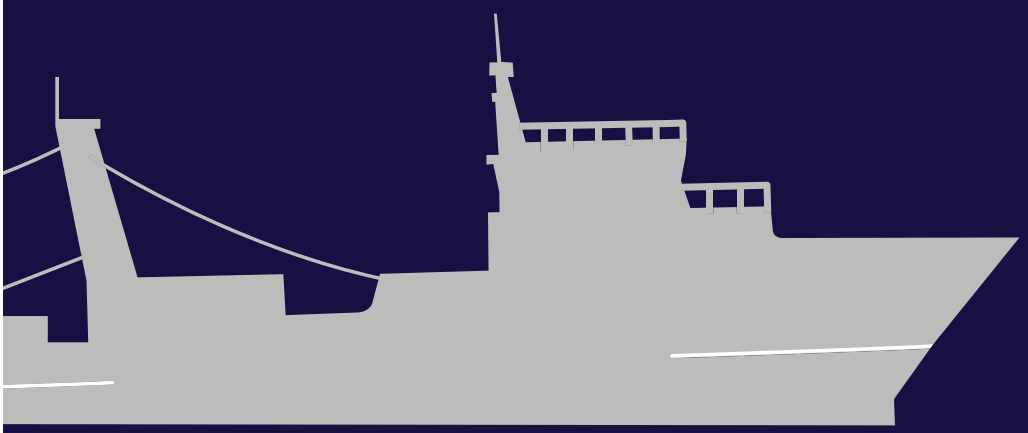
MCS PRACTITIONERS INTRODUCTORY GUIDE TO:

TRAWL FISHING



TMT

INTERNATIONAL MCS NETWORK

CONTENTS

GLOSSARY OF TERMS

AIS	Automatic Identification System
CMM	Conservation and Management Measure
DDD	Dolphin Deterrent Device
IMO	International Maritime Organisation
IUU	Illegal, Unreported and Unregulated (fishing)
MCS	Monitoring, Control and Surveillance
MMSI	Maritime Mobile Service Identity
RFMO	Regional Fisheries Management Organisation
SLED	Sealion or Seal Exclusion Device
SSD	Seabird Scaring Device
TAC	Total Allowable Catch
TED	Turtle Excluder Device
VMS	Vessel Monitoring System

This MCS Practitioners Introductory Guide has been developed by TMT in cooperation with the International MCS Network (IMCS Network). The guides in this series are intended to be used as a training tool to introduce common international industrial fisheries vessels and gear types, towards building knowledge in personnel working in all government agencies (Fisheries, Port, Coast Guard and Navy, Maritime etc.) who may play an operational role in fisheries monitoring, control and surveillance (MCS), as well as for use by broader interested stakeholders.

While this guide is a stand-alone tool focussed on fishing vessels that utilise trawl fishing gear, it has been developed as part of a series of similar introductory guides on other major industrial fishing methods and related operations, as well as complementary material on fishing vessel inspection considerations.

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OPERATIONAL OVERVIEW: TRAWLERS

In this Guide, 'trawling' refers to fishing gear, specifically trawl nets or dredges, that are towed or dragged behind a single vessel, or, in the case of pair trawling, two vessels. Trawl fishing can be used to target different marine species depending on the depth at which they operate. In the case of demersal[1] fisheries, the trawl is towed along or close to the bottom. This is often referred to as bottom trawling. In a pelagic[2] trawl fishery, the net is towed at the desired depth in the water column, wherever the targeted fish has been located. This is often referred to as midwater trawling.

There are many different types and sizes of trawl vessels. Trawl vessels can vary from small vessels that operate close to shore and keep their fish on ice or in sea water, to large factory or freezer vessels that can remain at sea for weeks at a time and often process, package, and freeze their catch onboard while at sea.

1. Demersal trawl fisheries target species that live on or close to the sea floor, such as shrimp and cod

2. Pelagic trawl fisheries operate their gear in the mid and upper areas of the water column, away from shore, generally targeting smaller pelagic species such as anchovies, sardines, and mackerel

DESCRIPTION OF THE FISHING OPERATION

A trawler will generally travel to fishing grounds at an economical cruising speed, somewhere between 8-12 knots. The speed is then usually reduced to between 2-6 knots while towing gear in the water, depending on the species being targeted and the type of trawl gear used.

Deepwater vessels usually work in shifts around the clock whereas coastal or inshore vessels will often work during daytime, and drift or anchor overnight. The duration of a trip depends on several factors. A large factory trawler is limited by freezer hold capacity and fuel whereas smaller vessels are usually constrained by the length of time the ice lasts and the demands of, and distance from, fresh fish markets. In some regions of the world, catch may be transhipped to carrier vessels[3] (legally or illegally), greatly extending

TRANSHIPMENT RISK

As trawling is a fuel-intensive fishing method, fuel costs are very high. Many trawl operators will look to reduce this cost by prolonging and optimising time spent at sea, to save on fuel transiting between port and fishing grounds. One approach is to bunker (transfer) fuel at sea. Another approach is to tranship catch at sea. In many countries, however, transhipments are either banned or require prior authorisation and/or the presence of fishery observers. In such cases, it is crucial to understand where illegal transhipment risks may lie, and to develop and integrate MCS routines to address and mitigate these risks.

3. In some fisheries, "carriers" may come in the form of other fishing vessels, or even large canoes, but are normally large-sized steel-hulled refrigerated cargo (reefers), ships such as the middle vessel above between two trawlers

the time a trawler can spend at sea. The fishing ground chosen depends on the season[4], the species being targeted, as well as regulations and market requirements. Weather forecasts and the experience of the skipper also play a large part in these decisions. Prior to setting the gear, the crew will ready the trawl, check for wear and holes in the net, make sure that floats are securely fastened, and that metal fittings are in good order. Any electronics, such as net and door monitors, and catch sensors, will need checking, and batteries replaced if necessary. The use of electronics in trawl fishing is discussed further in a dedicated section below.

Once 'marks' (target catch) have been detected on fish-finding instrumentation, the trawl gear is deployed. The marks displayed on the depth sounder render fish schooling close to the bottom or in mid-water. As the fish tire and fall back into the net, the cod-end expands until the stretched diamond mesh triggers a catch sensor, if these are being used. The net gradually fills up, until the decision is taken to bring it in.

Once onboard, the net is lifted up and the fish is released onto the deck, or through hatch openings into the bunkers, holds, or fish pounds below. A vessel with a short deck may have to make several lifts to clear the net while a large vessel can get the whole cod-end on board. Following release of the catch from the net, the fish can be gutted[5], sorted and iced for fresh fish trawl vessels, sorted into boxes or containers for freezing, or on factory trawlers, released into the factory for sorting and further processing.

While the net is coming on board, crew are checking the metal fittings that might contact the seabed for signs of wear. The net is cleared of fish that are stuck in the wing ends or larger meshes, while broken meshes, rips or tears in the net are noted for mending at a later stage. The emptied net is then prepared for deployment again.

4. Some trawl fisheries will target spawning aggregations and so targeted effort in these fisheries will be seasonally focussed

5. Whether fish is gutted depends on the species and the end market

FISHERIES MANAGEMENT CONSIDERATIONS

The selectivity[6] of trawl gear depends on the type of trawl gear used, where it is used and how it is used. However, in general, trawl fishing is not a selective fishing method, so trawling can often result in the unintended catch of non-target species, commonly referred to as bycatch; this is particularly true of bottom trawling.

Trawl fishing can also catch or cause the mortality of protected and/or endangered species, such as birds, seals, turtles, and marine mammals. This means there can be requirements in place to minimise these impacts and these requirements may differ between jurisdictions.

Bottom trawl fishing can also cause disturbance of soft sea bottom sediment and the destruction of hard and soft corals and seagrass beds. Because of this, sensitive seabed areas should be considered for closure to bottom trawling. Some countries have banned bottom trawling gear altogether. Trawlers also consume significant amounts of fuel. It has been shown that in many areas trawling is not financially viable in the absence of fuel subsidies, or support from transhipment and bunker vessels at sea, which poses MCS challenges.

6. Selectivity refers to how effective a fishing gear is at catching the target species and fish size without impacting non-target sized fish and species (bycatch)

HOW TRAWLERS CATCH FISH

BOTTOM TRAWLERS

Bottom trawlers target species that live on, or just above the seabed. Trawl nets are attached to the fishing vessel by two trawl warps (wires) and are towed behind the vessel at the desired fishing depth, which can be anywhere between 10 and 2000 metres. The trawl warps run off their drums and through towing or trawl blocks, which are like pulleys and are usually located as far aft as possible.

The catching operation begins with the vessel finding the fish and deciding on the towline (the vessel course along which the gear will be towed to harvest the fish) prior to shooting the trawl. The vessel is lined up on the tow-line and the trawl net is lowered into the water directly behind the vessel. Once the trawl is in the water, the deck crew will check to see that there are no hook-ups and the headline or headrope floats are floating freely from the ground line or footrope. The gear is towed behind the vessel at a speed generally between 2 to 4 knots, along the sea bottom.

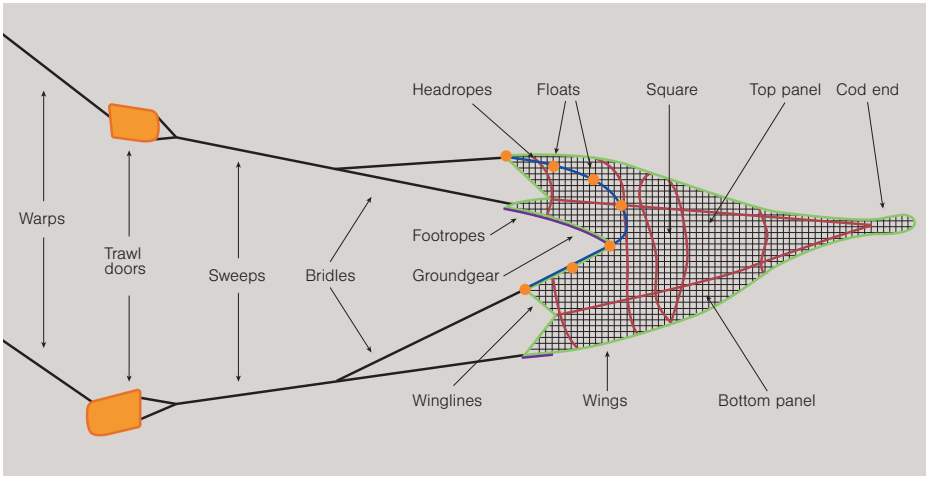


Figure 1. Overview of a trawl gear setup

Trawl nets commonly have either two or four panels of mesh. These panels are joined together by ropes running the length of the trawl which provide longitudinal strength. The top and bottom wings on either side of the net extend the lengths of the headline and ground rope and are tapered to reduce drag.

The mouth of the trawl net must be kept open during fishing operations and there are different methods used to achieve this, including the use of trawl doors or otter boards (otter trawls), beams (beam trawls) or metal frames (dredge), or by towing the net between two vessels (pair trawling) – discussed in detail further below. In all cases, the body of the net tapers down towards the end of the net, known as the cod-end, the part of the net where the catch is gathered. Floats attached to the headline lift the mouth of the net and heavy ground gear keeps the fishing rope close to the seabed.

The vibrations of the warps and sweeps, and the action of tickler chains[6] direct the fish into the path of the net. The gear, through making contact with the bottom, also stirs up a cloud of sediment which acts as a curtain, again forcing the fish to remain in the path of the net. As the fish tire, they fall to the back of the net and are captured in the cod-end. Fast swimming and under-sized species may escape, either by swimming above the headline or through the large meshes at the front of the net.

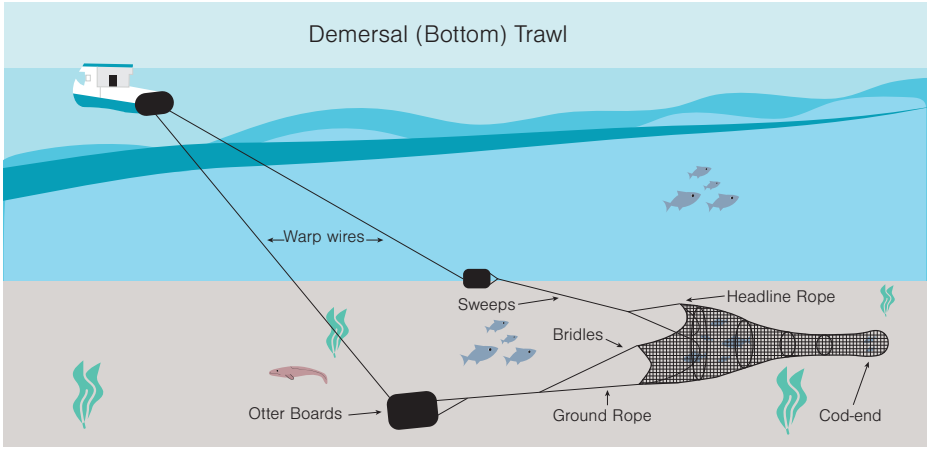


Figure 2. Demersal bottom trawl

Towards the cod-end the meshes reduce in size while the twine often increases in diameter. When the diamond-shaped meshes come under tension the side knots move closer together, restricting the escape of undersized fish. The design of the cod-end is important because the quality of the catch starts to deteriorate as soon as a fish has been caught. Some cod-ends are constructed using a knotless design to reduce damaging the catch. Some vessels may also have chafing gear, used to protect the trawl against wear and damage. Often, provisions are in place that regulate the use of chafing gear.

The progress of each tow is monitored by a variety of means, depending on the degree of sophistication of the vessel. The aim is to direct the trawl into the path of the fish once the fish marks have been located. For bottom trawls, this may mean following a depth contour; towing up, down or over an underwater pinnacle; or simply towing a straight line over flat bottom. The nature of the seabed needs to be considered and with a bottom trawl this will dictate the line a vessel may take, this also being a function of the design of the ground gear.

7. These are also called chain matts.

HOW A TRAWL NET IS KEPT OPEN

In an otter trawl, the width of the opening is achieved by using the hydrodynamic forces of trawl "doors" (also called otter boards), attached to the towing warps. As the otter boards are towed under tension, they move away from each other, causing the mouth of the net to open. Floats are attached to the top of the net (i.e. the headline or headrope) to lift the mouth of the net open while ground gear, such as chains or weights and metal bobbins weigh and keep the bottom of the net down.

With a beam trawl the width of the opening is maintained by a rigid beam supported at each end by metal shoes. The height of the opening is achieved by attaching the headline or headrope to the beam and attaching the foot rope, or ground rope, to the metal shoes. Improvements in vessel power and manoeuvrability have allowed beam trawlers to move from towing a single trawl to towing two trawls from derricks on either side of the vessel. Beam trawls enjoy several advantages over conventional trawl designs. They are easier to tow, having less drag and the net mouth opening remains the same when the vessel turns. A dredge trawler is similar in some ways to a beam trawl, but instead of a beam, will have a rigid frame around the entrance of the net.

In a pair trawl, two vessels are used to tow either side of the net. The net is kept open by maintaining the distance between the two vessels. Using two vessels to tow the trawl removes the need to use trawl doors or a beam to keep the net open. Much of the hauling and shooting of a pair trawl is carried out by one of the two vessels. The net is spread between the two vessels by use of a transfer rope which allows a vessel to transfer one of the warps to the other vessel at the start of the fishing operation. Pair trawling is banned in many countries, mainly due to the negative impact the method has on the marine environment.

MIDWATER (PELAGIC) TRAWLERS

Pelagic or midwater trawling targets fish which school between the surface and the seabed. A midwater trawl works in much the same way a bottom trawl does, but the trawl mouth of a midwater trawl generally has a wider opening. Weights are attached to the bottom sweeps to pull the groundline downwards. Midwater trawls are generally conducted at slightly higher speeds than bottom trawls.

Fish finding electronics play an important part in the operation with the trawl speed and warp length being adjusted so that the shoal of fish enters the mouth of the net. The trawl itself does not usually touch the bottom but the doors can make contact at times. Because a midwater trawl is usually targeting schools of fish, the net generally fills up faster, and so tows are generally of a shorter duration than is the case with bottom trawling.

Most large trawlers can choose between a pelagic or a bottom trawl setup, and it may be difficult to see which method is being used based on the outward appearance of the vessel; this is important where a trawler's licensing conditions may allow one but not the other, or where is it fishing in water depths where it may be possible to fish in both configurations. Small vessels may also use midwater trawls, and sometimes this is done by two vessels in a pair trawling configuration.

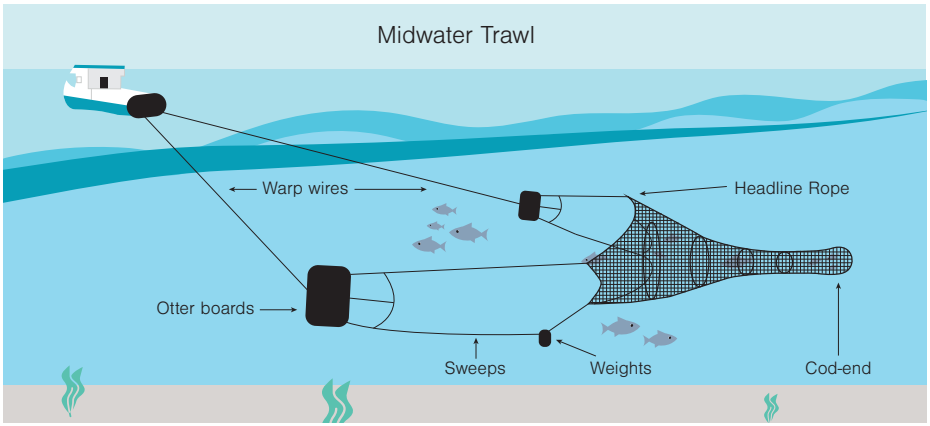


Figure 3. Midwater Pelagic Trawl

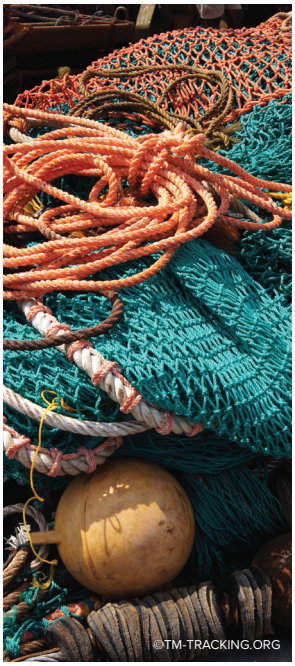
GETTING THE CATCH ON BOARD

Once the net is full bottom and mid-water trawlers need to be able to lift the cod-end aboard. This is done either over the side or up a specially designed stern ramp. Once aboard, the cod-end is lifted and then released so the fish are tipped either onto the external deck (often in a holding area that can be either forward or aft of the superstructure, depending on the vessel design) or directly below deck into hold areas. Large modern pelagic trawlers can, in some circumstances, also pump their catch on board while the net remains alongside in the water. Aboard factory trawlers, the areas where fish are stored below deck prior to being processed in the factory are generally called pounds, or bunkers.

A midwater trawler retracting gear through the stern ramp

A midwater trawler that specifically targets small pelagic fish such as herring and mackerel, and that does not bring the cod-end on board but rather pumps the fish out while the net is still in the sea, may not have an open work deck. Instead, the working area is dominated by gear handling machinery. The superstructure on these pelagic trawlers is usually located amidships and there is no gantry (crane) as might be found on bottom trawlers because heavy lifting, hauling, and tipping is not required. An outstanding feature on a pelagic trawler are the two large doors hanging off the stern when the net is not fishing.

Trawl nets, when not in use, can be stored on deck or on a net roller or drum that is usually mounted above the deck. Rollers are particularly used in midwater trawls, which can use nets that are much wider and longer than the standard bottom trawl. The warps are generally wound onto large drums on either side of the deck.



Trawler warps and mesh

HOW TO RECOGNISE A TRAWLER

Trawlers come in all shapes and sizes. This can make identifying a trawler difficult on first sight, but there are certain functions that a trawler of any size must be able to perform, and therefore it must have the relevant equipment onboard to perform these functions; this equipment can be used to identify the vessel as a trawler.

Most trawlers will have the superstructure or deckhouse in the forward part of the vessel and the work deck in the aft part. How the vessel lifts the net onboard can help identify a trawler. The ramp at the stern of Stern Trawlers makes these vessels very easy to identify as trawl vessels. On smaller, older vessels and the minority of vessels with an aft superstructure where the lift takes place over the vessel's side (Side Trawlers) it can be more difficult to identify the vessel immediately as a trawler[8], in which case an examination of the gear may be necessary.

When not in use, otter boards will often be visible at the stern of a trawler (for those that use otter boards). If no doors can be seen, the vessel will probably be trawling, and the warps should be visible running from the towing or trawl blocks into the water astern of the vessel.

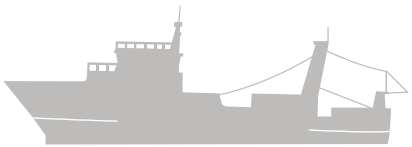
8. In some fisheries, particularly inshore fisheries with smaller vessels, multiple gears including trawls may be used, depending on the target species, time of year, licensing conditions etc

A trawler with the trawl doors stored

The warps on this trawler show that it is in the act of fishing

DIFFERENT TYPES OF TRAWLERS

FACTORY TRAWLER



Factory trawlers can use either bottom or midwater trawls and do in some cases operate both types of gear. These are the largest of all trawl vessels and have onboard processing facilities (factory) that enable the vessel to process, and to freeze, its catch at sea. The factory is located below deck and fish is generally taken from the pounds along a series of conveyer belts that move the fish through the different stages of processing. Catch is generally processed into blocks that are packaged and frozen onboard and ready for sale when they are offloaded. Some of these vessels can spend months at sea.

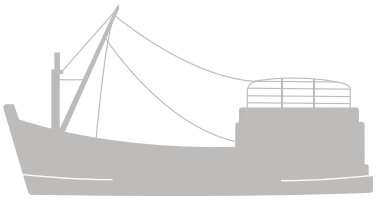
What processing takes place varies between vessels and species caught. For many, fish are simply separated into individual species, packaged whole or "green" in boxes or other containers, and then frozen. In larger vessels, fish can be processed to different states[9] for the market. Some vessels may also contain a fishmeal plant that is used to turn processing by-products and less valuable or lower quality catch into fishmeal; increasingly there are trawlers that process all catch into fishmeal only. Fishmeal is generally packed into bags onboard the vessel.

FISHMEAL PLANT RISKS

Fishmeal plants onboard trawl vessels provide an opportunity for vessels to misreport species and hide catch they may not want to report. This risk is heightened in fisheries based on Total Allowable Catch (TAC) and quota management systems. Fishmeal is often produced from the offal of multiple species following onboard processing. In this case the catch will often be reported as the primary product (fillets, headed and gutted), while fishmeal is a secondary product and so may not need to be accounted for. Therefore, catch that vessels want to hide, such as bycatch or lower quality catch of species under catch management, may be sent to the fishmeal plant and reported as other lower value species, hidden as a secondary product that cannot easily be verified.

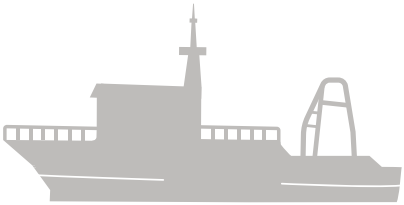
9. This can vary from minimal processing to states, such as gutted or headed and gutted, through to the full processing of fillets onboard

FRESH FISH TRAWLER



Fresh fish trawlers are generally small- to medium-sized vessels (5-40m) and can come in many different types (stern trawler, side trawler, multi-use vessels). The catch is generally chilled whole, or subject to minimal processing, and landed for further processing and/or sale. Fresh fish trawlers generally operate close to their home ports and will undertake short trips, from a day to up to a week in duration. The catch is generally loaded into bins or baskets and will be kept in the holds, if below deck storage is available on the vessel. Smaller vessels conducting shorter trips may keep the catch bins on deck.

FROZEN FISH TRAWLER

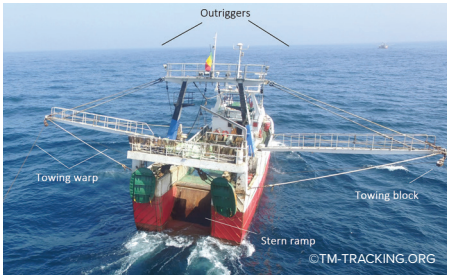


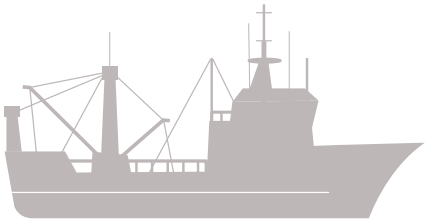
Frozen fish trawlers are positioned somewhere between factory and fresh fish trawlers. They are generally somewhere between 10-40 metres in length, and also come in many different types (stern trawler, side trawler, multi-use vessels). Once on board, the catch can be subject to minimal processing, either on deck or in a dedicated work area in the hold. The catch is then generally packed into containers or boxes, generally by species, or as a mix of species that end up in the same market[10], and are then landed for further processing and/or direct sale. Frozen fish trawlers can operate further afield than fresh fish trawlers and may spend significant time fishing before returning to port, particularly if they can refuel and tranship their catches at sea.

Boxes of frozen demersal fish being offloaded from a frozen fish trawler

10. An example of this is the 'Africa Mix' of species that are destined for local markets in West Africa, which are fish destined for local markets that are separated out from the species that have a higher value on the international export market. Rather than being separated into individual species, Africa Mix fish species are packed together in boxes and frozen

MULTI-RIG TRAWLER





In fisheries targeting bottom-dwelling finfish and crustacea, such as prawns and shrimp, the spread of the gear (how wide the mouth of the net is) is more important than headline height. In these fisheries, one vessel may use two, three or four nets, sometimes towed by outriggers, with the nets smaller than a single trawl net. When outriggers are used, the outriggers are fastened to the mast or at the foot of the mast and are extended over the sides of the vessel during fishing.

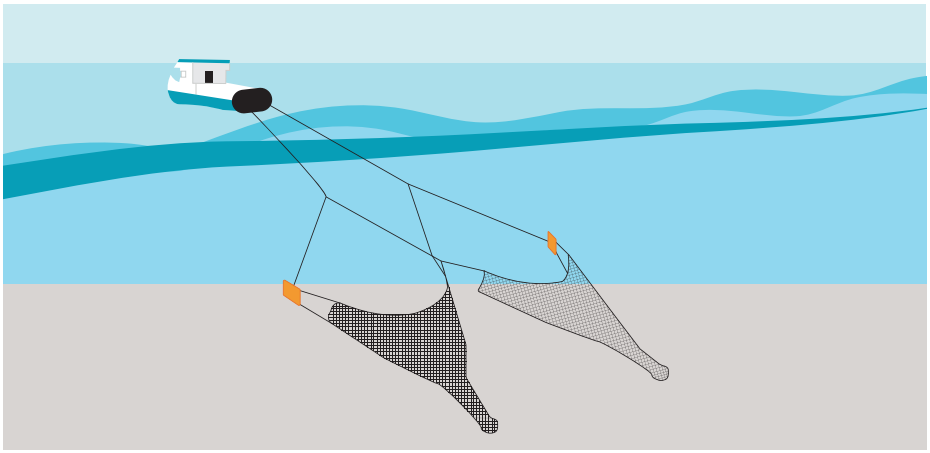


Figure 4. A twin rig

A twin rig is towed with doors attached to the outer ends with clumps or sleds weighing the trawl down in the centre between the two nets. Two warp wires can be used and sometimes a third wire is attached to the clump.

Splitting the catch over two or three cod-ends results in less damage to crustacea and reduced bruising to fish. Lowering the headline height also reduces the unwanted bycatch of demersal fish. Impact with the seabed can be controlled by altering the towing speed or adding floats to the headline. The multi-rig trawl also increases the catch by sweeping a larger area for a minimal increase in fuel cost.

SHRIMP TRAWLERS

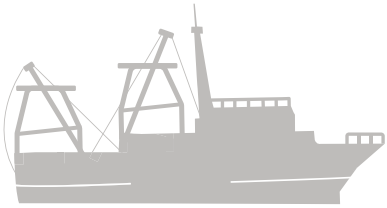
Shrimp (or prawns) are a major target species for specialised trawling operations in various parts of the world. These fisheries targets shrimp species with various gear types, but mainly utilise skimmer or otter trawls in both demersal and mid-water trawl configurations, dependent on the region of the world and the target species.

An example is the United States (US) bottom trawl shrimp fishery that operates virtually year-round in the Atlantic Ocean from North Carolina through Florida and in the Gulf of Mexico from Florida through Texas. Shrimp trawling in this region occurs in estuarine areas, near shore coastal waters, and along the continental shelf and slope of the Atlantic and Gulf of Mexico. The fishery typically operates from sunset to sunrise when shrimp are most likely to swim higher in the water column. The most commonly employed gear in this fishery is a double-rig otter trawl, which normally includes a lazy line attached to each bag's cod-end. The lazy line floats free during active trawling, and as the net is hauled back, it is retrieved with a boat- or grappling-hook to assist in guiding and emptying the trawl nets. Shrimp trawl soak time is approximately three hours before the nets are hauled back.

Similar fisheries operate in other areas of the world, such as the Gulf of Guinea, South Asia, and the Southwest Indian Ocean. Midwater shrimp trawl fisheries operate in various parts of the world, from cold water sub-polar species to those found in the tropics, with biomass highest over inshore waters and the continental shelf. In oceanic waters pelagic shrimps are mostly distributed in deeper water by day, rising closer to the surface at night, which can impact the time that nets are set.

Shrimp trawl fisheries have a particularly high risk of bycatch and are particularly significant to marine reptile catches and mortalities. It is therefore particularly recommended that relevant trawl fisheries require Turtle Exclusion Devices (TEDs). This is legally required for example in the US fishery above. In cold water shrimp fisheries, Nordmøre grids are used to reduce bycatch of cod, haddock, halibut and redfish caught during shrimp trawls.

DREDGERS



Dredgers mainly harvest bivalve molluscs such as oysters, scallops and clams, and can range in size from quite small to very large vessels. The catch is usually brought ashore for processing, but larger vessels can process it onboard. The dredge itself has a rigid frame at the front end. The top part of the frame will sometimes have a bar that is angled to drive the dredge onto the seabed, while the bottom of the frame has a rake (or row of teeth) to dislodge the shellfish from the seafloor. Structures called shoes at either end of the frame allow the dredge to move easily over the bottom. Chain bridles attached to the frame lead up to a single towing warp. The bridles can be adjusted to achieve the optimum angle of the frame to maximise the catch.

Once dislodged from the bottom, the shellfish pass into the cod-end (in these fisheries also known as a catch bag). The top of the catch bag suffers very little wear and can therefore be made of conventional diamond cod-end mesh. The bottom of the bag however is in contact with the seabed, and is therefore usually made of inter-connected steel rings or wire steel or wire mesh. The dredges are towed behind the vessel from either the towing or trawl blocks or from blocks at the end of extended masts.

ELECTRONICS AND TRAWLING

Fish finding technology and gear monitoring systems allow vessels to locate target species, and to fish over pinnacles and avoid bottom obstructions, such as wrecks and foul ground. They can also help ensure that the net is working as close as possible to its design specifications which can assist vessels to maximise the quality of the catch. In some cases, this equipment can even aid in the location of missing trawl gear.

A net monitor can be mounted in a central position on the headline and acts as a small depth sounder, showing the depth of the trawl and sending temperature information to the bridge. Sensors can also show the headline height and the passage of fish through the trawl mouth. In some fisheries, cameras that can identify fish by size and species can be mounted on the headline.

Catch sensors can also be attached at various points on the cod-end and be set to activate when a certain catch level is reached. A sound signal and change of light colour on the bridge display unit lets the skipper know when to haul and this helps match volume of catch to the processing capacity of factory vessels.

MITIGATING TRAWL BYCATCH

Concerns about the impact that trawling has on particular species or the marine environment has led to the implementation of mitigation measures in some fisheries, countries or geographical areas. Fisheries that need to avoid interaction with endangered or protected species, such as marine mammals and reptiles, and flying or diving seabirds, have developed techniques to reduce interactions, capture and related mortality.

The use of these measures may be provided for in fisheries regulations or, in some cases, they might be part of an industry Code of Practice or certification scheme. Where they integrate fisheries regulations it is important that the presence and correct use of these mitigation devices is confirmed during inspections. Some common mitigation measures include Turtle Exclusion Devices (TED), Sealion or Seal Exclusion Devices (SLED), Seabird Scaring Devices (SSD) and Dolphin Deterrent Devices (DDD).

TEDs and SLEDs are specialised devices that allow a captured sea turtle or seal / sea lion to escape when caught in a trawl net. Since sea turtles and marine mammals are air-breathing animals, they cannot survive long underwater without surfacing and will eventually drown if caught in a trawl net. TEDs and SLEDs are made of metal bars and mesh that fit inside the neck of a trawl net. While catch species such as fish and shrimp pass between the bars to the back of the net, the larger marine reptiles and mammals bump against the metal grid and escape through a flap in the mesh.

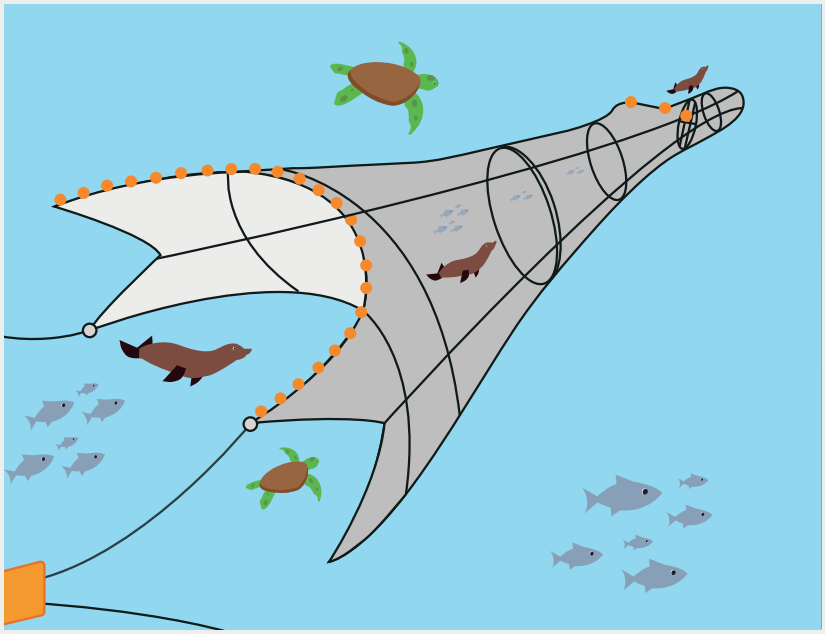


Figure 5. How a TED and SLED works in a trawl net to reduce sea turtle and seal / sea lion mortality

SEABIRD SCARING DEVICES

Seabird bycatch is an issue for trawlers. Trawlers, especially those that process at sea, are magnets for seabirds and the warp wires can represent a danger to birds flying around the stern of the vessel in search of food. A common device is a curtain of dropper lines deployed from booms suspended at the vessel's stern. This technique is usually combined with other practices, such as controls on when or how offal can be discharged, and the towing of warp streamers or buoys behind the vessel.

DOLPHIN DETERRENT DEVICES

Dolphin and other cetacean bycatch can present a problem in some trawl fisheries. Acoustic technologies have had some success in mitigating this challenge. Dolphin Deterrent Devices (also referred to a pingers) are small transmitters that are attached to the wing ends and headline. They transmit high frequency pulses that dolphins can detect. The intent is that dolphins will actively avoid areas where pingers are active.

Dolphin Deterrent Device attached to net.

TRAWLER POSITIONAL TRACKING (AIS AND VMS)

The ability to get a clear indication of what gear type is being used by an individual fishing vessel, based on vessel movement patterns from remote monitoring sources such as the Automatic Identification System (AIS) and Vessel Monitoring Systems (VMS) varies considerably across gear types, the length of the fishing operation, and the frequency and availability (temporal/spatial resolution) of the position signals. However, in general, it is true that vessels using different gear types generate distinctive positional patterns or signatures. The longer that fishing operations last, the more likely the fishing method of the vessel can be determined, owing to the increased number of vessel positions received. One characteristic that is common to all fishing operations is that there is always a stop or drop in speed at some point in the fishing operation.

Due to the different variations of trawl as a gear type, with different characteristics, target species and fishing grounds, trawl fishing is not always straightforward to identify through AIS or VMS. There are often no distinctive course change patterns as compared to longlines and purse seines. However, the main identifier in the track patterns of a trawler to be aware of is a consistent low speed of roughly 2-6 knots over a period of time, indicating the towing of the trawl. Trawl vessels will sometimes operate over the same areas within a single trawl to capture all fish in identified marks or, in the case of bottom trawling, to avoid foul or rough ground. Shorter periods of lower speeds following a towing indicate the hauling of the net. Often longer periods of higher speeds when transiting to new grounds, or shorter periods when aligning the vessel for a new set following the tow and/or haul, may be identified.

When analysing potential demersal trawl tracks, particularly where limited data is available, an important consideration is that these vessels frequently follow bathymetric (depth) contours. Track comparison with bathymetric (benthic) maps can therefore sometimes provide further insight as to whether a track indicates trawling activity. Depending on the target species, midwater trawls may sometimes correlate with prevailing currents and tide runs, which can impact the movement of some target species.

It is important to be aware that while the described pattern in most cases would be indicative of fishing activity, it could also be an indicator of other activities, including restricted manoeuvring due to weather conditions, maintenance/mechanical issues and others. Overall, among all trawling gear, pair trawling is a lot easier to detect and differentiate from other activities, as two vessels will be visible that display the same reduced vessel speed at similar times while maintaining a small consistent distance apart.

Example a)

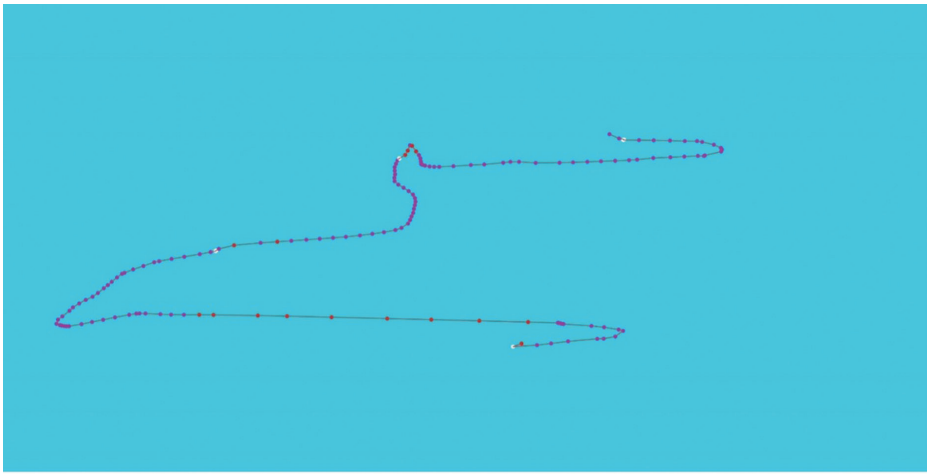


Figure 6. AIS positions showing the fishing pattern of a trawler. The indicated towing operation can be seen in the purple positions, where the vessel held a speed of 1-4 knots. Breaks in this pattern can be seen through the white and red positions, representing lower and higher speeds, indicating the hauling and re-aligning of vessel/transit pattern

Example b)

Figure 7. Extended track of vessel seen in example a, where multiple operations can be observed in the north-east corner, potentially indicating good catch levels

TRAWLER VESSEL INSPECTIONS – WHAT TO LOOK FOR

VESSEL GEAR AND OPERATIONS

Inspections of trawlers will vary, according to what the vessel is doing at the time of inspection; i.e. is it in port, steaming, transhipping or engaged in fishing? Fisheries inspectors may board the vessel at sea, in port, or observations could be carried out from a distance, during an aerial surveillance flight.

Officers onboard an aircraft will be able to determine whether the vessel is fishing or not (warps in the water behind the vessel?), whether a fishmeal plant is in operation or not (is any steam being vented?) and if any seabird mitigation devices have been deployed (lines streamers or buoys behind the vessel?). Aerial inspections can also determine the vessel's course, speed, and position, and detect any evidence of oil pollution[11].

A trawler with warps in the water, indicating that it is actively fishing

OPERATIONAL AND GEAR RESTRICTIONS

In some areas particular aspects of trawling may be prohibited. This includes gear or methods that are considered particularly damaging to the marine environment, such as the use of tickler chains, or bottom trawling by pairs of vessels. Trawling may also be prohibited during certain seasons or in particular geographic areas such as Marine Protected Areas. MCS practitioners need to be aware of such restrictions as they relate to any vessel they may be inspecting.

11. For more information on conducting air patrols, see the Photo Manual for Fisheries Air Patrols to support Fisheries Aerial Surveillance available at www.tm-tracking.org/post/photo-manual-for-fisheries-air-patrols-to-support-fisheries-aerial-surveillance

For a more thourough inspection, a boarding team will need to board the vessel. Most jurisdictions will have regulations concerning the way a net is constructed and mesh sizes, particularly in the cod-end. The mesh size of any bottom or midwater trawl cod-end can be inspected and measured if the trawl is laid out on deck. In the case of a midwater trawl, the cod-end may have to be wound off the net roller but a bottom trawl will usually be laid out on deck when not in the water. It is challenging to measure trawls on deck (apart from mesh size) so inspectors should ask to see the net plans for the trawl gear in use, and check them against those present on board. The trawl gear should always have the appearance of having been competently constructed and maintained and any lost or abandoned fishing gear should be recorded in the ship's log.

The size of the mesh can be measured using a specialised tool called a net gauge

One of the most common infringements are actions to reduce the size of mesh in the cod end, thereby not allowing under sized species to pass through. Ways to achieve this include simply using undersize mesh; a 'double cod-end' where the outside mesh is of legal size, but then a second cod-end is put inside with smaller mesh; or blocking the cod-end completely. Cod-ends should be a particular focus of inspections, and a search for illegal mesh size on the vessel that could be used for this purpose considered. Dumping of undersize mesh nets ahead of inspection is not uncommon.

Any chafing gear attached to the bottom lengthener panel and cod-end needs to be fastened in such a way (usually along the leading edge only) so that undersized fish can escape unharmed. It is not common practice to label trawls, but many fishermen can distinguish a trawl's country of nationality by looking at the materials used and the construction details. Check for burst panels or windows[12] designed to spill excess catch where these are prohibited.

Inspectors should be aware of the conservation and management measures (CMM) that may apply to a particular fishery and ensure, as part of their inspection, that the vessel is complying with these measures. In fisheries where the use of excluder devices designed to eject marine mammals and turtles are mandated, these should be inspected; these are often linked to a particular vessel by identifying marks stamped into the stainless steel frame. The device will need to be measured and checked against the excluder plan which should be carried on board.

Mesh size, particularlly in the cod-end, should always be inspected to ensure it meets regulatory requirements

12. Burst panels or windows can regulate the size of catches when nets become overfilled

CATCH RELATED

Most trawler licencing conditions will specifiy catch limits and target species as well as the bycatch able to be retained on board. In some cases the licence may specify minimum legal sizes for particular species and instructions for the disposal and recording of protected species. These conditions are implemented through national legislation and controls, such as conditions attached to a vessels licence or authorisation.

The Authorisation to Fish (license) will indicate the species that the vessel may target and an inspection of the processsing area, freezers or storage holds and galley freezer must check whether the conditions of the licence are being honoured.

The Authorisation to Fish may specifiy the vessel's reporting obligations and catch recording requirements. Catch effort is usually recorded on a tow-by-tow basis and should include duration of the tow, depth of headline and groundrope, position at start and end of tow and an estimate of the amount of target species and bycatch landed per tow. In the case of factory trawlers, the catch reporting may also be required to include processing figures. For catch that is packed whole into cartons or boxes, the vessel name, catch area, species, date and similar information should appear on the box or container, though it should be noted that labelling requirements vary significantly in different countries and regions. What is important is to inspect and ensure compliance with the requirements by fishery, port and/or market.

For catch processed aboard factory trawlers, cartons containing frozen product may be labelled with the name of the vessel and packhouse number, common and Latin name of the species, its product type (eg. headed and gutted, dressed, filleted), declared weight and grade and date of production. In some cases, the coded identity of the packer may also appear. Officers should, to the extent possible, verify that the contents (species, weight etc.) and vessel details match the label.

A factory vessel should also be able to provide product specifications for each species, detailing processing instructions (where cuts are to be made), tolerances for quality faults and weight/quality grades. Each factory vessel will only be able to process a certain amount of fish over any particular period. This may depend on the freezing capacity and the capacity limits of the factory processing machinery. Fish begins to degrade from the time it is caught and if fish is caught in too great a quantity, it may not be of sufficient quality by the time it reaches the factory. This may lead to the fish being disposed of or dumped. Fish disposed of will generally need to be recorded in catch records and the practice is prohibited in fisheries where all fish caught must be landed.

When inspecting trawlers with fishmeal plants, it may be worthwhile to scrutinise the reported catch that has been processed into meal. Specifically, if the vessel is only reporting secondary products such as frames being turned into meal, it is important to verify that the quantities of meal produced match the vessel's recorded catch.

Records held on the bridge (catch records) or by the factory manager (processing summary) should show how much catch is held on board with a breakdown by species and state. By applying a conversion factor for each species/state an estimation of the greenweight the vessel has caught can be made. It is important to note that conversion factors can differ depending on the species, area caught and method of processing, so it is important that the correct conversion factors be used. The processing records should align with the provisions of the authorisation to fish and any related conditions.

VESSEL IDENTITY

Fishing vessels must be marked in accordance with international standards so that they may be easily identifed, in port, at sea and from the air. Establishing the correct identity of fishing vessels is a key tool in the prevention of IUU fishing and makes possible the monitoring of compliance with the rules that apply to any given vessel.

Clearly marked unique vessel identifiers, such as the vessel name, the port of registry and the radio call sign are minimum vessel marking requirements, but other identifiers, such as the International Maritime Organisation (IMO) number, authorisation numbers and the Maritime Mobile Service Identity (MMSI) number will assist in verifying a vessel identity against entries in Regional Fisheries Management Organisation (RFMO) vessel registers or similar authorised vessel records.

For an overview of the general needs and considerations for the inspection of all fishing vessels, please refer to the brief *An MCS Practitioners Introductory Guide to Industrial Fishing Vessel Inspections*.

Trawlers operating in distant water fisheries, such as in West Africa, frequently have unclear and missing vessel markings

LABOUR SAFETY AND WORKING CONDITIONS

Working conditions on fishing vessels can range from excellent to unsavoury and dangerous; in some parts of the world trawlers have a particularly bad reputation for poor vessel safety and labour conditions and abuses. Whatever the nationality of the vessel, fishing is hard work, the hours are long and rewards can vary. Fisheries inspectors should learn to recognise a 'happy ship'. More importantly, they should know how to read the signs that all is not well – sullen demeanour, crew illness or injury, or obstruction on the part of the ship's officers.

Larger factory trawlers generally operate 24 hours a day, seven days a week, during fishing trips. This means that the crew working in the factory will generally operate split shifts across the 24 hour period. It is important to ensure that staff working in the factory are getting sufficient rest and breaks and that catch levels are not overloading the factory.

The hours recorded as worked by factory crew should be checked, and these should be cross-verified with specific members of the factory crew away from senior vessel officers, where possible.

Poorly treated fishermen will often be too scared to talk, so inspectors must be able to make an independent judgement on conditions based on their own observations. This means visiting sleeping spaces (is “hot bunking” happening?), checking on showers, toilets and handbasins, visiting the galley and mess spaces, inspecting first aid kits, looking for evidence of vermin (any bait stations?) and talking to crew away from the presence of officers.

Where an observer is embarked they should be spoken to away from the fishing vessel and any crew and observer safety issues should be documented and followed up. Taking an interest in the welfare of the crew is the best way of ensuring that conditions for fishermen improve throughout the industry. If inspections uncover any evidence of crew mistreatment, the relevant national labour agency should be notified as soon as possible, and follow-up inspections ought to be made.

TRAWL DEFINITIONS

Beam trawl: The mouth of a trawl net held open with the help of a wooden beam.

Bottom trawl: The trawl net which gets operated over and on the bottom portion of the waterbody.

Bunker vessel: vessel that carries fuel and lube oils to refuel fishing vessels at-sea or discharge at another port.

Chafing Gear: Pieces of netting; rubber matting or hide that are attached to the lower side of the cod end and bellies to reduce damage from ground contact.

Cod End: Is the terminal bag of trawl net where the catch of the net gets accumulated. It is made up of strong twine and smaller mesh size.

Cod End Rope: A rope used for seaming (closing) of the cod end during the net operation and opening of the cod end after operation to release the catch from the net.

Double-rig trawl: Two trawl nets that get operated from a single boat.

Fish Trawl: The trawl net which is involved in catching fish.

Foot Rope: The rope by which the lower edge of the belly of the lower panel and the inner edge of the lower wings are attached. This is also called the ground rope, ground line, foot line or lead line. Weight/sinkers are attached with this line and with the help of floats and sinkers, the mouth of the trawl net gets opened in a vertical direction.

Four seam trawl: The trawl net which consists of four panels i.e. upper panel, lower panel and two side panels.

Head Rope: This is the rope by which the upper edge of belly and inner edge of top wings are attached. This rope is also called head line, float line or cork line. Floats are attached with this rope to get buoyancy for lifting of the upper part of the net. The size of trawl net gets decoded by the size of head rope.

Lifting Bag: A cover over the cod end that is normally made of a larger mesh size and is used to strengthen the cod end whilst lifting the catch aboard.

Marks: Where target catch is identified on relevant instruments / electronics.

Midwater trawl: The trawl net which gets operated in the subsurface and midwater area of the waterbody.

Multi-rig trawl: More than two trawl nets that get operated from a single boat.

Neck (or throat): Is a portion of webbing placed in between the belly and cod end and called an extension piece, intermediate or lengtheners.

Otter Board: Is a device used in pairs for keeping the mouth of a trawl net horizontally open during operation. Otter boards are also called trawl doors.

Otter trawl: The mouth of a trawl net opens horizontally with the help of wooden or metallic otter boards.

Pair trawl: The mouth of trawl net held open horizontally by two boats pulling in opposite directions.

Side trawl: The trawl net which gets operated from the side portion of the trawler.

Single rig trawl: One trawl net that gets operated from a single boat.

Six seam trawl: The trawl net which consists of six seams.

Soak Time: The period of time the fishing gear is in the water before it is retrieved with the catch.

Stern trawl: The trawl net which gets operated from the stern of the trawler.

Sweep Lines: Ropes or wires attached between the end of the net and the otter boards to help in directing the fish into the track of the net.

TAC (Total Allowable Catch): The maximum amount of a particular fish species that can be taken by commercial fishers during a fishing period.

Tickler Chain: Iron chains attached with foot rope in shrimp trawls to disturb the bottom and to induce the shrimp and fish to enter inside the net.

Two seam trawl: The trawl net which consists of two panels i.e. upper panel and lower panel where both the panels are joined together laterally.

Warp: Warp is a rope or cable with distinguishing marks at regular interval used for towing the trawl net.

Wing Lines: Ropes that frame the wing ends of a trawl.

Wings: Are the side extension of the trawl net between head and foot ropes beyond the mouth of the net used to prevent escape of fish from the sides and guide them towards the cod end of the net.

The MCS Practitioners Introductory Guide series has been developed by TMT in cooperation with the International MCS Network (IMCS Network).

They are intended to be used as training tools to introduce common international industrial fishing vessels, gear types, and operations, towards building knowledge in personnel working in all government agencies (Fisheries, Port, Coast Guard and Navy, Maritime etc.) who may play an operational role in fisheries monitoring, control and surveillance (MCS), as well as for use by broader interested stakeholders.

The tools are also supported and made available by the cooperating organisations of the Joint Analytical Cell (JAC)
www.tm-tracking.org/joint-analytical-cell

The Guides are available for download at
www.tm-tracking.org/updates-and-resources and https://imcsnet.org/documents/

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