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Evaluation of sampling gear for demersal resource surveys

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ABSTRACT

The three demersal trawls evaluated were 38 m HSDT-II, indigenously developed by CIFT for deep sea fishing in Indian EEZ; and two imported designs, viz., 45.6 m Expo model demersal trawl and 50 m fish trawl operated from vessels of FSI and IFP, respectively. Vertical opening at trawl mouth was heighest for 50 m fish trawl (3.2 m), followed by Expo model demersal trawl (2.5 m) and 38 m HSDT-II (2.2 m), due to differences in overall dimensions and design features. Estimate of horizontal opening between otter boards was highest for 38 m HSDT-II probably due to low drag of the gear, followed by 45.6 m and 50 m trawls. Lowest catch per unit effort obtained by 38 m HSDT-II is presumably due to smaller dimensions of the gear, larger codend mesh size and difference in ground rig, in addition to chance factors. However, 38 m HSDT-II scores on several features desirable in demersal sampling gear such as simplicity in design and construction, ease of operation; lower twine surface area and drag; and ground rig suitable for wider range of bottom conditions. Modifications to make it more effective while sampling for crustaceans and small-sized finfish components are described.

INTRODUCTION

Scientific trawl surveys are widely used for monitoring demersal stocks and estimating population parameters for calibration of stock assessment models (Sparre *et al.* 1986). Diversity in gears and sampling procedures have often limited the quality of stock assessment results (Jhingran, 1982). The implication of variability in trawl selectivity on stock assessment and management have been discussed by Gulland (1969), Pope *et al.* (1975) and Sparre *et al.* (1969). Adoption and consistent use of standard sampling gear and standard sampling procedures would minimise the effect of gear-dependent variation in selectivity and abundance estimates. Further, knowledge of size selection attributes of such sampling trawl could be used for getting unbiased estimates of age composition of the population.

The main objective of cruise no. 109 (5-19 May 1993) of *FORV Sagar Sampada* (71.5 m LOA; 2285 hp) was determination of design, rigging and operational parameters of different designs of trawl nets available with user agencies such as Central Institute of Fisheries Technology (CIFT), Fishery Survey of India (FSI) and Integrated Fishery Project (IFP). These parameters were evaluated against features adjudged desirable in a demersal sampling gear.

MATERIALS AND METHODS

The three trawls operated were: i) 38 m HSDT-II (G1), indigenously developed by CIFT for high speed demersal trawling in Indian EEZ and successfully field-tested from *FORV Sagar Sampada* (Panicker, 1990; Panicker, *et al.* 1993); ii) 45.6 m Expo model trawl (G2), an imported design operated from FSI vessels and iii) 50 m fish trawl (G3), a Norwegian design operated from IFP vessel. Salient features of the trawl nets are given in Table 1 and their comparative sizes are represented in Fig. 1. All the three gears are proven designs and have been extensively operated earlier, under the range of fishing conditions appropriate for each gear. *Perfect* (Denmark) economy model V-shaped otter boards of 285 x 126 cm, approximately 2800 kg weight per set

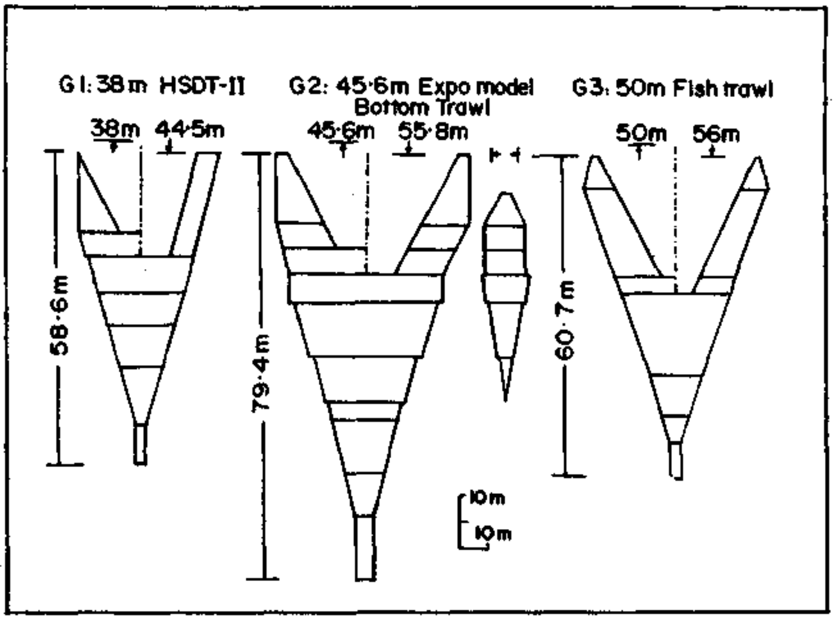

Fig. 1—Comparative sizes of trawls

with through flow and square keel and weathering surface, were used for the operations.

Gear parameters such as vertical opening at trawl mouth and horizontal opening between otter boards were measured at 118-126 m depth off Karwar, keeping vessel speed (3.5 kn), tow direction and fishing area unchanged. Towing speed was measured by ship's doppler speed log. Vertical opening at trawl mouth was measured using SIMRAD FR 500 Trawl Eye System connected to SIMRAD CF 100 Colour Display at 10 m expansion mode. In the absence of acoustic sensors for measuring horizontal opening between otter boards, its relative measure was estimated by multiplying the measured divergence of main warps for 1 m distance from the towing points with the

Table 1 — Salient features of trawl nets operated

	G1	G2	G3
	38 m HSDT-II	45.6 m Expo model trawl	50 m fish trawl
Head rope (m)	38.0	45.6	50.0
Foot rope(m)	44.5	55.8	56.0
Construction:			
Panels (no.)	2	4	2
Panel sections(no.)	15	37	19
Mesh sizes (stretched mm):			
Wings	150	400	140
Square batings and belly	150-50	400-40	120-80
Codend	50	30	45
Bridles (no.)	2	3	2
Bridle length (m)	50	50	50
Floats	200 mm diam.	270 mm diam.	200 mm diam.
	45 nos	17 nos	17 nos
Ground rig	Rubline with 200-100 mm diam. discs; ca. 750 kg in air; tied to foot rope with 10 cm gap	Link chain 150 kg in air; closely tied to foot rope	Link chain and SWR seized with sisal; 140 kg in air; closely tied to foot rope

number of metres of warp paid out and adding this to the distance between towing points. Total twine surface area of the nets were estimated using the method suggested by FAO (1974). An estimate of the net drag at 3.5 kn was obtained using the formula developed by MacLennan (1981) which is based on twine surface area.

Comparative fishing operations were conducted in the waters off Karwar, Kottekunnu and Quilon at depths ranging from 120 to 350 m. The bottom trawls G1, G2 and G3 were operated in rotation, keeping operational parameters such as towing speed, tow direction, depth zone and fishing grounds unchanged for each set of comparative fishing operations and data on total catch and catch composition were collected. Twelve comparative operations were conducted in 4 cycles using the three gears.

RESULTS AND DISCUSSION

Gear parameters and catch details are summarised in Table 2. Higher vertical opening was realised by G3 (3.2 m), followed by G2 (2.5 m) and G1 (2.2 m). The difference in vertical opening is attributed to variation in overall dimensions of the gears; and particular design features such as a deep V-cut in the wings of G3; four panel construction and multi-bridles in G2.

Vertical opening of the trawl ideally should match the vertical distribution characteristics of the target species for optimisation of fishing efficiency. Experience during fishing investigations onboard *FORV Sagar Sampada* (cruise nos. 97, 99, 109; unpublished data) has shown that 87 % of the shoal pattern of demersal fishery resources representing *Nemipterus* spp., *Decapterus* spp., *Priacanthus* spp., *Centrolophus* spp., elasmobranchs, *Trichiurus auriga*, deep sea prawns, deep sea lobster, *Sphyraena* sp., cephalopods, perches, *Neopinnula* sp., catfish and miscellaneous fish are generally restricted to less than 2 m height. Demersal echo traces during cruise nos 109, rarely exceeded 2 m height and were generally within 0.5 m.

Horizontal opening between otter doors is an important gear parameter as it influences the effective sweep area by virtue of herding effect of sweeps, otter boards and sand-mud clouds generated by the doors, on many finfish components (Main & Sangster, 1981). Horizontal opening is primarily determined by sheer force of otter boards, towing speed and drag of the gear. Horizontal opening index was maximum for G1, probably due to low drag of the gear, followed by G2 and G3.

Twine surface area of G1, G2 and G3 were calculated as 136, 166 and 161 m^2. As the twine surface area is proportional to the net drag, formula devoloped by MacLennan (1981), was used to get an approximate estimate of total net drag. At the towing speed (3.5 kn) used, net drag worked to be 70230, 85720 and 83140 N, respectively for G1, G2 and G3. The low drag of the gear make it suitable for operation from a wide range of vessel classes.

Mean haul-wise CPUE obtained by G1, G2 and G3 was respectively, 134, 589 and 405 kg/h. Percentage composition of the catches obtained by the three trawls, during

Table 2— Gear parameters and results of comparative fishing operations

	G1	G2	G3
	38 m HSDT-II	45.6 m Expo model trawl	50 m fish trawl
Gear parameters			
Vertical opening at trawl mouth(m)	2.2	2.5	3.2
Horizontal opening between otter boards (m)	90	76	70
Twine surface area (m^2)	136	166	161
Net drag at 3.5 kn (N)	70230	85720	83140
Fishing results			
No. of hauls	4	4	4
Total towing duration (min)	240	240	285
Towing speed (kn)	3.5	3.5	3.5
Mean haul-wise CPUE (kg/hr)	134	589	405
Catch composition (%)			
Decapterus sp.	37.0	0.8	10.4
Nemipterus spp	23.4	35.2	44.8
Centrolophus spp	5.4	10.0	22.4
Priacanthus sp.	3.7	1.8	3.0
Cubiceps sp.	3.4	19.4	2.7
Chlorophthalmus sp.	1.9	0.9	0.7
Saurida sp.	1.5	0.3	0.9
Elasmobranchs	0.4	2.8	2.4
Deep sea prawns	3.2	1.4	1.4
Deep sea lobster	5.8	1.1	5.3
Cephalopods	1.3	1.5	1.3
Others	13.0	24.7	4.9

comparative operations is given in Table 2. The data set is insufficient for evaluation of fishing performance through statistical inference of the catch (Nair, 1982). The variation in catch rates among the trawls could have been caused by: i) difference in overall dimensions of the gear - head rope of G3, G2 and G1 was respectively 50, 45.6 and 38 m (Fig.1) ; ii) difference in codend mesh size and consequent difference in size selectivity - G2 had the smallest codend mesh size (30 mm), followed by G3 (45 mm) and G1 (50 mm); iii) difference in ground rig and consequently operating height of fishing line - G1 was rigged for operations in smooth to moderately uneven ground conditions using rubline with a bosom disc diam. of 200 mm, loosely hung (10 cm) to the foot rope; G2 was rigged with iron link chain and G3 with pieces of link chain and SWR seized with sisal, closely tied to the foot rope for smooth bottom operations; and iv) chance occurrence of shoals in the fishing ground which was supported by echogramme readings during comparative fishing operations.

Sampling gear for survey of demersal resources, ideally should have features such as carefully selected wing, body and codend mesh sizes to retain representative size range of fishable stock; low overall dimensions and drag to permit its operations from a wide range of vessel classes; optimum net mouth configuration to suit the vertical distribution characteristics of fish shoal; simplicity of construction and operation; inter-changeable net panels to facilitate easy repairs and replacement onboard; and design and rigging features to facilitate its operation in a wide range of bottom conditions.

Among the three bottom trawls evaluated , 38 m HSDT-II could prove to be more advantageous as a sampling gear, considering the following:

i) Lower CPUE obtained by HSDT-II during the limited number of comparative operations, could be attributed to smaller overall dimensions, larger codend mesh size, and difference in ground rig, in addition to chance factors. Cumulative data from cruises 97, 99 and 109 of *FORV Sagar Sampada*, for HSDT-II has given an average CPUE of 1.27 t/hr and maximum of 12 t/hr (no. of operations :19; total towing duration: 18 hr 25 min) with representation of all expected demersal components of the fishing area, which indicate the overall fishing efficiency of the gear in demersal operations (*FORV Sagar Sampada* cruise reports: 97, 99 and 109).

ii) Vertical opening at trawl mouth of 2.2 m realised by HSDT- II though less than the other two gears seems to be adequate for demersal trawl surveys particularly when accompanied by acoustic observations, as vertical distribution of fish close to bottom is most often within 2 m.

iii) Horizontal opening between wing-ends as proportion of headline length could be expected to be better in HSDT-II as reflected in the indices of horizontal opening between otter boards.

iv) Having rigged with rubline of 200-100 mm diam. discs HSDT-II would be workable over a wider range of ground conditions.

v) Having got a lower twine surface area (136 m^2) and consequently lower net drag (70230 N), HSDT-II would be operable from a wide range of vessel classes.

vi) From the point of view of ease of fabrication an ease operation, HSDT-II scores over the other two gears due to lower number of panel sections in its make-up, two-bridle system and smaller overall dimensions.

As most of the intrinsic gear selection occurs in the codend of a trawl (Clark, 1963; Ellis, 1963) in order to make HSDT-II less size-selective, it would be advisable to reduce the codend mesh size to 30 mm for demersal finfish surveys. Further, as crustaceans are generally not amenable to herding leading to their escape through large meshes in the front trawl sections, it would be advisable to modify the gear using a mesh size sequence of 80, 60, 50 and 40 mm for wing, square, batings and belly and codend mesh size of <30 mm.

Knowledge of gear efficiency in terms of escapement of fish through codend, front trawl sections (Ellis, 1963) and underneath the foot rope (Godo & Walsh, 1992) and resultant size selection with respect to particular species is essential to get unbiased estimates of age composition of the population for biological investigations and absolute abundance estimates. Such details for the adopted sampling gear need to be determined through specially designed gear selection experiments.

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