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A PRACTICAL APPROACH TO THE DESIGN CONSTRUCTION AND OPERATION OF MIDWATER TRAWL USED IN KAINJI LAKE NIGERIA

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1. Introduction

Like most other man-made lakes in Africa, there has been an initial increase in the fish stocks in Lake Kainji due to the enrichment of nutrients leached from newly flooded land. Soon after impoundment of the lake, the fish family Citharinidae dominated the catches. They made up 37.4% by number and 23.1% by weight of the first years catch (Lelek, 1973). At present the pelagic fishes, namely Characidae and Schilbeidae, have shown a considerable increase in gillnet catches.

Otobo (1974) has shown that there is a potential for a clupeid fishery in Lake Kainji while Sagua & Otobo (In press) put the annual biomass of clupeids at 3,000 metric tons. Whereas the Characidae and most Schilbeidae are satisfactorily harvested by gillnets which are the main fishing gears used by the local fishermen in Lake Kainji the clupeids are not caught by the same gear because of their small size (Average Standard Length 40-50mm)(Otobo, 1974).

Commercial exploitation of the clupeid fishery is currently being carried out at Faku (a village just below the dam), and around Yauri which is located in the northern part of the lake (Otobo, 1974). The only local method used in harvesting clupeids is the atalla lift net. In an attempt to introduce a better and more effective method the light attraction technique was tried. The limitations of both the atalla lift net and the light attraction techniques have been reported by Otobo (1974).

The next development was the introduction of clupeid midwater trawl, which was initially designed by Stride (1975). It has the size of 12.75 meters headrope. He modified the net at first from 12mm and 9mm codend to 6mm codend. The modification was necessary because clupeids escaped through 12mm and 9mm codend in large numbers - but with 6mm codend the escape rate was low. This trawl was found very effective for harvesting clupeids, and as such it was recommended for commercial use (Stride, 1975).

Sagua & Otobo (In press) also showed that the clupeids could be successfully harvested by means of a midwater trawl, and proved the advantages of the trawl net over both the atalla and the light attraction techniques. Because of the potential importance of clupeids in the lake fishery it has been considered desirable to present a handbook on the midwater trawl intended as a basic guide to fisheries organisations, fisheries extension workers and the fishermen themselves.

2. A Trawl Net:

A trawl is an active fishing gear with wings. When in operation, it looks like a funnel or a cone. There are many types of trawls, broadly classified into two:

(a) Midwater Trawl and (b) Bottom Trawl. The main principle of constructing either is the same.

This paper is mainly concerned with the clupeid midwater trawl operated by two boats using 15 h. p. outboard engine. It is a large square mouthed net with a theoretical opening of 12. 75 square meters. It has four wings, attached to the mouth of the trawl and its total length is 22. 5 meters. It has four panels, top, bottom and two side panels (Fig. 1). The two bridles on each side terminate into an eye, from where the warps run to the boat. Big weights are attached at the end of the wings with weights on the footrope and floats on headrope to give the net its vertical opening. The codend buoy tied to the codend shows the position of the codend while towing.

The basic knowledge in selecting a trawl is to know the horse power of the towing engine. This in turn determines the size of trawl, its mesh sizes and twine thickness of the nettings especially at the codend. Knowledge of the type of fish, habitat and the depth of water is quite essential also.

3. Materials

3.1 Nettings:

With small boats and engine up to 40 h. p such as used at present in Kainji Lake, the following twine sizes are recommended:

6mm	stretched	mesh	210/6
9mm	stretched	mesh	210/6
13mm	"	"	210/6-9
25. 5mm	"	"	210/12-18
51mm	"	"	210/18-24
76mm	"	"	210/24-36
102mm	"	"	210/30-48
127mm	"	"	210/32-50
127-203 mm	"	"	210/48-60

The mesh sizes and twine thickness are larger at the wings and front portion of the trawl, and decrease gradually down to the codend. This is to allow an easy

water flow through the meshes in order to reduce the towing resistance.

3.2 Ropes:

Size of ropes depends upon the size of nettings in use. The standard size of rope here for mounting a midwater trawl with head-length of 12.75 meters is 25mm to 32mm circumference, and 32mm circumference for the towing ropes. Rope made of synthetic fibre is much stronger and preferable to natural fibre. But it is better to avoid any rope material that can easily twist.

3.3 Weights:

The best material for weight is lead. Small pieces with holes already made are quite ideal for easy threading onto the footline. The two towing weights for attaching at two ends of the wings on the footline are made by moulding lead from old motor batteries etc. in empty tins or pipes after melting.

Various lead sizes are made by using this method. The more the power of the engine, the heavier the side weights needed to keep a trawl properly opened.

3.4 Floats:

The best type of floats for the trawls are rigid floats, because they maintain their shape and buoyancy in the water. 127mm and 203mm diameter trawl floats are ideal for a midwater trawl with head-length of 12.75 meters. For midwater trawl, footrope should approximately equal the headrope buoyancy. Floats are used on the floatline in order to assist in keeping the upper side of the trawl mouth opening up.

4. Designing the Trawl

It is very essential to plan, draw and calculate correctly the depth, width and length of trawl needed before construction. A trawl can be designed for a particular type of fish or requirements can be compromised to make a general purpose trawl.

Calculation for designing a trawl may be started from the front, and depends upon the tapering ratio. However, the following method of calculation is based on the four seams midwater trawl in use in the Kainji Lake (See Fig. 2).

4.1 Method of Calculation:

The first step is to decide the size of the net required for fishing, for example, the current clupeid midwater trawl in use is 12.75 meters headrope, i.e. 150 meshes of 102mm mesh webbing.

(a) To find out the number of meshes for the wings and bosom, (Fig. 2) W is divided by 3 and the answer is allotted to each as shown in Fig. 2. But it is not not a rigid statement that the number of meshes at the bosom should equal those of the wings. Meshes could be fairly more or less at the bosom depending upon one's decision. Because the bosom is mounted in halves i.e. 50% slack and the wings 100% tight, therefore the length of the bosom after mounting is 2.55 meters and each wing is 5.1 meters long. Total length of headrope is 12.75m.

The depth of a wing from the centre of its base to the apex is 50 meshes. Half of the base is 50 meshes, therefore the whole base is 50 x 2 = 100 meshes. On Fig. 2 the gape of the trawl is 150 meshes in each panel. In all, there are four wings and each wing covers side, top, and bottom panels by 50 meshes either way. Two equal sides are tapered from the apex all bars down to the base. Note, each mesh gives two bars, therefore there are 50m x 2 = 100 bars.

(b) The tapering ratio here is 2 bars to 1 point. This means that the cutting on two sides goes down vertically by 2 meshes (each bar cut makes $\frac{1}{2}$ a mesh), and horizontal is also doubled, thus 2 meshes. So to get the number of meshes at W_1 : use the formula:

$$W_1 = W - \left(\frac{D}{V} \times h\right)$$

$$W_1 = 150 - \frac{36 \times 2}{2}$$

$$W_1 = 114 \text{ meshes}$$

V = vertical cut, h = horizontal cut, D = Depth of the panel.

W_1 = Width of the tapered bottom part of W.

(c) To find out the number of meshes in W_2 with two different mesh sizes to be joined, use the formula

$$W_2 = r \times w_1$$

$$W_2 = 102{:}76 \times 114\text{m}$$

$$W_2 = \frac{102}{76} \times 114\text{m}$$

$$W_2 = 153 \text{ meshes.}$$

r = ratio of two different mesh sizes.
W_2 = width of the front second piece of the panel '76mm' mesh.

For the rest of the calculation down to the codend, the above method is repeated using their appropriate figures. Note that all points are cut in the codend.

(d) In order to know the proportion of meshes of two different size webbings to be joined, say 102mm and 76m meshes, first, the ratio of the two different mesh sizes is figured out. The ratio of joining is 2:1 for the first twenty-six. After this, the ratio of joining is 1:1.

(e) In case of even ratios say 76:38 $= \frac{76}{38} \frac{2}{1} = 2{:}1$

The ratio of joining is 2:1 throughout.

4.2 Length of the Bridles and Warps:

The lengths of the bridles depends upon the size of the trawl (Parrish 1959). Here the required length of both upper and lower bridles is five times the headlength i.e. 12.75 meters x 5 = 63.75 meters. The length of each upper and lower bridle is the product of 5 x the headlength divide by 2 i.e. 63.75m ÷ 2 = 32 meters. On the footline (lower) bridles an extra 1 to 2 meters is essential.

The length of the towing ropes (warps) depends upon this requirement as well as the depth of the water. The following formula is used $F = (3 + \frac{25}{D}) D$ (Miyamoto, 1959). Where F is the length of the warp and D is the depth of the water. Both mounting and towing ropes are well straightened (killed) so as to avoid twist during operation.

Construction

After the design, the number of meshes in each piece are counted and all the pieces cut one by one to shape.

Wings: From the apex, the piece that will form the wing is cut along the sides in bars. It is then cut to points at the base. The wing, if correctly cut should be triangular in shape. Three more identical wings are cut.

Top and Bottom Panels: On either side along the edge, the piece is cut 2 bars to 1 point. For each bar cut, the number of meshes decreases by half.

Side Panels: As above.

Codend: Codend is a narrow untapered piece, therefore all sides are cut in points. This is only a single piece.

After cutting pieces to shape, they are assembled into a trawl. Thus, the panels are firstly joined. The wings are selvaged before being joined to the panels. After a complete assembly, the mounting rope is tied between two poles, a loop or eye having already been made. More such loops are made whenever the end of each apex of a wing is reached. Now, mounting is started by picking the apex. This is continued along the bars with the hanging ratio of 100% tight. When a bosom is reached, the net is mounted in halves, '50%' slack. Thus, two meshes into the length of 1 mesh. Big weights are attached to the lower wings with leads on the footrope and floats on the headrope. These give the net its vertical opening.

6. Operation of Midwater Trawl

Towing depth depends upon the length of the warps and the speed of the boats. Thus, the slower the boats, the lower a trawl goes down and the higher the speed, the higher a trawl comes up. Therefore the correct required towing depth is a compromise of the two. These factors also influence the depth of the trawl in operation, and can also be influenced by the distance between the two towing boats. It is very important to follow the direction of the wind when shooting and hauling. For safe operation in the river, it is essential to trawl up the river.

In order to make the operation of midwater trawl economic, it is essential to locate precisely the position of the fish so as to enable the operators know the trawling depth. The use of an echosounder is therefore advisable.

6.1 Side Operation Using Two Boats

6.1.1. Shooting and Towing:

A trawl is arranged in boat A. Boat B and A should come together parallel to each other (Fig. 3). The equal towing warps in each boat are tied at the front bow or amidship. Again the appropriate wing bridles are carefully tied to the towing warps. One of the appropriate bridles is pulled into boat B until the wing is nearly reached.

The two engines are started and driven straight gently, and at the same time paying out the codend into the water until the footline and floatline of the trawl are reached. The bridles are allowed to clear off the stem in both boats. Boat B is pushed to assume the V position to boat A, and quickly the towing weights are slide down while the foot and floatlines are paid out simultaneously (Fig. 3). When the trawl is in the water, the bridles are gently paid out until the ends are reached. Then the towing starts (Fig. 3).

While towing a trawl, the distance between the two boats varies with the length of the towing warps. Thus, the distance is very important and the optimum distance being largely dependent on experience gained from repeated operations. But the shorter the warps, the less is the distance between the two boats: and the longer the warps the wider the distance. A short guide to the distance between the two boats is half the length of warp in use (Parrish, 1959).

6.1.2. Hauling the Trawl:

At the end of the tow, the two boats are allowed to head down wind and moved in towards each other until they come together (Fig. 4). The bight of the towing rope in boat B is quickly tied fast to a loop or eye of the towing warp in boat A and then its engine stopped (Fig. 4). At the same time, boat B is allowed to continue ahead towing until the wings are reached. The towing weights and the trawl are heaved-in evenly into boat A. The fish at the codend (Fig. 4) is collected.

6.2 Stern Operation Using the Stern Deck

The method of operating a trawl on the stern deck is almost the same as side operation, except that in stern operation, the trawl is arranged on the aft or stern deck of boat A (Fig. 5). In both operations, changing the direction of the tow is possible by manipulating the towing warps to different positions.

6.2.1. Hauling the Trawl on the Stern Deck:

Method of hauling the trawl on the stern deck is almost the same as side hauling, except that in the process of hauling, the warp in boat A slides gently on one side of the bit. This tends to keep the hauling in a straight point. (Fig. 6).

6.3 Labour Effort Using Two Boats

For efficient operation of a trawl, four to five fishermen are needed. Thus, two fishermen should be in boat B and two or three in boat A.

6.4 Care and Repair of Trawl

When in the field, it is advisable to carry along the mending needles and twines for repairing the minor damages observed in a trawl. For major tears a trawl should be brought into the shed for mending, or the torn portion may be replaced with a new webbing. Remove all the fish after operation. When not in use, trawls made of nylon or other synthetic twine should be protected from direct sunlight.

7. Acknowledgement

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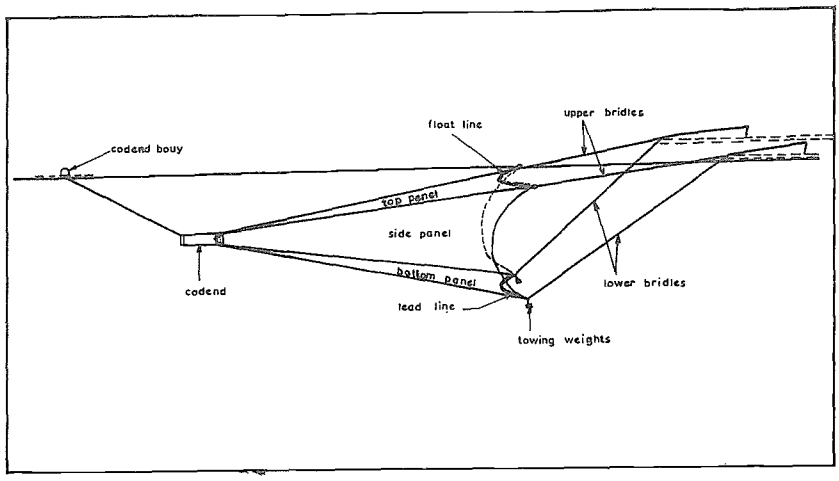


Fig. 1. Rigging and Towing Arrangement

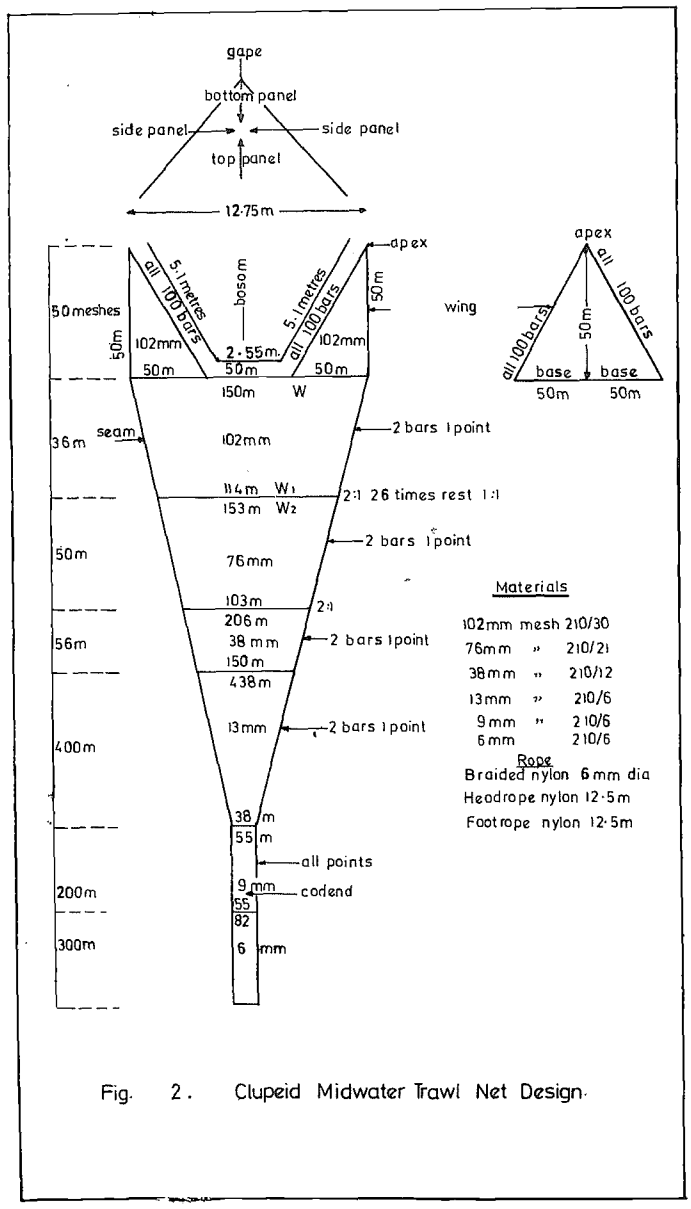


Fig. 2. Clupeid Midwater Trawl Net Design.

SIDE OPERATION

Stages of shooting

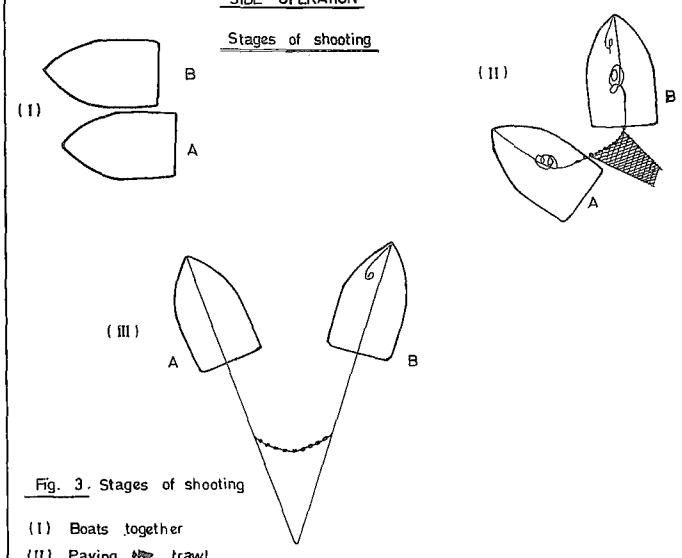
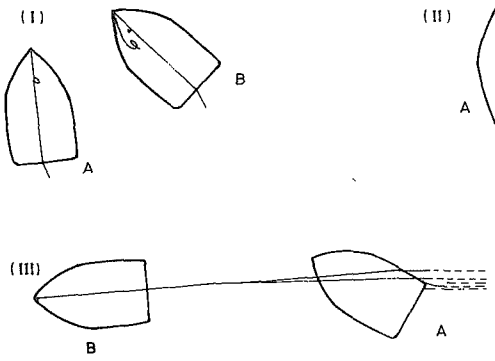


Fig. 3. Stages of shooting

(I) Boats together
(II) Paying the trawl
(III) Towing

Fig 4. Stages of hauling

(I) Boats coming together
(II) Boats together to tie a bight
(III) Hauling a trawl



STERN OPERATION

Stages of shooting

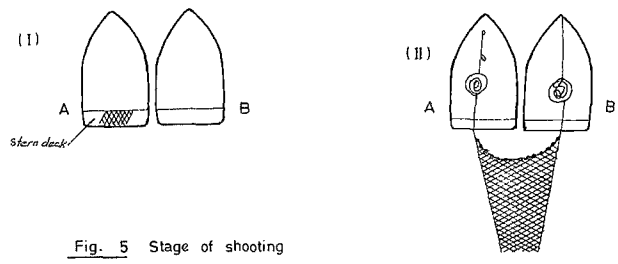


Fig. 5 Stage of shooting

(I) Boat together
(II) Paying the trawl
(III) See fig 5. of III

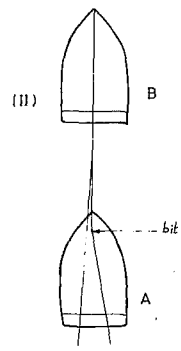


Fig. 6 Stage of hauling

(I) See Fig. 6. of II
(II) Hauling a trawl

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