



Chapter 14

Purse Seines: Design and Operation Strategies for Resource Conservation

P. Pravin

Central Institute of Fisheries Technology

Matsyapuri P. O., Cochin - 682 029

E-mail: pravin2005@gmail.com

1.0 Introduction

Purse seining is an aimed fishing method mainly to catch dense, mobile schools of pelagic fish and includes all the elements of searching, hunting and capture. A purse seine is made of a long wall of netting framed with float line and lead line and having purse rings hanging from the lower edge of the gear, through which runs a purse line made from steel wire or rope which allow the pursing of the net.

2.0 Purse seine design

The purse seines vary widely depending on the method of operation, gear handling, depth of operation, target species and vessel characteristics. Brief description of a typical purse seine net is given below.

Bunt: The region in the purse seine net where the catch is accumulated before brailing is called the bunt because of the excess strain it has to withstand. It is made up of heavier netting. The bunt is placed in the centre or at the end of the wall of the netting depending on the type of operation. The bunt should be at least as long and deep as the length of the boat.

Main body: It extends from one end to the other end of the net except the bunt region. It is the largest part of the net and facilitates surrounding of the fish shoal during operations. It is made by joining together large sections of netting of appropriate mesh sizes to catch the

target fish. The material used should have high specific gravity to increase the sinking speed during setting. Twisted knotless netting and Raschel braided netting are lighter and are widely used for purse seines. But, of late knotted webbing is preferred over knotless webbing, because of the difficulty to repair knotless webbing when damaged.

Selvages: These are strips of strong netting used for strengthening the main webbing and to protect it from damage during operations. It is provided in the upper, lower and side edges of the main body of the net. It consists of few rows of large meshes of thicker twine. The upper selvedge is attached to the float line also called the head rope and the lower selvedge to the lead line or foot rope. It is also attached to the side ropes or gavel lines. Lead line is usually longer than float line by 10%.

Floats: Cylindrical or spindle shaped floats are generally used. Total buoyancy of float is maintained at 1.5 to 3.5 times the total under water weight of the purse seine net and its appurtenances. Higher buoyancy is provided in the bunt area in order to counteract the sinking force due to weight of heavier netting in this area and the weight of fish while concentrating the catch. Usual extra buoyancy of floats is 2 to 4 times the weight of foot rope with sinkers. Usually double float lines, one rope with right hand twist and the other with a left hand twist is rigged, which prevents it from twisting. Braided rope is very good for float line because once stretched it does not kink twist (turn around itself) or twist.

Sinkers: Spindle shaped sinkers are attached to the lead line to attain 1-3 kg/m for small purse seines and up to 8 kg. m⁻¹ for large tuna purse seines. Lead sinkers of approximate weight of 50-65 g each are used. Usually 180 to 220 kg of sinkers are used for a sardine purse seine of 250 m with the distribution of 0.5 kg to 2 kg per metre of lead line.

Bridles and tow line: Bridles are ropes attached to float line and lead line on either side and are connected to a tow line of sufficient length to facilitate setting and hauling operations.

Lines and ropes: Twisting of fibre ropes may cause considerable problems hence braided ropes are preferable to twisted ones. It is recommended to pre-stretch new ropes before the netting is stapled to them. This can be done putting the rope under load and using swivels to take out extra twist. In case multiple head lines and float lines are used it is advisable to use ropes with opposite twist directions so that the twisting forces of each rope counteract one another.

Float lines: Floats are threaded to the float lines to which the netting is hung directly. Single rope float line is disadvantageous due to distortion of the meshes of the guarding strip which occurs around the floats if the hanging is tight. With loose hanging the distortion is less, but spaces are created between the float line and the netting where small fish may escape or large fish or porpoises may get jammed during hauling. Both the distorted net edge and the loose hanging create weak spots along the float line which may give way when under load. It is advisable to have float lines made up of two or more ropes. While rigging the net, it is more convenient to hang the netting from the hanging line and then to seize it together with another rope carrying the floats.

Lead lines: Lead lines as a rule are made of ropes of the same size as that of the float lines. Single rope lead line are used more often than that of single rope float lines. It could be mainly due to the size of the sinkers which are smaller than the size of the floats and hanging netting directly on the lead line does not cause problems. Chain lead lines and lead lines without sinkers are also used.

Gavels and other vertical ropes: Gavels (breast lines) are made of similar ropes to the lead lines or float lines. Their length depends on the net.

Purse lines: Fibre ropes and steel wire ropes are used for purse lines. Fibre ropes are used when the pursing is manual. Most seiners have purse lines at least 10 - 20% longer than the total length of their seines. If the purse lines are very long then swivels are used to connect one or two purse lines to prevent twisting and kinking. Purse lines are subjected to considerable frictional wear in the purse rings and abrasion on the winch barrel and in the purse blocks. Steel wire, polyamide and PES are considered good for purse lines. It must be about 100 to 150 times longer than the joint length of the lead line and the gavels. Purse lines are made of synthetic rope for small and light purse seines while steel wire rope of 5/8" or 3/8" for heavier purse seines.

Hanging coefficient: The most common horizontal hanging coefficient on float line is 0.7 and for body and bunt is 0.65. In the case of lead lines, it is 0.75 for body and 0.7 for bunt

Tow lines: It is usually made of rope or steel wire and is the last part of the seine that is paid out from the purse seiner. The end of the tow line remains attached to the seiner and it can be used to allow a greater circumference of set to be made by using the tow line as an extension of the net.

Tow ropes: It is about 2/3 rd of the float line length. The tow rope or lazy line is paid away at the same time as the bunt.

Purse rings: must be strong - steel or brass rings are used with snap type or closed. The size of purse rings depends on the size and weight of the net. These in turn depend on the size of the boat. For small and light purse seines, purse rings of 100 mm to 150 mm across made of steel 10 mm in diameter and weighting 1 to 1.5 kg each can be used. For bigger nets, rings of 120 mm to 180 mm across of steel 12 mm in diameter and weighing 2 kg to 3 kg each can be used. Number of purse rings may vary from 20 to 60.

3.0 Design Considerations

The following important factors will have to be considered before designing a purse seine gear viz; the area to be fished, the size of the vessel; the biological characteristics of the target species (such as shoal size, swimming speed, swimming layer, size composition and behaviour of fish during approach of the craft and during surrounding, and pursing of the gear, the of length, depth and shape of the net; depending on the target species. Selection of materials; mesh size and twine thickness for the bunt and the body netting, hanging

coefficient, and determination of weight and number of sinkers and floats required for the net.

The size of purse seine: varies in different region, in different conditions and the mode of operations also may differ. The webbing surrounded by selvedges on all its four sides is of uniform mesh size depending on the type of fishery. It is formed by lacing a number of vertical pieces of webbing one after another. The depth of which increases systematically from both wing ends and reaches at the maximum at the central strips. The mesh sizes are usually the same throughout but the twine size will be generally thicker at the bunt end and the wing region.

The length and depth: The length and depth of the seine must be determined by the size of the vessel, the species, behaviour of fish, fishing method and condition. It is easiest for operation when the depth is between 10-15% of the length. However, in certain cases the depth goes upto 30 - 50% of the length for inshore purse seines for sardines, anchovies, pilchard where the shoal depth will be more. On the contrary deep sea purse seines for fast swimming fishes like tuna, skipjack etc long and relatively shallow seine is most suitable. A rough rule of thumb is that depth of the purse seine is one-tenth of the float line. For purse seines for deep swimming and quick diving shoals, the depth may vary from 1/4 to 1/3 of the float line.

The overall size of purse seine is best expressed as length of float line. A purse seine in water is not a truly vertical wall of webbing but the net is hung so that it is roughly cup-shaped when laid out in a circle. This is accomplished by making the lead line shorter than the float line.

Mesh size: The mesh and twine size is directly related to the size of fish and the quantity of fish caught. Choice of too small mesh size increases the cost and results in slow sinking. Too large a mesh size results in loss of catch as well as in gilling. The mesh size of purse seines must be small enough not to gill the fish in any part of the seine. A common practice is to select a mesh size considerably smaller in the bunt than the other parts of the seine.

Choice of mesh size is a function of the target species. It is necessary to avoid enmeshing or gilling the fish (with respect to regulations on minimum mesh size)

$$OM = 2/3 \times L/K \text{ (Fridman formula)}$$

Where

OM = mesh opening (mm) in the bunt

L = length (mm) of target fish

K = Coefficient, a function of the target species viz., K = 5 for fish that are long and narrow; 3.5 for average shaped fish; 2.5 for flat, deep bodied or wide fish.

Twine Size: The main criterion for determining the twine thickness for netting in a purse seine is to provide sufficient strength for pursing and hauling when the load due to the fish is maximum. The wing ends and the lower and upper selvages of the seine are subjected to the greatest stresses. Therefore twines of greater thickness are used in these parts. Minimal loads are imposed on the central sections of the seine.

Floats and sinkers: Sinking speed is found to be proportional to the square root of the apparent lead line weight. Excessive weights result in damage, strain on hauling equipments and handling problem. The normal requirement is 0.5 to 2.0 kg/m of foot rope. The buoyancy requirement is 2-4 times of the weight of the foot rope.

Ratio of ballast to weight of netting (in air): The weight (in air) of the ballast normally ranges between 1/3 and 2/3 the weight of the netting in air. The weight in air of the ballast per metre of seine foot rope is often between 1 and 3 kg (although more is used for small mesh purse seines used to catch deep swimming small pelagic fish and upto 8 kg m⁻¹ is used in large tuna seines).

Ratio of buoyancy to total weight of the seine: The rigging of floats on a purse seine must take into account not only the buoyancy needed to balance the total weight of the gear in water, but also additional buoyancy. This additional buoyancy should be of the order of 30% for calm waters and upto 50-60% in areas of strong currents, to compensate for rough sea conditions and other factors related to handling of the gear. Buoyancy should be greater in the area of the bunt (which has heavier twine) and mid way along the seine (where pulling forces are greater during pursing). In practical terms the buoyancy of the floats should be equal to about 1.5 to 2 times the weight of the ballast along the bottom of the seine.

The hanging ratio (E): It is usually greater on the lead line than on the float line. Hanging ratios generally range from 0.50 to 0.90, depending on the type of the net. The hanging ratio may also vary along the float line or lead line, usually being lower in the bunt.

The tow line: It is normally about 25% of the length of the purse seine.

The purse seine must have good resistance to abrasion and good breaking strength. As a general guideline the breaking strength (R) of the purse line should be as follows:

$R > 3 \times (\text{combined wt of the netting, lead line, leads and purse rings})$

$R = (\text{tonnes}) = \sqrt{\text{tonnage of vessel}}$

Volume occupied by the seine when rigged.

$V(\text{m}^3) = 5 \times \text{weight (tonnes) of the seine (in air)}$

Depth in water: As an approximation the actual depth or height (AD) can be considered equal to roughly 50% of the stretched depth. (SD, or stretched mesh size x No. of meshes) of the seine at its extremities and 60% near the center of the net.

$AD = SD \times 0.5 = SD/2$ extremities

$AD = SD \times 0.6$ centre of net

Sinking speed: Sinking speed of a purse seine for different seines - sinking speed has been measured in a range from 2.4 - 16.0 m/min, with an average of 9.0 m/min.

4.0 Selection of materials

Properties of the netting materials exert profound influences on the fishing net. Based on the requirements of the fishing gear the materials are selected. The choice of material for the construction of purse seines is very important. The properties to be considered before selecting the material for purse seine are high breaking strength, excellent elastic properties, high specific gravity, low resistance against current, good water shedding capacity and type of knot.

As it is a huge net, the material used for purse seine should be thinner (preferably knotless) to reduce the bulkiness of the net. It should have high breaking strength. As the net has to withstand enough energy against impact forces due to accumulation of fishes and during hauling, the netting material should have high elastic property. For better performance of the net, the material used should sink fast and the net has to be pursed as quickly as possible to evade escape of fish shoals. The sinking speed depends on the sp gravity, degree of twist and the smoothness of the twine. This also can be increased by increasing the amount of weight in the foot rope.

To avoid the distortion of the net due to strong under water current, which sometimes could be from two different directions, the material selected should have less resistance against current. Knotless netting is preferred to knotted netting because the resistance will be less than the knotted netting. Hence large parts of the netting in purse seines use knotless webbing. Recently hexagonal meshes netting has been introduced due to the advantages of comparatively low hydrodynamic resistance and saving in the total material required for the net. Only the bunt and selvedge are constructed using knotted net for the required strength in these parts of the net. Among synthetic materials, terylene and nylon are preferred as they are having high breaking strength. Recent trends is to make combination twines like PA and PVC so as to combine the strength of the former and the high sp gravity of the latter material.

5.0 Operations Strategies

Fish detection and scouting are the most important aspects in purse seining. Searching for fish aggregation, then identifying wherever possible the fish species and evaluating school sizes and its catchability, prior to surrounding is the major part of a purse seine operation. Purse seining operations involve location of fishing grounds, scouting, setting, pursing and hauling.

Location of fishing grounds is very much necessary to reduce expensive searching time, which will also save fuel costs. Satellite imagery, aerial spotting, and general hydrographical information are very helpful in locating fishing grounds. Information on position and extent of fish concentrations, average size of shoal and depth and general movement of schools are very vital for increased efficiency of purse seine operations.

Different species and sizes of the fishes have different schooling characteristics and this makes it possible to identify different school types from the air and sometimes at night due to bioluminescence. In fact, experienced fishermen are able to identify the species and also are able to roughly estimate the size of the shoal.

Visual spotting- They can be spotted from high places out at sea or from the crow's nest placed on the main mast. Scouting is also done using powerful binoculars which are generally mounted on the bridge. A constant look out is maintained for fish schools.

Fish location using hydroacoustic equipment - Echosounders is one of the most practical and effective fishing tools and can be used even by the smallest of seiners. Sonars are also used for searching the fish school.

Purse seines can be set in one of the following four ways.

- (a) with a skiff
- (b) using a buoy with or without sea anchor
- (c) using an anchor with or without skiff
- (d) using a tow rope

The traditional method of seining is the side method. The purse seine can be operated either with the aid of purse boat, with the help of the drive line and without purse boat or drive line.

It is not enough if a shoal is located. Its movement is another factor to be encountered, to determine the position of the boat to be taken before spotting. After locating and scouting the fish shoal to determine its movement and ascertaining the direction and velocity of wind and current, encircling is done generally in a clock wise direction.

6.0 Resource conservation

Purse seine like other surrounding nets are not selective. However, operational selection is possible, if schools are judiciously selected after evaluating the presence of bycatch species. Bycatch species are commonly present in FAD assisted purse seining and more than 40 species of fish and cetaceans have been reported from purse seine landings. Special escape panels known as Medina panels which are sections of fine mesh, prevent dolphins from becoming entangled in the gear and 'back down manoeuvre' have been deployed to prevent capture of dolphins in purse seines. Selection of mesh size for the purse seine appropriate

for the target species, proper choice of fishing area, depth and season could also head to better selectivity of purse seine.

7.0 Further reading

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