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## Research Note

# A Preliminary Study on Trawl Geometry: Effect of Speed and Warp Length on Mouth Opening

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With a total of 35,228 trawlers of various sizes in operation, trawling is one of the most important fishing methods in India (CMFRI, 2012a;b). For efficient trawling operations, the geometry of trawl, particularly opening of trawl mouth (horizontal and vertical) is very crucial (Kunjipalu et al., 1992). There are different methods to keep the mouth of the net open during operation and the most popular is use of shearing boards (otter boards) on each side of warp to attain horizontal opening. Floats, sinkers and at times vertical sheer devices called kites are used to achieve vertical opening of the net (Boopendranath et al., 1986). Two-boat trawling or pair trawling, which involves towing a single trawl by two identical boats is also practised. Though beam trawls were common, their numbers have now reduced considerably (Depestele, 2007). In trawling, the probability of catch is directly proportional to the swept volume and thus to the mouth opening of the trawl is very critical. Total drag and net drag is directly proportional to towing speed (Queirolo et al., 2009). Weinberg (2002) studied the effect of towing speed on efficiency of a survey bottom trawl at three different speeds i.e. 2.5, 3.0 and 3.5 kn. Fujimori (2005) investigated effect of warp length and efficiency in terms of opening and reported improved result with scope ratio of >3. The effect of speed and warp length on the mouth opening of an experimental bottom trawl is reported in the study.

Bottom Trawl System (BTS) with 27 m head rope length rigged with 126 kg 'V' form otter boards was operated on-board *RV Matsyakumari-II,* ($L_{OA}$ 17.7 m, 325 hp at 1800 rpm, 66 GRT) (Fig. 1 Table 1). Experiments were carried out in depth range of 10.5-15 m off Cochin, during March 2017. Trials were conducted with six acoustic sensors (NOTUS™, Canada) two each, attached to otter board and wings, and one each to the head rope and foot rope of the bottom trawl system (Fig. 2). Sensors attached to head rope and foot rope were used for recording vertical mouth opening of trawl net and those attached at wings and otter boards were used for recording horizontal mouth opening and trawl door spread. All sensors were acoustically linked to hydrophone which was connected to processor on-board through cable for real time data recording using *'trawlmaster'*™ software (www.notus.ca/trawlmaster-for-multitrawls). The performance of BTS was evaluated at three different speeds (2.9, 3.3 & 3.7 kn) with three different warp lengths (60, 70 & 80 m). Repetitive tows were made at different combinations of warp length and towing speed. Towing speed was increased from 2.9 kn to 3.7 kn, at interval of 0.4 kn. For each warp length and towing speed combination, a 10 min were given for stabilization, before measurements were made. The measurements were noted in triplicates and were averaged for final value.

Results showed that, at 60 m warp length the mouth opening increased from 44.23 to 45.55 $m^2$ with increase in the towing speed from 2.9 to 3.3 kn, opening decreases to 31.96 $m^2$ when towing speed was increased to 3.7 kn (Fig. 3). At warp length of 60 m, the vertical opening was almost similar at 2.9 kn and 3.3 kn towing speed i.e 4.26 $m^2$ and 4.36 $m^2$ respectively, but decreased by 3.13 $m^2$ with increase in speed from 3.3 kn to 3.7 kn. For warp lengths of 70 m and 80 m, vertical opening reduced when towing speed increased from 2.9 to 3.3 kn (Fig. 4

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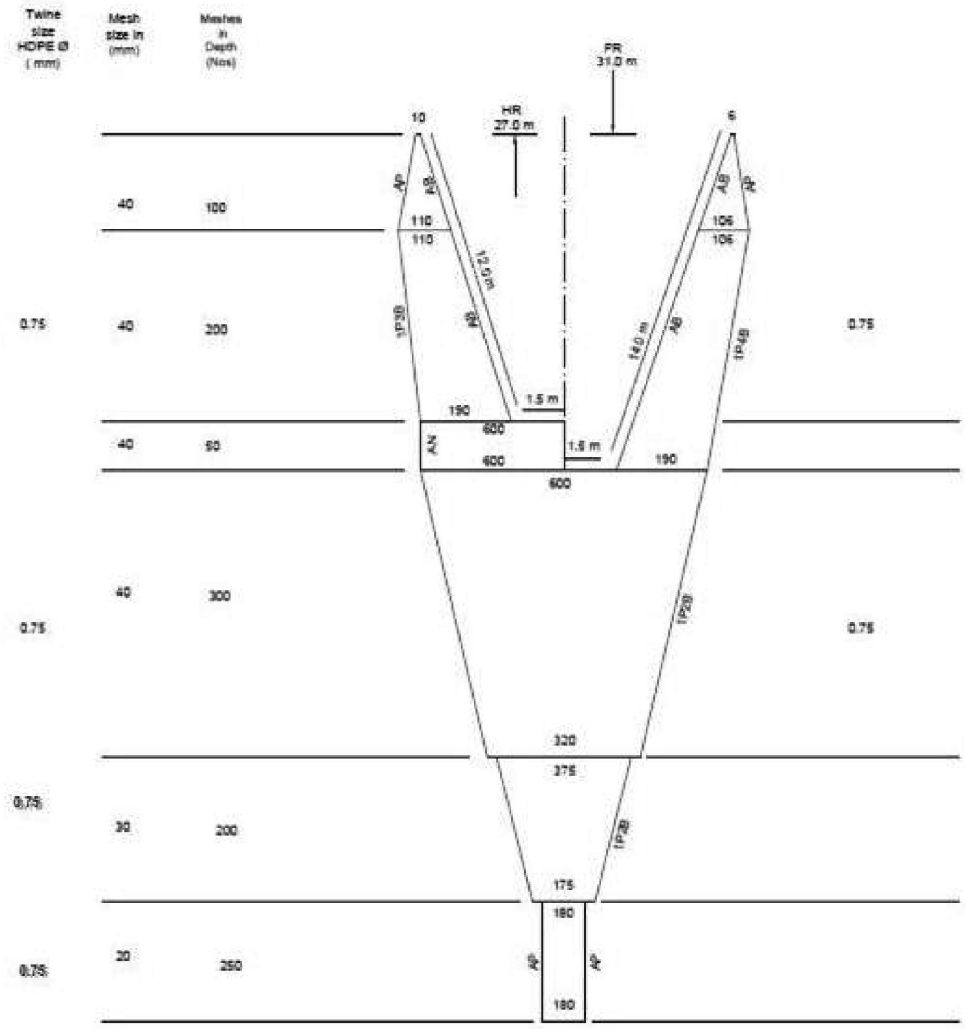


Fig. 1. Design of experimental bottom trawl

and 5). At higher towing speed, the otter board spread is likely to decrease due to sheer force of the board and drag of the net. A similar result was also reported by Park (2007). At very high towing speed, the angle of attack and coefficient of sheer force of the board and net drag might change, and the total mouth opening of net depends upon the resultant effect of drag from different parts of the net (Fridman, 1986). In the present study, at 70 m warp length, the total mouth opening decreased with increase in speed from 2.9 to 3.3 kn and showed maximum value at towing speed of 3.7 kn. In 70 m warp length, the maximum opening was recorded at a speed 2.9 kn. (Fig. 3). Similar trend was observed at 80 m warp length. At 3.7 kn towing speed with 70 and 80 m warp length, the opening was maximum (Fig. 4). In bottom trawl system; the distance between otter boards, angle of attack and

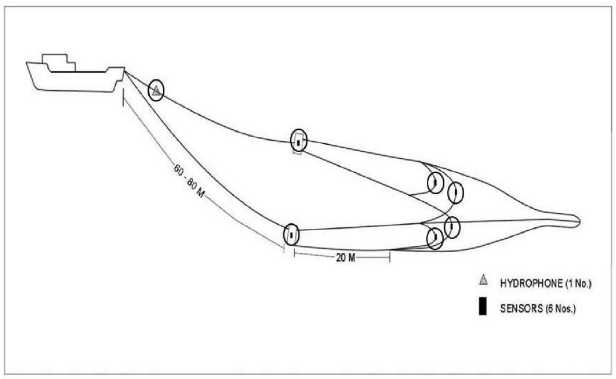


Fig. 2. Schematic diagram showing location of hydrophone and sensors on experimental trawl

Table 1. Details of Bottom Trawl System (BTS)

| Component | Material | Length (m) | Width (m) | Weight (kg) | Diameter (mm) |
|---|---|---|---|---|---|
| Head rope | PP | 27 | - | 2.5 | 14 |
| Foot rope | PP | 31 | - | 2.9 | 14 |
| Floats (4 nos.) | PVC | - | | - | 304 |
| Sinkers (100 nos./ spindle shaped) | Lead | 0.045 | - | 0.25 | Inner: 25<br>Outer: 35 |
| Warp | UHMPE | - | - | - | 11 |
| Otter board | Steel | 1.5 | 0.9 | 126 | - |
| Webbing | HDPE (twisted monofilament) | - | - | 25 | 0.75 |
| Bridle | PP | 20 | - | ~ 3 | 18 |

PP: Polypropylene; PVC: Polyvinyl Chloride.; UHMPE: Ultra High Molecular weight Polyethylene; HDPE: High Density Polyethylene

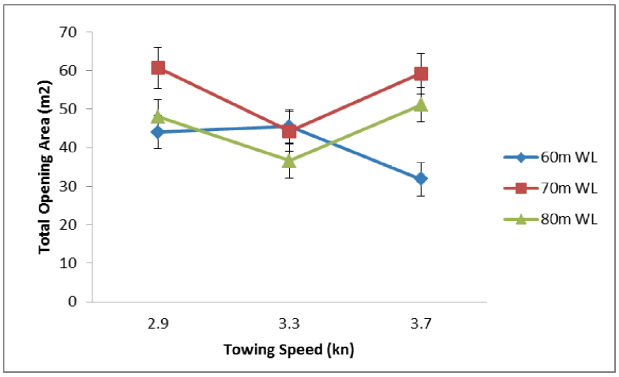


Fig. 3. Graph showing relation of total opening with towing speed at different warp length

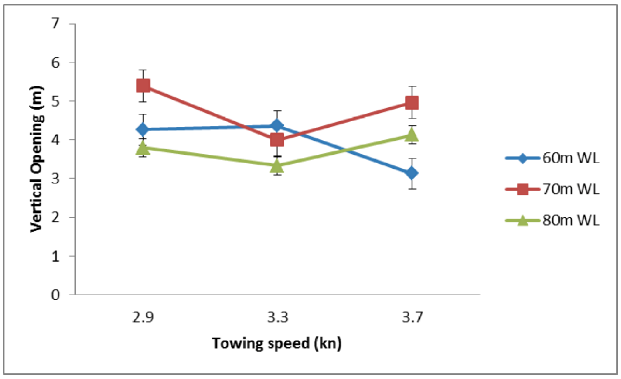


Fig. 4. Graph showing relation of vertical opening with towing speed at different warp length

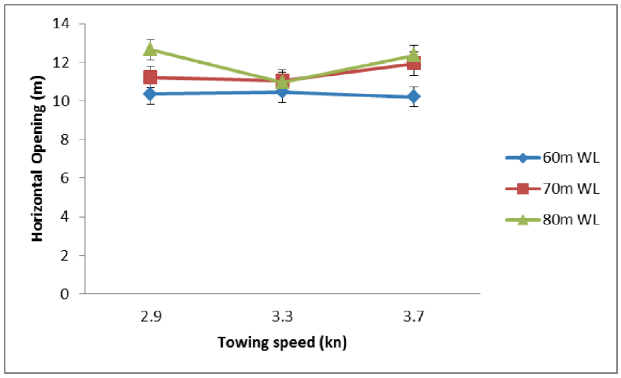


Fig. 5. Graph showing relation of horizontal opening with towing speed at different warp length

distance between head rope and foot rope are important for trawl performance. Also the shape of gear changes with towing speed (Park, 2007). Somerton & Weinberg, (2001) found improved spread and thereby better mouth opening by increasing the towing speed. Weinberg (2003) reported that the trawl opening is a function of towing speed and many other factors tend to reduce the mouth opening. The findings of this study also follow the pattern reported by the above study.

Satyanarayana et al. (1962) reported that the horizontal spread reaches a maximum and thereafter decreases even with increase in speed. They

reported a maximum opening at a towing speed of 2.5-3.5 kn and corresponding horizontal opening was 75-84% of the length of rope between otter boards. The catch volume also influences the door spread (Daniel & Amelia, 2015). De Boer (1959) reported that the horizontal spread increases with length of warp. Trawling at a depth of 10.5-15 m, the best result was obtained at 2.9 and 3.7 kn with 70 m warp length. Considering fuel consumption at higher speed it may be advisable that greater mouth opening can be obtained at 2.9 kn with 70 m warp length. Factors like water current, leeway, torsional stiffness, bottom friction catch in codend etc. also affect the geometry of the trawl in addition to warp length and speed (Madhu & Panda, 2006; Juza et al., 2010). The results of this study should be considered as preliminary because other factors that could have affected the trawl geometry were not included in the analysis. More detailed analysis using techniques to quantify the contribution of external factors that influence trawl geometry are required.

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