

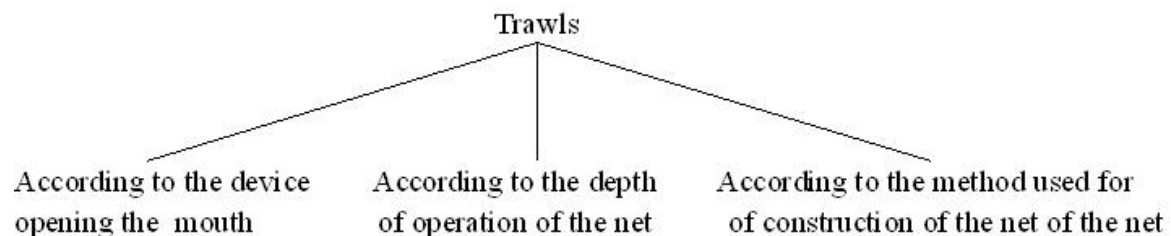
## Unit 4 - Trawl fishing gear and operation

### Expected learning out-come

- Trawl fishing gears and their parts
- Classification of trawling methods
- Different types of ground gears used
- Use of scope ratio, Towing speed and duration of trawling operation
- Deck equipments onboard trawlers

### 4.1.Trawling

Fishing is the art of catching aquatic living beings. Various methods are adopted for the capture of fishes. Due to advancement of Science and Technology many progressive changes have been introduced in design, construction and operation of fishing gear. The introduction of trawls and trawling is one of the important development in the history of fishing technology. The modern trawl net is basically a large conical shaped; bag netting which is drawn along the sea bed just above the bottom or in the water column to catch bottom fishes or shell fishes. Initially trawling gear were all for bottom fishes and in later years more complicated innovation were devised. The present day trawls may be classified as under.



### 4.2.Parts of a trawl net

Trawl Types:

Beam Trawl	Shrimps and Flat fish
2 Seam Granton Type	Fine Ground fishing
Prawn Trawl	Shrimps
Wing Trawl	Mixed Demersal species
Dual Purpose Trawl	Nephrops & Demersal Species
Baloon Trawl	High swimming Demersal Species
Box Trawl	Mixed Demersal species
Butterfly Trawl	High Swimming species
4 Panel Trawl	Shrimp prawn and demersal fish
Pelagic or Mid water trawl	

The size of a trawl net may be defined by the length of the foot rope, headline or the number of meshes around the fishing circle, and the mesh size at that point.

Mesh sizes are usually at their largest in the mouth of the trawl and progressively reduce towards the codend.

## **4.2.Trawl Diagram**

### **4.2.2.Trawl net parts**

Top Wing - The two sections of netting forming the upper parts of the mouth of the trawl, to which the Headline is attached along the inner edges.

Square – The upper trapezoidal panel of netting leading forward of the baitings, to which the top wings are attached. This forms the forward running cover to restrict the upward escape of fish.

Baitings or upper Bellies – The upper part of the tapered funnel of the net that guides the fish towards the codend.

Lower Wing – The lower part of the trawl mouth that is directly below the top wings. The inner edge of this is attached to the fishing line beneath the square.

Bunt – This is a continuation of the lower wing that is attached beneath the square.

Lower bellies – The lower part of the funnel of the net that guides fish towards the codend.

Extension or Lengthening Piece – This is a continuation of the belly, and is usually rectangular like the codend. It may be inserted to improve the flow of the net, close the meshes in front of the codend or to make the hauling of the codend easier.

Codend – This is the final section of netting, usually constructed from a heavier or double netting. That is used to hold the catch of fish.

Flapper – A panel or panels of netting inserted inside the trawl to prevent or restrict the escape of fish from the aft part of the trawl. This is usually positioned in the after part of the belly or extension.

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

Chafers – Pieces of netting; rubber matting or hide that are attached to the lower side of the codend and bellies to reduce damage from ground contact.

Dolls – Pieces of stranded rope that are cow hitched through the meshes on the underside of a trawl or chaffer to help protect the net from damage. These are usually used on nets that are being worked on stony ground, and are most commonly found on the underside of beam trawls. Dolls also help to block the meshes hence reducing the effective mesh size.

Wing Tips – These are triangular sections of netting found at the forward ends of the mouth of some trawls.

Side Panels – Sections of netting that are placed between the upper and lower parts to change the cross sectional shape of the trawl and give it 4 seams.

Headline – the upper rope framing the mouth of the trawl to which the headline floats are attached.

Fishing Line – The lower framing rope at the mouth of the trawl to which the foot rope, bobbins or ground rope is attached.

Bolsh – A rope that may be inserted between the wings and a framing rope.

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

Belly Lines and Selvedge Lines – These are ropes that run along seams in the trawl to give additional strength. The trawl is held open vertically by the floats attached to headline. It retains contact with the sea bed by the weight of the ground rope. The trawl is held open laterally by the otter boards, which also act as a major weight force to keep the gear on the sea bed.

A series of sweeps and bridles connect the otter boards to the trawl. These may have considerable length and are used to herd the fish to the mouth of the trawl. Tensions in these wires may also be adjusted to control the engineering performance of the gears.

## **4.2.Trawl Diagram**

### **4.2.3.Selecting Netting Materials**

The material most widely used in demersal trawls is Polyethylene. This is usually blue, orange or green in colour, and may be constructed in a twisted or braided form. The codend

section of the trawl is most commonly constructed from braided twine, and is often made in the form of a double netting.

Polyamide or Nylon netting is widely used in the construction of Beam trawls, Mid water trawls and Shrimp trawls.

All synthetic materials are subject to shrinkage, which may have several causes, and could lead to a net contravening a fishing gear regulation.

Polyethylene is subject to shrinkage caused by prolonged periods of storage in direct sunlight.

Polyamide may be subject to shrinkage by submersion in water unless adequate heat setting processes have been undertaken during the twine and netting manufacture.

Contact with chemicals, hot water pipes etc. may also cause problems. Another form of shrinkage is caused by dimensional change. This is particularly common with braided twines that are used in close contact with a sandy sea bed. The sand particles find their way into the lumen of the twine causing an increase in diameter and reduction in length of the twine bars.

**Rigging of otter boards**: -Otter boards are rigid sheer devices which are used to keep; the trawl mouth, bridles and warps horizontally open. They keep the bottom trawl in contact with the sea bed and help to maintain the fishing depth of the mid water trawl .Otter boards were first used trawling in 1894 in Scottish waters. By the end of the century otter trawler had become popular. Originally otter boards were attached directly to the wings of the net. By around 1920, Vigneron-Dahl system was introduced. In this system otter boards were attached to wing by means of sweep lines and bridles. (Fig.page 69 Modern F.G.). There was an increase in the catch rate, the effective swept area and through the herding effect of sweep lines, bridles and otter boards on fin fishes. Otter boards contributes about 24% of the total drag of trawl system and is responsible for about 16% of total fuel consumption in trawling operation.

#### **4.2.Trawl Diagram**

##### **4.2.4.Ground gears used during trawling**

Floats and sinkers are used all along the head rope and foot rope to give the fishing gear the desired shape, keep the mouth of the gear vertically open and maintain a good ground contact. Floats are buoyant material which gives an upward thrust due to which the head rope is lifted off. Whereas sinkers are provided on foot rope to give a downward thrust. The vertical mouth opening of the trawl net is achieved due to these opposite actions.

When the trawl net is dragged in the sea bottom, specially made ground rig is attached of the foot rope to offer protection from snags. Rubber discs of appropriate diameter, threaded together in a rope used for trawling in a moderately rough ground. Rubber bobbins of cylindrical or spherical shape and appropriate diameter and weight (230-440 mm dia and 4-14 kg in air) and steel bobbins (230-600 mm dia and 13-144 kg) with a spacer and washers packed on to the steel wire ropes are used for trawling in hard rough ground. Rubber rock hopper disc (400-600 mm dia; 7-21 kg) with rubber spacer packed together using iron link chain are connected to foot rope are also used in very rough grounds. Rock hopper gear causes less wear and tear to the ramp and deck of the vessel when compared to bobbins.

#### **4.2.Trawl Diagram**

##### **4.2.4.Scope ratio**

It is the ratio between length of warp line released to the depth of water in which a trawl is operated. It varies with towing speed, type of ground, depth and type of species to be caught.

For bottom trawling the towing speed ranges from 1.4 to 3.4 knots depending on size of the vessel. The bottom towing speed generally ranges from 1.4-2.0 knots for shrimps, 2-3 knots for fishes. For mid water and pelagic trawls it is 3.4-6.0 knots.

Towing a particular trawl too slowly may cause the otter boards to close together, resulting in insufficient spreading of the net which may sag on the bottom. On the other hand, towing too fast could result in the net lifting off the bottom and floating, which may lead to its turning

over and becoming foul gear. Scope ratio is around 1:4 in shallow waters less than 20 m with smooth ground. The warp length could be 4-10 times the depth in deep water for operating a heavy gear and in rough grounds length of warp could be 2.4-4 times the depth. Scope ratio is mainly depending on the nature of the fishing ground for e.g.

- For smooth fishing ground : slightly reduce the scope ratio
- For sandy bottom: slightly increase the scope ratio
- For rough ground: greatly reduce the scope ratio

Swimming speed of the fishes to a large extent determines the required trawling speed. As the trawl drag depends on the towing speed, maximum dimensions of the trawl will be determined by the available towing force of the vessel and the towing speed requirements for the target species. Swimming ability of fish depends largely on their size and varies with different species. If the trawling speed is above the cruising speed, the fish in front of the footrope would eventually tire and drop back to be caught in trawl codend.

- Typical towing speed for beam trawls 1.0 - 2.4 knots
- Typical towing speed for bottom trawls 2.0 - 4.4 knots
- Typical towing speed for mid water trawls 3.0- 8.0 knots

### **4.3. Bottom trawling**

When a trawl net is dragged in the bottom or just above the bottom it is known as bottom trawling. Stern bottom trawling was first introduced in the late 1940s and has become widely popular since then. The advantages of stern trawling is the maximum utilization of the towing power and ability to set gear in straight line.

#### **4.3. Bottom trawling**

##### **4.3.1. Stern trawling**

In the stern trawling the wheel house is placed forward leaving the aft deck clear for the fishing gear and fish handling. Split winch is placed abaft the wheel house and each drum is wound with about 300 m of steel wire rope or synthetic wire rope. This forms the warp line. The entire warp line is marked at regular intervals. This marking is required to know the amount of warp line released during bottom trawling. Mast and derrick are provided just abaft the winch. Mast is used for hoisting the navigational signals and derrick is used to lift the cargo/cod end. Gallows with towing blocks are provided on either side of the stern deck part of the trawler. In large stern trawlers towing blocks are fixed on the stern gantries instead of gallows. A clear view of the aft deck from the wheel house is provided so that the fishing master can observe and ensure increased safety during the operations.

Large stern trawlers are provided with a stern ramp which facilitate hauling up of the gear. In this case the transom of the vessel is cut and deck is lowered to form a smooth gradient up to the water level. Shooting and hauling of the gear are thus made easier and requires less man power. In large trawlers net drums are used to haul up, pay out and store the sweeps bridles and net with rigging.

#### **4.3. Bottom trawling**

##### **4.3.2. Preparation of the trawl net:**

The trawl net is to be rigged and kept ready in the fishing deck or in the net drum. Required number of floats should be attached on the head rope at regular intervals. Check the foot rope and tickler chain. The head rope and foot rope are connected to the bridles and sweeps which is then connected to otter boards. The winch warp line is connected to the other side of the otter boards through the brackets. Net is arranged on a stern part in such a way that codend part of the net should be on the top of the net for easy releasing. The open end of the codend should be tied by using self securing knot and keep ready for further operation.

### **4.3. Bottom trawling**

#### **4.3.4. Shooting of the net**

As soon as reaching the fishing ground, one should observe the meteorological and hydrographical parameter such as direction and speed of wind, temperature, surface temperature, direction and speed of current, type of ground, depth of water, fishing position etc. Bring the vessel into lee word side and slow down the vessel with the trawler moving release the codend with forward motion of the trawler and then release throat portion belly followed by head rope and foot rope. Once the net is in the water, the sweeps and bridles connected to the otter boards are released with the vessel slowly steaming ahead so that net sweeps and bridles spread out and open properly. The otter boards are lowered to a few meters below the surface of water and kept for a few moments to ensure that they are spreading properly. The gear is then lowered to the desired fishing depth by releasing sufficient length of the both warps. The length of warp released during bottom trawling depends on the depth of the fishing ground, nature of sea bottom and towing speed of the boat. The ratio of depth of fishing ground and the warp released is known as scope ratio and is typically around 1:6 in shallow water up to less than 20 m, beyond 20 meter it would be 1:4 and in deeper waters it is 1:3.

#### **4.3. Bottom trawling**

##### **4.3.4. Towing speed and duration**

Towing speed of bottom trawling should be more than the swimming speed of fishes. Usually good quality fishes one should drag for a short period. If dragging duration is increased fishes will get damaged and deteriorate fast. fishes will swim at a normal speed of 3-4 times of its body length and will increase the speed up to 7-8 time of its body length per second and fishes will increase further up to 10-4 times of its body length per second when they are in danger known as burst speed which will last for few seconds. For bottom trawling towing speed should be in the range of 1.4-3.0 knots. They again vary with targeted species. For e.g. shrimps and soles 1.4-2.0 for other bottom fishes 2.0-3.4 knots.

Normally towing duration is one hour but commercial trawlers are dragging for 2-4 hours. In order to get.

##### **4.3. Bottom trawling**

##### **4.3.6. Hauling**

After dragging the gear for a prescribed duration of 2-4 hours depending on the catch, the hauling operation begins. Decelerate the engine and engage the winch clutch. The winch drums start rotating and the main warps are heaved in evenly on to the winch drums until the otter boards reach the gallows. As soon as otter boards reach the gallows stop the hauling and fix the otter board to the respective gallows. Then the net is dragged with full speed for some time so that fishes present in the body of the net are driven into the codend. This also help in cleaning the net. After decelerating the engine, sweeps and bridles are hauled in followed by the main body, throat and finally codend of the net. If the codend is heavy with the fish catch, mast and derrick is used for hauling up the codend. Further, the codend was full of fish catch then catch may be split in to two parts by using split rope provided in the middle of the codend and then part by part catch is taken aboard.

In large trawlers, a system consisting of Kelley's eye, independent wire and back strap is used for transferring the load back to the powered hauling system or net drum after otter boards have reached the gallows.

#### **4.4. Side Trawling**

In side trawling the net is set over the side. This method has been gradually replaced with stern trawling. There are only very few side trawlers operating throughout the world. Side trawlers have a forecastle- the forward part of the vessel and wheel house at the aft with the engine room below. The working deck is forward with one or more hatches to the holds below. A two drum winch with towing warps is situated in the forward of the wheel house which also has two warping heads or gypsies for handling running lines. The winch may be placed anywhere on the fore deck to allow convenient runs of wire ropes with the help of deck bollards. Two gallows are provided on port the side of the vessel. Forward gallow is situated just abaft the forecastle and aft gallow is placed in the side of the wheel house. A towing block is situated at the aft port side of the vessel were warps are clamped together

while towing the trawl gear. A well stayed mast is situated at the forward end of the working deck and in a second mast is situated in the aft.

#### **4.4. Arrangement of trawl gear for side trawling**

The towing warps from the vessel is connected to the brackets of the doors with a link so that it can be easily engaged and disengaged. The net is connected to the otter doors through a short chain and ground cables. The end of ground cable passes through the Kelly's eye and is connected to a stopper. The end of the stopper is connected to the ground cable and is small enough to fit into the eye of the figure of 8 link and transmits the pull from the door to the ground cable. The section of the stopper that is forward to the eye is fastened to a wire or chain known as the independent wire. Quarter ropes are fitted to the trawl net and is connected to the ground rope at the point where the wings merge into the body of the net. They then pass around the outside of the net and through the rings attached to the headline. These ropes are used in bringing the net aboard the vessel.

#### **4.6. Stern Trawling**

The side trawler sets and hauls the trawl gear over the side and tows trawl gallows and towing block on the side. The stern trawler carries out these operations over the stern.

#### **4.6. Stern Trawling**

##### **4.6.1. Gear handling in stern trawling**

A number of basic methods after handling the gear have been developed and became associated with vessels of different size ranges. Although the method for gear handling may differ, the general layout of most of the vessels are similar. Small stern vessels are usually single decked with a transom stern, while medium size vessels have a full or partial sheltered deck. The large vessels, which have the capacity of freezing their catch at sea have full sheltered decks together with extensive superstructures. All stern trawlers are characterized by a wide, clear, working deck at the aft and a wheel house or living quarters forward. The engine room is usually forward of amid ship below the wheel house. Some medium sized vessels have the engine room aft with exhaust uptakes on each side of the working deck. The fish hold normally lies below the working deck or in the case of shelter deck vessels, below the main deck or amid ship so that trim does not change markedly as fish is taken aboard and stowed below.

The main winch is situated abaft the deck house or superstructure and the gear towed from gallows sited aft on each side of the stern. Stern trawlers offer two striking advantages when compared with other trawlers.

- Gear is worked over the stern.
- The vessel maintains a straight course during hauling, setting and pulling along the direction of motion.
- Most cases the vessel can therefore be headed directly into the wind and able to continue fishing under severe sea conditions than a side trawler.
- The working area at the after end of the vessel is much steadier as it is not affected by pitching. The forward deck house provides protection from pulling. Thus the stern trawler provides greater safety and comfort for the crew.

The main methods of gear handling:

- Use of quarter ropes
- Net drum
- Stern ramp
- Various combinations of the above

Equipment: for stern trawler winch should have at least two main drums and two warping heads. In order to ensure a working deck clear of running wires the winch may be mounted at fore-castle level so that the wire run over the heads of crew members on the working deck.

## 4.6. Stern Trawling

### 4.6.2. Towing and Handling warps and doors

A smooth run of warps from the winch to the gallows is necessary. The required blocks and sheaves must be arranged in the working area to permit easy spooling on the winch and a smooth run over the gallows with minimum changes in the direction.

A pair of gallows to be mounted at each side of the working deck at the aft and alternative method for towing support is to have a gantry structure which will leave the working deck completely free of towing blocks.

### 4.6.3. Net drum

In this method the net is wound aboard on to the drum. The deck space required is limited when compared to other method. Here the space required to mounting the drum plan the area needed to dump, clean, sort trawl catch.

**Size of vessel:** 40ft-90ft.

## 4.6. Stern Trawling

### 4.6.4. Equipment

**Winch:** Requires at least two main drums for the warps and two warping heads for handling the codend.

**Trawl drum:** Must be large enough to wind on the trawl and the bottom gear. This may be fitted in between the gallows.

**Gallows:** Situated on each side of the aft deck, and are usually tripod in structure. This is often are made portable and pinned into socket at their base.

**Boom:** The boom must be of sufficient length to bring the codend aboard in the required position. A separate topping winch for the boom will be useful.

## 4.6. Stern Trawling

### 4.6.4. Operation

I. While towing, the warps pass atwartship from the winch round rail mounted sheaves to the gallows and doors.

II. During hauling, otther doors are pulled up to the gallows and are attached to the warps. Independent wires are disconnected from the towing brackets and is connected to leads from drum. Drum rotates to take pull and ground cables are disconnected from blackstrap and wound on to the drum.

III. The mouth of the net is wound on drum. A ring strap is used to lift body and vessel turns to star board. Bull rope being taken forward to bring codend along side.

Trawl along side, the body is lifted to fill codend. Codend lift is taken by second whip.

Full codend is lifted and dumped and return to the water and filled again.

## 4.6. Stern Trawling

### 4.6.6. Stern Trawling With gantry

Operation is similar to that of side trawling but carried over the stern.

- Small stern trawlers are usually single decked with transform stern
- Wide, clean working deck aft
- Wheel house and leaving room forward
- Forwarded engine room
- Fish holds are below the working deck
- Aft the fish hold fuel tanks are located to allow control of trim
- Some vessels will have engine room aft and fish hold forward
- The winch is sited abaft the wheel house
- Gallows are situated aft on each side of the stern

## **4.6.Stern Trawling**

### **4.6.7.Advantage over side trawler**

- As the gear is worked with stern, the vessel is maintained on a straight course while hauling and shooting.
- The pull is along the direction of motion. In most cases the vessel can therefore be headed directly into the wind and sea.

## **4.6.Stern Trawling**

### **4.6.8.Operation**

It is similar to that of side trawling. However, some of the points to be remember

- Trawling speed should be slightly increased on heavy ground (at least 3 knots)
- Minimum warp scope possible
- Trawl without quarter rope is a good protection in heavy grounds.
- In all areas whether bottom is unfavourable for trawling, all drags should be made a straight courses. Since change of al course may result in an overturned codends clearing lower wings and trawl board digging into ground.

## **4.7.Mid water Trawls**

Mid water trawls are used for pelagic trawling. These are conical bags with wide mouth made of light netting yarns and large meshes. Based on the construction of the trawls can be grouped into

- Two seam pelagic trawls
- Four seam trawl (with all the four equal panels for pair trawling)
- Four seam trawl (The upper and lower panels are identical and the two identical side panels are narrow)

True mid water trawls are four seam trawl net with short wings. These nets considered are not fit for bottom trawling due to their lightness and get easily damaged on contact with sea bottom. This gear is known as “fly catchers” among the fishermen.

Gear technologist are in the process of developing new gears like rope trawl, hexagonal mesh trawls, big mesh trawl, Danish trawl etc.

## **4.7.Mid water Trawls**

### **4.7.1.Rope trawl**

Rope trawl was developed during 1970 in Poland, Germany, Norway, France and Netherland. In all designs rope can be found in three or four panels running from; head rope, foot rope or side rope down to approximately one quarter of the length of the net.The biggest concern in the design was what shape the leading ropes were going to take. Unlike normal netting, the ropes are independent of one another on the basis of equal tension in each of the ropes. Wings are narrow at the top and wider at the bottom, with a very small bosom resulting in a very noticeable reduction of drag. But this is not superior to conventional gears in the quantity of catch. The ropes do not have herding effect on fish that a normal net do. An explanation of this can be that these ropes which are stretched in the direction of towing seems to be static to fish. But the sound and the vibration that goes along with the movement of the ropes makes the fish to get away. Between the ropes, water does not move and it is safe and easy for fish to escape. As a comparison, these make a whole wall of vibrating water between the twines drive the fishes into the net.

## **4.7.Mid water Trawls**



#### **4.7.2.The Danish Trawl**

This is a modification of the rope developed in Denmark. In this trawl ropes and twines are at an angle to the direction of the flow. The ropes are positioned like the normal netting bars. Therefore, they appear to transfer the forces acting on the net very well on to the headlines and provide excellent herding effect.

#### **4.7.Mid water Trawls**

##### **4.7.3.The Line Trawl**

The line trawl developed in Newzealand to reduce the drag. In this design rather than avoiding water flow into the net like in previous designs. This net is based on the theory that it makes easier for water to flow out of the net. Once it leads the fish into it, a series of lines are as far apart on the meshes would have been which they replaced. The reduction of drag in this design is not as high as in the previous two designs. Advantage is that all the lines are of the same length, which makes it easy to repair.

#### **4.7.Mid water Trawls**

##### **4.7.4.The Big Mesh Trawl**

This design was introduced in France. Mesh size at wing and first part of the net is around 18 meter. This net is very successful in catching of shoals of clupeids, anchovies, sea bass and whiting. Netherland modified this net with 20 m mesh size and producing community.

##### **4.7.Mid water Trawls**

##### **4.7.4.The Hexagonal Mesh Trawl**

Mesh size is around 30 m was developed in Norway and Netherlands. There is a moderate reduction of drag and superior efficiency for catching mackerels.