Effect of Large Meshes on the Body of Trawl Net in Energy Conservation

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Incorporation of large meshes in the body of trawl nets reduces the drag substantially and thereby the fuel consumption. Comparative trawling of 28.6 m large mesh four-seam trawl with 26.7 m high opening bottom trawl were conducted off Mangalore coast during December 1989 to May 1990. The large mesh trawl was found to register 33-34% less resistance than the high opening bottom trawl at an average trawling speed of 2-2.5 knots according to theoretical calculations without any significant effect on catch.

It is important to reduce the cost of fishing in order to make the commercial fishing more profitable. In trawling the operational cost alone takes about 80% of the total revenue of the vessel. Fuel consumption being directly proportional to the resistance offered by the trawl gear, it is desirable to adopt low resistance gears to reduce the fuel cost which is the major component of the operating cost of the vessel. Mesh size of the net, type of otter-board, towing speed and the size and type of material used for twine and warp are the major factors influencing trawl gear resistance. Large mesh and thin twine are supposed to reduce the drag of the net (Prado, 1977; Fujishi, 1985) and for a given engine power, it is possible to tow a much bigger gear, thereby sweeping more area with the possibility of catching more fish. Therfore, a New Large Mesh Trawl (NLMT) was developed to catch the demersal fishes. The efficiency of this gear was judged by comparing with the more established high opening Bottom Trawl (HOBT) of BOBP design which is also used for catching the same demersal resources.

Materials and Methods

A four-seam trawl of 28.6 m headrope length with 240 mm mesh on the fore part of upper panel and 600 mm mesh on fore part of lower panel was operated from a wooden trawler of 13.26 m LOA fitted with an engine developing 102 bhp at 1800 rpm. This new large mesh trawl has a codend of 30 mm mesh size. The standard net used for comparsion was a two-seam high opening Bottom Trawl with 80 mm mesh size on the fore part of upper and lower bellies. The codend of HOBT has the same mesh size as that of NLMT. The design details of both NLMT and HOBT are shown in Figs. 1 and 2 respectively. Weekly fishing experiments were conducted off the coast of Mangalore, Karnataka within a depth range of 20-50 m. The fishing was conducted by using both the gears alternatively for a towing duration of 90 min, in the same direction and in the same ground. The catch collected by both the gears were analysed separately to judge the efficiency of the

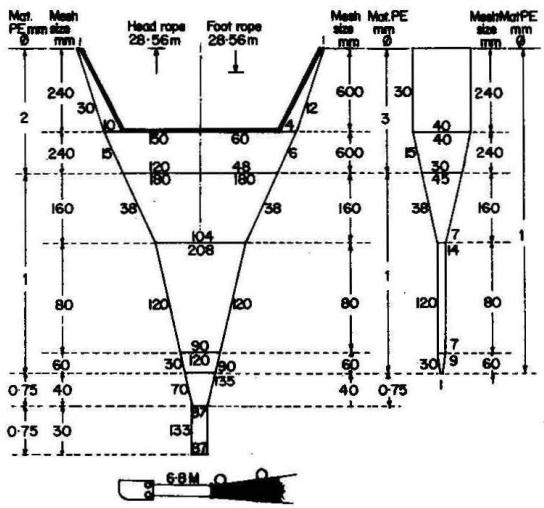

Fig.1 Design details of 28.6 m new large mesh

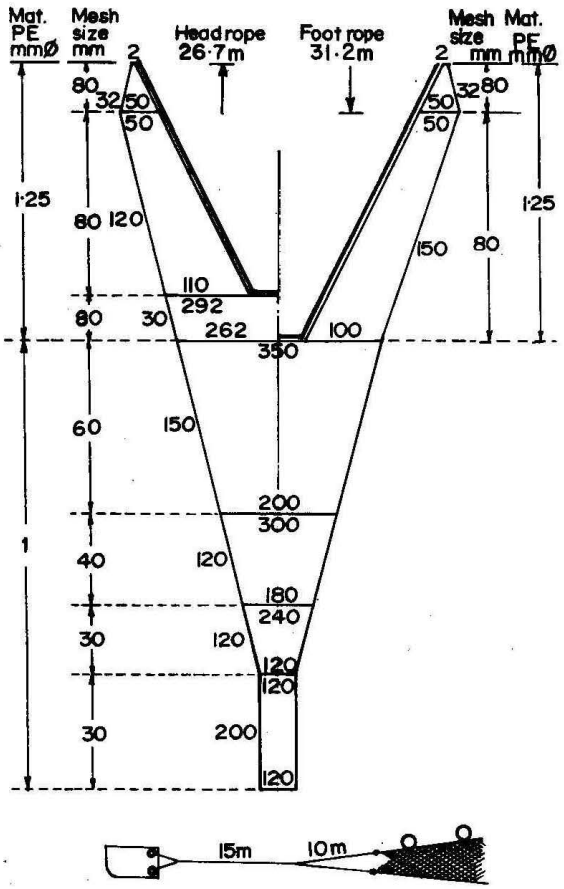

Fig. 2. Design details of 26.7 m high opening bottom trawl

gears. The total drag of the trawls at various towing speeds were calculated theoretically for comparison. The total drag of each gear was determined by calculating the drag of different components of the gears. The drag of the netting panels were calculated using the formula suggested by MacLennan (1981) which is essentially a function of total twine area. Total twine area of the nets were estimated according to the method suggested by Ferro (1981). Drag due to floats, sinkers, lines and ropes were calculated using basic hydrodynamic formula given by Fridman (1986). This method of calculation of drag is said to be precise upto 90% level. However, the drag due to warps and otter-boards are excluded from calculation since same otter-boards were used for both the nets and same length of warps were paid out for each operation.

The nets were towed by using the same engine output power keeping the engine rpm constant and the towing speeds were measured for comparison. Horizontal opening between the otter boards was estimated by the method suggested by Benyami (1959).

Results and Discussion

The average catch of commercially valuable fish and trash catch in 17 hauls made with the two gears from January to May 1990 and their respective contribution to the total average catches are presented in Table 1.

Table 1. *Average catch per haul from January to May 1990.*

Groups	NLMT		HOBT	
	Weight in kg/haul	%	Weight in kg/haul	%
High value fish	45.81	87.24	30.75	80.64
By-catch	6.70	12.76	7.38	19.36
Total	52.51	100.00	38.13	100.00

The average catch per haul was found to be 52.51 kg for NLMT and 38.13 kg for HOBT. Thus NLMT yielded 36.8% more catch than HOBT. However, Mann Whitney-U test for total catch of both the gears of different day's sampling shows that there is no significant difference in the total catch at 5% level (Table 2).

Table 2. *Mann Whitney-U values for the total catch obtained in NLMT and HOBT.*

Gear	Sum of marks	Value of U	Minimum of (Ul, U2)
NLMT	327	Ul=117	
			117
HOBT	268	U2=174	

Similar results are reported from New Zealand where 22% increase in catch was

Table 3. *Measured speed and otter board opening of NLMT and HOBT in different days' operation.*

Sl. No.	rpm	NLMT		HOBT	
		Speed kn	O.B. opening, m	Speed, kn	O.B. opening, m
1	1300	1.85	-	1.84	-
2	1300	2.11	15.0	1.95	14.22
3	1400	2.31	15.36	2.11	13.88
4	1350	2.60	15.25	2.20	14.34
5	1350	2.60	15.50	2.27	14.30
6	1350	2.84	14.90	2.46	14.50
7	1300	2.60	-	2.02	-
8	1300	2.53	14.80	2.24	14.44
9	1300	2.75	-	2.40	-
10	1350	2.92	15.80	2.57	14.00
11	1300	2.30	14.90	2.07	14.20
12	1300	2.70	-	2.35	-
13	1300	2.60	15.40	2.40	14.80
14	1300	2.06	14.40	1.92	14.10
15	1300	2.70	14.80	2.50	14.50
16	1300	2.35	14.30	2.22	14.10
17	1300	2.72	15.10	2.43	14.45
Average		2.502	15.039	2.232	14.295

observed by doubling the mesh size of 23 cm (Anon, 1974). This result is also corroborated by the results of Kunjipalu *et.al.* (1979,1989).

Table 3 indicates the towing speed of the boat during each fishing experiment. It is clear from the Table that the NLMT always registered higher speed than the HOBT at the same ground, in the same direction of tow and with the same engine rpm. The average towing speed registered by NLMT was about 12% higher than HOBT. The otter board opening of NLMT and HOBT at their average towing speed (Table 3) were 15.039 and 14.295 m respectively and the higher horizontal opening of NLMT may be one of the factors contributing to higher catch.

Resistance offered by the different gear components and the total resistance were calculated theoretically for both the nets and given in Table 4 and their variations are shown graphically in Figs. 3 and 4. From the Table, it can be seen that netting alone contribute more than 80% of resistance for both the gears. Again it is clear that the

Table 4. *Resistance offered by different gear components and the total resistance at some assumed speeds for both NLMT and HOBT.*

Speed		New Large Mesh Trawl					High Opening Bottom Trawl				
		R_n	R_f	R_x	R_s	Total	R_n	R_f	R_x	R_s	Total
kn.	$m.s^{-1}$	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf	kgf
0.5	0.257	154.099	0.406	3.888	1.224	159.617	246.454	0.491	4.703	1.037	252.685
1.0	0.515	223.567	1.630	15.611	4.916	245.724	357.555	1.970	18.881	4.164	382.570
1.5	0.772	334.401	3.663	35.079	11.045	384.189	534.514	4.429	42.428	9.357	591.028
2.0	1.030	483.077	6.520	62.443	19.663	571.633	772.594	7.884	75.525	16.656	872.659
2.5	1.287	666.459	10.180	97.492	30.700	804.831	1065.881	12..309	117.916	26.004	1222.110
3.0	1.544	881.750	14.652	140.316	44.185	1080.904	1410.200	17.716	169.713	37.427	1635.056
3.5	1.802	1126.443	19.958	191.127	60.186	1397.714	1801.543	24.131	231.168	50.980	2107.882
4.0	2.059	1398.290	26.057	249.532	78.577	1752.456	2236.312	31.505	301.809	66.558	2636.154
4.5	3.316	1695.263	32.967	315.711	99.417	2143.356	2711.268	35.860	381.852	84.210	3213.90

Note: R_n = Netting drag; R_f = Float drag; R_x = Drag due to ropes and bridles; R_s = Drag due to sinkers

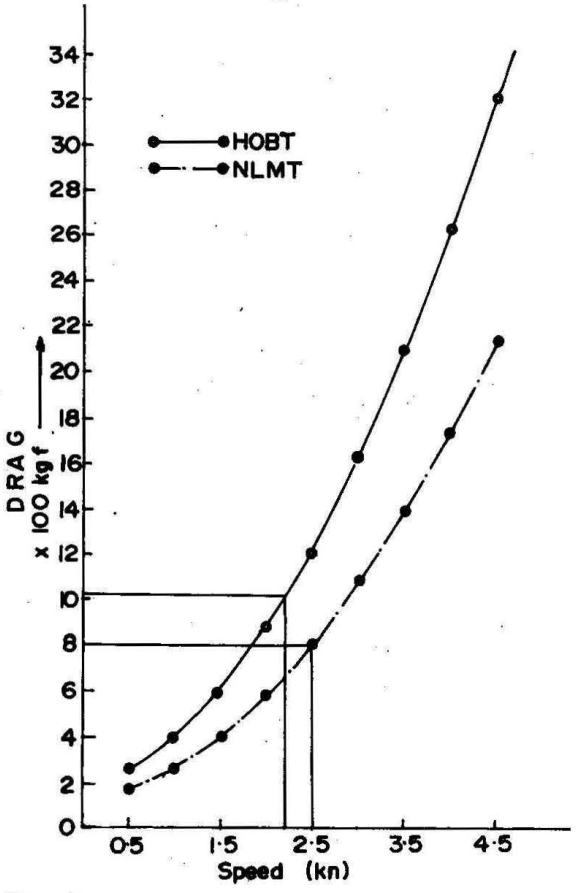

Fig. 3. Total drag of new large mesh trawl (NLMT) and high opening bottom trawl (HOBT) at different towing speeds.

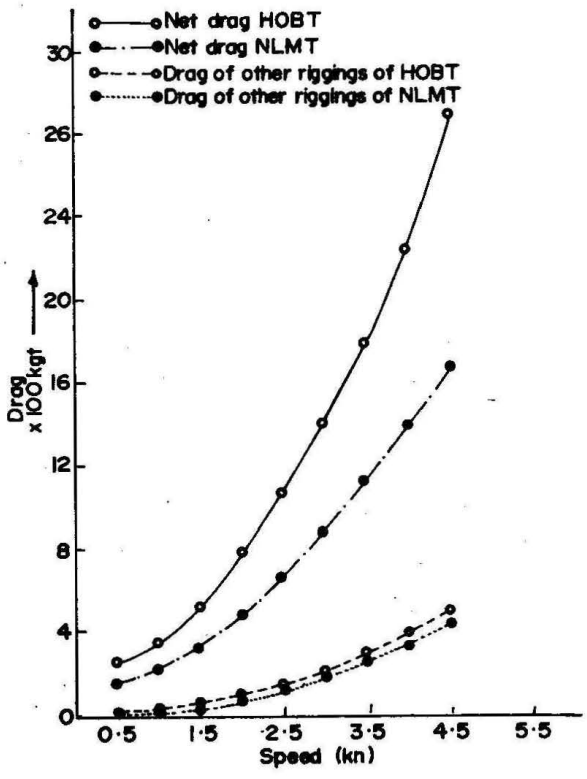

Fig. 4. Drag due to the netting panel and trawl components of new large mesh trawl (NLMT) and high opening bottom trawl (HOBT)

total resistance of the NLMT is considerably lower than HOBT. Though the NLMT has a higher head rope length, the total netting area is much less than the HOBT and that has been the factor for reducing the resistance. The contribution of drag by sinkers, floats and lines and ropes is considerably low. For the same weight to floatation ratio, the NLMT required more sinkers than HOBT, thus increasing the resistance due to sinkers in NLMT. At 2 knots, the total estimated resistance of HOBT was about 34% higher than NLMT and at 2.5 knots it was 33% higher. (The average towing speed for both the trials remain in the range of 2-2.5 knots). The total drag of NLMT and HOBT excluding the otter board and warps at their average speeds work out to be 800 kgf and 1010 kgf respectively (Fig.3). Thus for an increase of 26.25% in resistance of HOBT the towing speed of the gear has been reduced by 10.8%.

The higher towing speed, wider otter board opening and possibly higher vertical opening of NLMT enables the gear to filter larger volumes of water and thereby helps in catching larger quantity of fish. Further, for a given towing speed NLMT offers much less resistance than HOBT and it is possible to reduce fuel consumption considerably. As both these gears are mainly aimed at catching the demersal fishes the present study clearly indicates the benefits of NLMT in energy conservation of the trawler.

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