Investigations on Flexible Float - A Canvas Headline Lifting Device for Trawls

K.K.Kunjipalu and M.R.Boopendranath
Central Institute of Fisheries Technology, Cochin-682 029, India.

Performance of 'flexible float', a newly developed two panelled canvas headline lifting device for trawls, has been evaluated through field trials in the waters off Cochin, India, during 1986-90. Statistically significant improvement in the yield of finfish by 115.9% and total catch by 69.0% were obtained by a 40 m demersal trawl when rigged with flexible float. Similarly, a 32 m high opening trawl registered a significant improvement in the yield of finfish and total catch by 23.2 and 27.8% respectively. Difference in the catch of crustaceans and cephalopods in both the gears, were not statistically significant. Improved fishing performance is attributed to higher headline lift coupled with enhanced herding effect on the finfish components in the vicinity of trawl mouth caused by addition of visually conspicuous flexible float. PVC-coated nylon fabric which is indigenously produced, has been identified as a suitable material for fabrication of flexible float in view of its improved tensile strength and resistance to bio-degradation in marine conditions, compared to cotton canvas.

Technical feasibility of using flexible sheering devices made of canvas to improve the headline height of trawls and/or to replace conventional lifting devices like floats and kites, has been discussed by Anon (1984; 1989a,b; 1990a,b; 1991), Ben-Yami (1979a,b,c,d), Boopendranath *et al*. (1986), Day (1978), Lange (1989), von Brandt (1984) and Wray (1979). The structure and operation of these devices ranged from relatively simple 'sailkite', a rectangular piece of canvas attached to the centre of headline (Ben-Yami 1979a,b,c,d; Boopendranath *et al*., 1986) to more complex designs such as 'flexible hydrofoil wing float' developed in China (Anon, 1984), 'Flex-Kite' developed in USA (Anon, 1991) and 'Biplane kite' developed by IFREMER Centre, Lorient, France (Anon, 1989; 1990a,b).

The present article describes a newly developed canvas headline lifting device named 'flexible float' and reports on its effectiveness in improving the performance of demersal trawls, based on full scale comparative fishing operations.

Materials and Methods

Design details and method of rigging of flexible float are given in Figs. 1 to 3. The device was fabricated as five modular units - a central piece attached to the bosom and two side pieces each tied symmatrically on either side. The leading edges were shaped and tailored to follow approximately the catenary of the trawl headline while in operation. Each unit has a top and bottom panel and is divided into a number of compartments by more or less equally spaced partitions. The partitions are specifically shaped to promote sheer effect

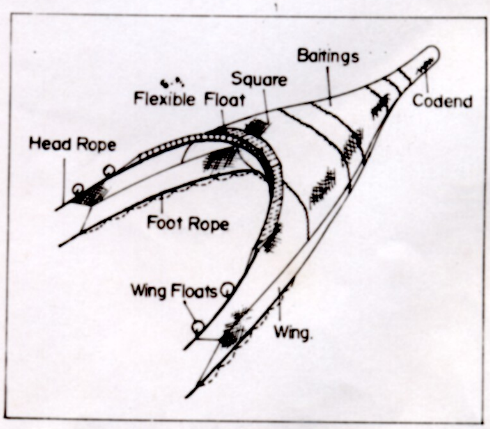

Fig. 1. Pictorial view of 40 m Demersal trawl rigged with flexible float

Fig. 2. Photograph showing front view of flexible float attached to the headline of trawl net

of the panels and oriented parallel to the water flow to minimise drag. The device was machine-tailored using nylon twine 210d/1/3, with single bind along the edges and seams. Edges and strain points were strengthened using 6 mm dia HDPE rope and eyelets were provided along the leading-edge of the lower panel for attachment to the headrope. Each fabricated unit has a vertical opening of 15 cm in the front and 3 cm in the rear. Adjacent units were attached side to side, rear edges secured to the webbing in the square and bridles of the top leading-edge to the headline as shown in Figs. 1 and 2.

Thick cotton canvas, natural white in colour was used for fabrication during the first stage of experiments. Later a new material - PVC coated nylon fabric otherwise known as nylon sail cloth or nylon tarpaulin, bright yellow in colour, was identified and used for fabrication, in place of cotton canvas.

Two trawl designs namely, a 40 m demersal trawl and a 32 m high opening trawl which are scaled up versions respectively of 32 m large mesh demersal trawl and 25m high opening trawl described by

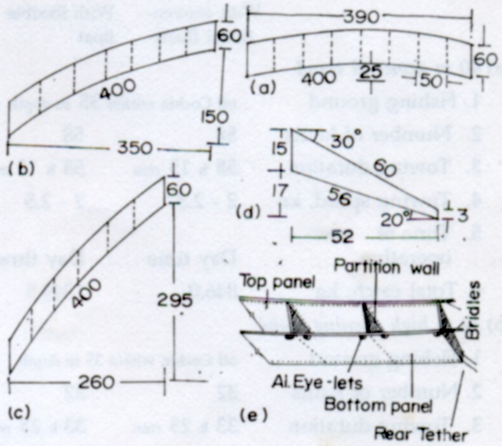

Fig. 3. Construction details of flexible float: a, b, c & d plan view of the top panels of central piece, side pieces 1 and 2 on the starboard side and partition wall, respectively and e, perspective view of a part of the finished float. Notes: 1. Lower panel is 4 cm less in breadth than top panel, other dimensions being identical; 2. An extra 2.5 cm. of fabric is provided on all sides of panels and partition walls while cutting out to facilitate tailoring and strengthening; 3. Dotted lines in a, b & c indicate orientation of partition walls connecting the top and bottom panels; 4. All measurements are in centimeters.

Kunjipalu *et al.* (1979, 1990), were used for experiments. Full complement of eleven hard plastic spherical floats of 200 mm dia were used in the control gear in both the cases. Two floats were provided on either wings in the experimental gear to give minimum buoyancy when the gear is not under tow. A pair of all steel V-form otter boards of size 1500 x 890 mm and weight 150 kg each (Kunjipalu *et al.*, 1984) was used for the operations. Day-fishing operations were conducted from research vessel MFV Matsyakumari (17.5 m LOA, 278 hp) during 1986-90, within 35 m depth, in the waters off Cochin, India.

Table 1. *Particulars of comparative fishing operations*

	With conventional floats	With flexible float
(a) *40 m demersal trawl*		
1. Fishing ground	off Cochin within 35 m depth	
2. Number of hauls	58	58
3. Towing duration	58 h 15 min	58 h 15 min
4. Towing speed, kn	2 - 2.5	2 - 2.5
5. Time of operation	Day time	Day time
6. Total catch, kg	846.0	1349.5
(b) *32 m high opening trawl*		
1. Fishing ground	off Cochin within 35 m depth	
2. Number of hauls	32	32
3. Towing duration	33 h 25 min	33 h 25 min
4. Towing speed, kn	2 - 2.5	2 - 2.5
5. Time of operation	Day time	Day time
6. Total catch, kg	560.0	741.5

The two types of gear arrangements namely, with conventional floats and with flexible float, were operated alternately, maintaining the same depth, duration, direction of tow and engine revolutions, during each of the paired comparative hauls. Operational details are presented in Table 1. Statistical analysis of the total catch and component groups were carried out using Student's *t*-test after logarithmic transformation of the data.

Results and Discussion

When the gear is towed, the flexible float become distended due to differential inflow and out-flow of sea water through it, and function as a turgid sheer device which depends for its effectiveness, on speed and angle of attack it assumes in relation to water flow. The hydrodynamic lift force, L, generated by the flexible float can be expressed by

$$L = 0.5\, \rho\, AV^2 C_L$$

Where ρ = sea water density (kg.m^{-3}); A = projected area of the sheer device in the direction of the current (m^2); V = current speed (m.s^{-1}); and C_L = the hydrodynamic lift coefficient which is a function of the attitude and design of the sheer device.

Table 2. *Group-wise average catch rates and percentage break-up of catches*

Groups	Flexible float CPUE kg.h^{-1}	Flexible float Percentage	Conventional float CPUE kg.h^{-1}	Conventional float Percentage
(a) *40 m demersal trawl*				
Finfish	17.79	68.3	8.24	31.7
Cephalopods	1.49	53.4	1.30	46.6
Prawns	3.72	62.1	2.27	37.9
Squilla & Crabs	2.20	41.5	3.10	58.5
Total catch	25.20	62.8	14.91	37.2
(b) *32 m high opening trawl*				
Finfish	12.15	55.2	9.86	44.8
Cephalopods	0.88	50.9	0.85	49.1
Prawns	0.33	62.3	0.20	37.7
Squilla & Crabs	8.89	57.8	6.50	42.2
Total catch	22.25	56.1	17.41	43.9

Results of comparative fishing operations are discussed below:

Table 3. *Results of statistical analysis using Student's t-test*

Category of fish	*t* value
(a) *40 m demersal trawl*	
Total catch	3.114**
Finfish	3.974**
Cephalopods	1.452
Crustaceans	1.221
Degrees of freedom, n-1:57	
(b) *32 m high opening trawl*	
Total catch	2.801**
Finfishes	2.215*
Cephalopods	0.646
Crustaceans	1.576
Degrees of freedom, n-1:31	

*, ** Significant at the 0.05 and 0.01 levels, respectively.

(a) 40 m demersal trawl

Details of catch rate and percentage break-up of the landings during the 58 comparative hauls, are presented in Table 2a and the results of statistical analysis for total catch, finfish, crustaceans and cephalopods in Table 3a.

Efficiency of 40 m demersal trawl improved by 69.0% when rigged with flexible float and the catch of finfish alone improved by 115.9%. The difference in catch rates for both total catch and finfish components were highly signigicant ($p < 0.01$). Finfish were constituted by *Nemipterus* sp., sciaenids, clupeids, saurids, high-value fishes, leiognathids and miscellaneous fish. Difference in the catch of crustaceans (prawns, squilla and crabs) and cephalopods (squid and cuttlefish) were not found to be statistically significant.

(b) 32 m high opening trawl

Catch details and percentage break-up of the landings during the 32 comparative hauls, are given in Table 2b and the results of statistical analysis in Table 3b.

Improvement in total catch by 27.8% obtained with flexible float, was found to be statistically highly significant ($p<0.01$). Catch of finfish components improved by 23.2% and the difference was significant at the probablity of 0.05. Improvement in the catch of crustaceans and cephalopods were not statistically significant.

It is evident from the analysis, that the flexible float has caused significant improvement in the catching efficiency of both the trawls. The difference in catch rates could be attributed to higher vertical opening and possibly, improved herding effect on finfish components in the vicinity of trawl mouth due to addition of visually conspicuous flexible float. Glass & Wardle (1989) have observed that most trawls, at light levels above a threshold of 10^{-6} lux, appear to rely on the visual stimulus of the sweeps and sand/mud clouds herding the fish inwards, with the stimulus of high contrast headline (in the present case, flexible float) forcing the fish down to the path of the net. Blaxter & Parrish (1964) and Wardle (1983, 1986) have also stressed the importance of visual stimulus of the peripheral parts of the trawl mouth underwater, in the fish capture process.

Efficiency of flexible float and related sheer devices depends on the aspect assumed by the projected sheer area in relation to water flow, which is evidently related to the method of rigging of the flexible float and the intrinsic design features of th gear itself. For trawls with squares which are nearly horizontal in action, adaptation of the rigging described by Lange (1989) for sailkite, using an auxiliary headline could be more effective. By regulating the number of units of flexible float in operation, it is possible to adjust the sheer force to suit different trawls and operating conditions.

PVC-coated nylon fabric, manufactured indigenously, was adjudged to be a suitable material for fabrication of flexible float considering its resistance to bio-degradation in marine conditions and better tensile strength by 15.5%, compared to cotton canvas.

Installation and handling of flexible float is simple. Stowage is easy as it can be folded and kept. It can be used at any depth unlike conventional trawl floats which have operational pressure limits. Drag of conventional floats is known to increase with increase in towing speed which in turn reduces headline height. Being hydrodynamic in action, magnitude of lift force created by flexible float, however, would increase with the towing speed. Further, in contrast to rigid headline lifting devices like kite, flexible float could be easily wrapped on a net drum, by virtue of its flexibility and robust construction.

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