, with or without handles. Scoopnets may be operated by wading in shallow water, from rocks in a river or from a boat.

FIGURE 67
Scoopnet (MSP 10.6) operated by hand in shallow water



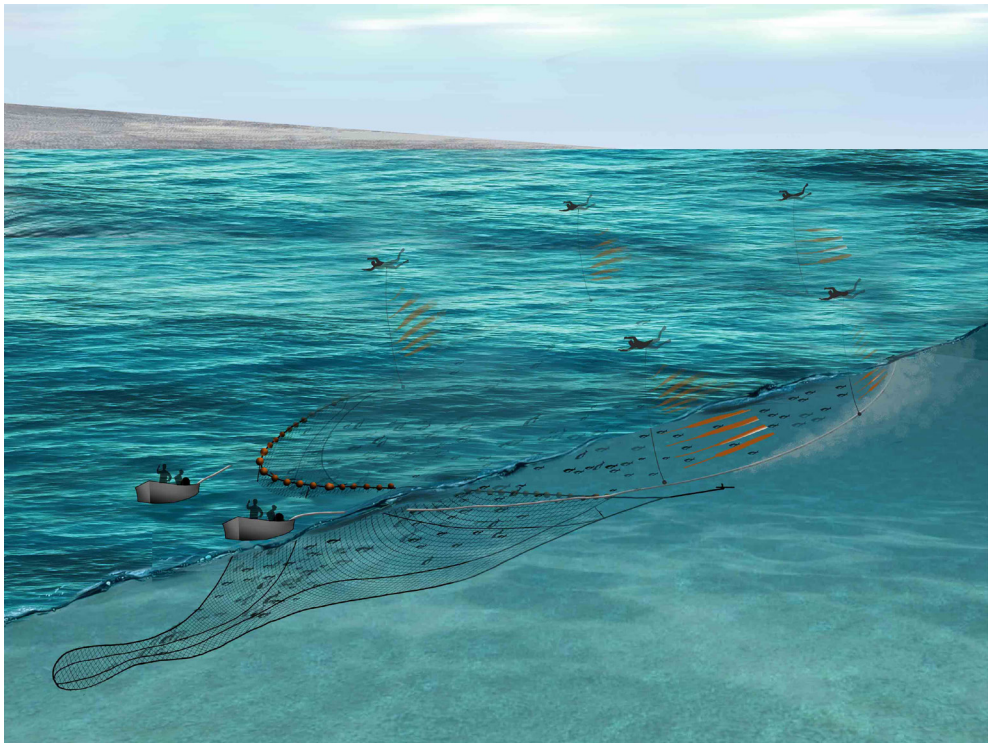
10.7 DRIVE-IN NETS

Drive-in nets are cone-shaped nets, usually with wings that catch and retain fish driven into the net by noise or visual stimuli such as scaring lines (Figure 68). The net may be a simple rectangular section of netting which is set like a scoop, or a more complex shape like a trawl, with long wings and a bunt or codend. The net may be anchored or staked to the bottom or held in place by boats. Swimmers or small boats drive the fish towards the net using visual or acoustic stimuli. The net is pulled by hand in shallow water or with the support of boats in deeper water.

Drive-in nets have been used in coral reef areas where swimmers/divers drive fish from coral reefs to the net – the *Muro-ami* fishing method. *Muro-ami* fishing consists of a large stationary bag net set over a coral reef into which fish are driven by a group of swimmers. Commercial *Muro-ami* operations may use up to 200–300 swimmers to scare the fish. The use of children and teenagers for this method of fishing and the massive destruction of the reef caused by this method have prompted calls for this fishing method to be banned in the Philippines (Corpuz *et al.* 1983).

FIGURE 68

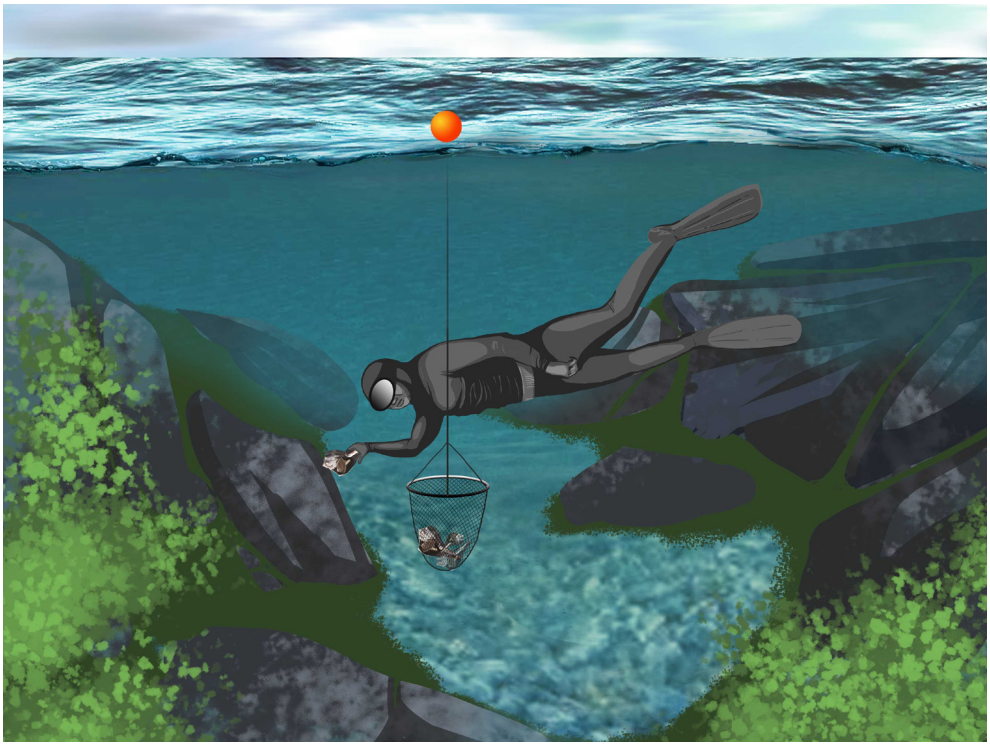
A drive-in net (MDR 10.7). Swimmers carrying streamers swim in formation to drive fish toward the net. The streamers are also attached to a rope on the seabed that is hauled gradually by fishers on the boats



10.8 DIVING

In a strict sense diving is not a fishing method but rather a way in which a fisher can get close to fish and other animals they wish to collect. If a diver collects fish (usually sedentary) by hand underwater (Figure 69) the landings should be reported as "Diving". If a diver uses other fishing implements such as a harpoon, tongs or net(s), the catch should be attributed to these gears rather than to diving. Diving can be free (with mask and snorkel) or assisted with scuba equipment, surface air delivery or other apparatus.

FIGURE 69
A diver collecting shellfish (MDV 10.8)



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Glossary

Anchored fish aggregating device (aFAD):	Device that is anchored or otherwise attached to the seabed and is used for attracting and concentrating fish for the purpose of capture by a fishing gear. Sea also drift fish aggregating device.
Beam:	In this report, beam refers to the horizontal pole used to spread the net horizontally in beam trawls.
Branch line:	Also known as snood, gangion, or leader. The line for attaching hook to the mainline in longlines. The term is often used in drift longlines for pelagic species such as tunas and swordfish.
Bridle:	In this report, bridle is referred to the rope that extend from the upper and lower wings of a trawl.
Bunt:	The small mesh part of a purse seine where the catch is accumulated before they are landed on board.
Bycatch reduction device (BRD):	Devices that is incorporated into design of a fishing gear, or added to a fishing gear for the primary purpose of reducing unwanted bycatch.
Clump weight:	The weight, usually chains, that is added to the lower wingend of a midwater trawl
Codend:	The terminal section of a fishing gear such as trawl or boat seine where the catch is accumulated before being landed on board.
Dhan (or Dhan buoy):	A marker used in Danish seine
Drifting fish aggregating device (dFAD):	Device that is neither anchored nor otherwise attached to the seabed and let adrift, and used for attracting and concentrating fish for the purpose of capture by a fishing gear. Sea also anchored fish aggregating device (aFAD).
Electronic transmitter:	In this report, electronic transmitter refers a device that actively or passively transmit a signal to indicate the location of the device, often a marker for a gear.
Fish aggerating device (FAD):	Device that is used for attracting and concentrating fish for the purpose of capture by a fishing gear. FADs can be anchored (aFAD) or let adrift (dFAD).

Fish chamber: In this report, fish chamber refers to the last section of an uncovered pound net where catch is accumulated before landed on board. It is also called bag net.

Floatrope: A rope that has built-in floatation. It is usually used as headrope of a gillnet.

Float line: The line where the top edge of a net and floats are attached. The term is more often used in gillnets and entangle nets. It is also called headline, headrope, or float rope.

Footrope: The rope to which the lower edge of a net and sinks are attached. In gillnets and entangling nets, footropes are often called sink rope, sink line, foot line or lead line as heavy lead or other weights are often attached to the rope. In trawls it is often called groundgear or groundrope.

Foot line: See footrope, but is limited in gillnets and entangling nets, not usually used in trawls and boat seines.

Gangion: Same as snood.

Groundgear: The component that is attached to the bottom edge of a trawl to withstand interaction with the seabed.

Groundrope: See groundgear.

Hanging ratio: The ratio of the rope to the stretched length of netting that is attached to the rope. When not specified, it often refer to horizontal hanging ratio (in T direction).

Headrope: The rope where the top edge of a net and floats are attached. In gillnets and entangling nets, headropes are often called float rope, float line. In trawls and boat seines, headrope is also called headline.

Headline: The line where the top edge of a net and floats are attached. In gillnets and entangling nets, headline is often called float line or float rope. In trawls and boat seines, headline is also called headrope.

Highflyer: Sometimes written as high flyer or hyflyer, is a type of marker that typically includes a buoy, a flag, a radar reflector, and a light if operated at night. Often used in fishing gears that are unattended, such as gillnets and entangle nets, set longlines and vertical lines, and pots, but also in Danish and Scottish seine for temporary marking or the other end of the gear.

Leader:	In uncovered pound nets and weirs, leader refers to the net or other structure that intercept, and guide fish into the main part of the net. In hook-and-line gears, it refers to the line that attach the hook to the mainline, which often called snood, gangion or branch line.
Leadrope:	The rope that has built-in leads and is used as footrope in a gillnet.
Mainline:	In set and drift longlines, it is the horizontal line to which snoods (branch lines) are attached. In vertical lines, it is the main vertical line to which snoods are connected.
Marker:	An identifier that allows for identification of owner and provides the position, nature and scale of the gear.
Mesh bar:	The length of twine between two adjacent knots in a mesh. It is one half of mesh size.
Mesh size:	The size of a mesh that is typically measured from the opposite knots in a mesh when fully stretched. When not specified, it usually refers to knot centre measurement.
Purse line:	The line that threads through purse rings to close the bottom of a purse seine when it is drawn.
Purse ring:	Metal or plastic rings attached to the lower edge of a purse seine to which the purse line is thread.
Otter board:	Sometimes spelt as otterboard and also called trawl door. It is a board or metal plate attached to each side of trawl net and keeps trawl open horizontally when it is towed over seabed or through water.
Snood:	A thin twine or monofilament line that attaches hook to the mainline in a longline or vertical line. It is also called gangion or branch line.
Sweep:	Usually refers to the rope that connect the wingend and the otter board in a trawl.
Trawl door:	See otter board (or otterboard).
Turtle excluder device (TED):	Grid device to exclude turtles from a trawl.
Warp:	The towing rope or wire that connect the trawl and the trawler. In otter trawls, the warp ends at the otter board. In pair trawls, it ends at wingend or at the joints of the bridles.
Wingend:	Also written as wing end. It is the terminal point of the wing of a trawl. It may refer to upper wingend or lower wingend.

Appendix 1

Coordinating Working Party on Fishery Statistics (CWP)
Handbook of Fishery Statistics
International Standard Classification of Fishing Gears (ISSCFG, 2016).
The relationship between the 2016 ISSCFG codes and those used in the previous classification (1980)

Gear categories	Standard abbreviations	ISSCFG code	
		Current (2016)	*Previous (1980)*
SURROUNDING NETS		01	01.0.0
Purse seines	PS	01.1	0..1.0
Surrounding nets without purse lines	LA	01.2	01.2.0
Surrounding nets (nei)	SUX	01.9	-
SEINE NETS		02	02.0.0
Beach seines	SB	02.1	0.2.1.0
Boat seines	SV	02.2	02.2.0
Seine nets (nei)	SX	02.9	02.9.0
TRAWLS		03	03.0.0
Beam trawls	TBB	03.11	03.1.1
Single boat bottom otter trawls	OTB	03.12	03.1.2
Twin bottom otter trawls	OTT	03.13	03.3.0
Multiple bottom otter trawls	OTP	03.14	-
Bottom pair trawls	PTB	03.15	03.1.3
Bottom trawls (nei)	TB	03.19	03.1.9
Single boat midwater otter trawls	OTM	03.21	03.2.1
Midwater pair trawls	PTM	03.22	03.2.2
Midwater trawls (nei)	TM	03.29	03.2.9
Semipelagic trawls	TSP	03.3	-
Trawls (nei)	TX	03.9	03.9.0
DREDGES		04	04.0.0
Towed dredges	DRB	04.1	04.1.0
Hand dredges	DRH	04.2	04.2.0
Mechanized dredges	DRM	04.3	11.2.0
Dredges (nei)	DRX	04.9	-
LIFT NETS		05	05.0.0
Portable lift nets	LNP	05.1	05.1.0
Boat-operated lift nets	LNB	05.2	05.2.0
Shore-operated stationary lift nets	LNS	05.3	05.3.0
Lift nets (nei)	LN	05.9	05.9.0
FALLING GEAR		06	06.0.0
Cast nets	FCN	06.1	06.1.0
Cover pots/Lantern nets	FCO	06.2	-
Falling gear (nei)	FG	06.9	06.9.0

Gear categories	Standard abbreviations	ISSCFG code	
		Current (2016)	*Previous (1980)*
GILLNETS AND ENTANGLING NETS		07	07.0.0
Set gillnets (anchored)	GNS	07.1	07.1.0
Drift gillnets	GND	07.2	07.2.0
Encircling gillnets	GNC	07.3	07.3.0
Fixed gillnets (on stakes)	GNF	07.4	07.4.0
Trammel nets	GTR	07.5	07.5.0
Combined gillnets-trammel nets	GTN	07.6	07.6.0
Gillnets and entangling nets (nei)	GEN	07.9	07.9.0
TRAPS		08	08.0.0
Stationary uncovered pound nets	FPN	08.1	08.1.0
Pots	FPO	08.2	08.2.0
Fyke nets	FYK	08.3	08.3.0
Stow nets	FSN	08.4	08.4.0
Barriers, fences, weirs, etc.	FWR	08.5	08.5.0
Aerial traps	FAR	08.6	08.6.0
Traps (nei)	FIX	08.9	08.9.0
HOOKS AND LINES		09	09.0.0
Handlines and hand-operated pole-and-lines	LHP	09.1	09.1.0
Mechanized lines and pole-and-lines	LHM	09.2	09.2.0
Set longlines	LLS	09.31	09.3.0
Drifting longlines	LLD	09.32	09.4.0
Longlines (nei)	LL	09.39	09.5.0
Vertical lines	LVT	09.4	-
Trolling lines	LTL	09.5	09.6.0
Hooks and lines (nei)	LX	09.9	09.9.0
MISCELLANEOUS GEAR		10	10.0.0
Harpoons	HAR	10.1	10.1.0
Hand implements (Wrenching gear, Clamps, Tongs, Rakes, Spears)	MHI	10.2	-
Pumps	MPM	10.3	11.1.0
Electric fishing	MEL	10.4	-
Pushnets	MPN	10.5	-
Scoopnets	MSP	10.6	-
Drive-in nets	MDR	10.7	-
Diving	MDV	10.8	-
Gear nei	MIS	10.9	20.0.0
GEAR NOT KNOWN		99	99.0.0
Gear not known	NK	99.9	-

This document elaborates the revised International Standard Statistical Classification of Fishing Gear (ISSCFG), as endorsed and adopted for implementation by the FAO Coordinating Working Party on Fishery Statistics (CWP) at its Twenty-fifth Session in February 2016 in Rome, Italy. The classification applies to commercial, subsistence and recreational fisheries in marine and freshwater fisheries. The document provides definitions and illustrations of the configuration and mode of operation of typical fishing gears. The primary purpose is to assist FAO Members, regional fishery bodies, as well as those working on fishery statistics and management, to correctly attribute and report fisheries catches made by different gear types. The document also contributes to the prevention, deterrence and elimination of illegal, unreported and unregulated (IUU) fishing by providing monitoring, control and surveillance personnel with information to identify the type of fishing gear with regard to licence and authorization to carry out fishing operations. Finally, the document also provides context and references for some contemporary conservation issues related to major fishing gear types; it can therefore be used as a reference text for students and researchers in fisheries and marine conservation.

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