IMPACT OF TRAWLING SPEED ON VERTICAL OPENING OF TRAWL NET BY MODELLING METHOD

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ABSTRACT

This study was conducted to find out the relations between trawling speed and vertical opening of trawl net. The study uses a trawl model to perform a test in a flume tank at various trawling speeds, from 0.46 m/s to 1.08 m/s, this is equivalent from1.5 knots to 3.5 knots in the field for full-scale net. The results show that the vertical opening of the net mouth decreases as the trawling speed increases, the vertical opening was reduced by more than 32% as the speed increased from 1.5 knots to 3.5 knots. The regression results show that there is an approximate relationship between trawling speed and vertical opening with a logarithmic function (correlation coefficient $R^2 = 0.9663$). The results of this study are entirely consistent with previous field studies conducted in the world.

Key words: Trawl net, vertical opening, trawling speed.

I. INTRODUCTION

Trawl net is one common and important fishing gear of the world. In Viet Nam, Trawls have been used for a long time and now Trawls are one of the most important types of fishing gear in Viet Nam. The fishing production from trawling is about 40% of total catch. Because of natural conditions in fishing grounds, trawl fishery only developed forcefully in the Northern and Southern provinces of Vietnam [2].

Trawl net were normally made of Polyethylene [2], it operates like a bag pulled by vessel, passing a volume of water including fish, the fish are filtered inside of net [4]. Shapes of the net play an important role on catching efficient of trawl net. One of those parameters is vertical openings, affecting on the ability to catch species which live near the bottom [5].

Bottom trawls are designed and rigged to have bottom contact during fishing. They are towed across the bottom at speed ranging from 1 to 7 knots (0.5-3.5 m/s), most frequently between 3 and 5 knots [3]. This results in the shape of trawl net that has the vertical opening of the trawl, affecting the efficiency of the trawl [5]. Once upon the speed of trawling change, the hydrodynamic force acting on the net changes and the result will change the shape of the trawl net and ultimately affect the fishing efficiency of the gears. Thus, the study on the relationship between the trawling speed to the trawl mouth shape in general and the vertical opening in particular is necessary, as a basis for choosing the speed of trawling or the plan to equip buoys and lead.

Figure 1. Trawl net in Vietnam

This experiments were conducted to determined such parameters during operation at many different speeds of trawling. Information of the experiment contributed to theoretical

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verification, clarifying the change of the vertical opening of the tensile net as the drag speed changed. Finally, recommendations can be made to improve fishing efficiency, helping fishermen/captains control the vertical opening of the mouth during operations when adjusting the speed of trawling. Depending on the target species, the distribution of fish to adjust the speed of trawling to improve the fishing efficiency.

II. MATERIALS AND METHODS

1. Objects

Model net was used in model experiment is 2.79m in length (Figure 2), made from Polyethylene (more detail in Table 1). This model was imitated the full-scale net with 22.3m in length, made of Polyethylene. Model trawl have ratios for the full scale net as below:

$$\text{Length ratio: } \frac{L_m}{Lf} = 0.125$$

$$\text{Speed ratio: } \frac{V_m}{Vf} = 0.6$$

$$\text{Force ratio: } \frac{F_m}{Ff} = 0.0056$$

Where L, V and F are length, speed of trawling and external force respectively.

m and f is annotated to the model and the real object.

Table 1: Specifications of model and full-scale net

Contents	Model	Full-scale
Length (m)	2.79	22.30
HR length (m)	2.14	17.10
GR length (m)	2.76	22.10
Wing's mmSt (mm)	25.00	200.00
Inner's mmSt (mm)	2.50	20.00
Buoyancy of float (kgf)	0.26	45.60
Sinking weight of sinker (kgf)	0.32	58.00

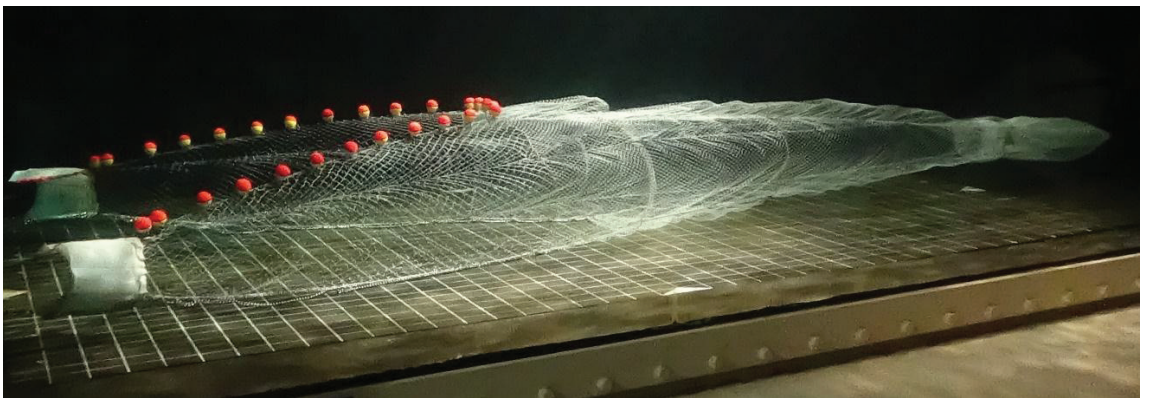


Figure 2. Model of trawl net

2. Methodologies

2.1. Flume tank:

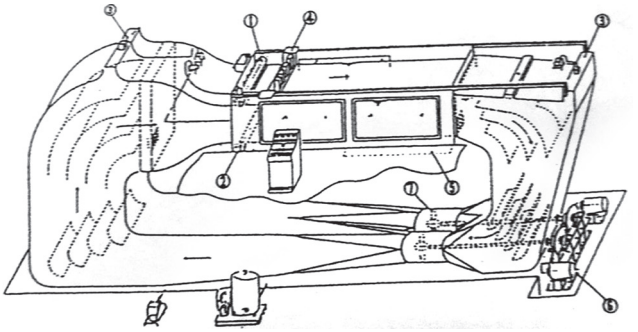
Model was tested in the flume tank in Kagoshima University, it is two impellers type vertical circulating water channel, dedicated to test fishing gear models (Figure 3). Its Basic specifications as follows:

Main body: Length x Width x Height: 14.8 x 2.0 x 5.9

Measuring section: Length x Width x Height: 6.0 x 2.0 x 1.0

Drive motor: 22 Kw, 2 sets

Velocity: 0 – 2.2 m/sec variable speed



1. Surface flow accelerator
2. Bottom flow accelerator
3. Deaeration equipment
4. Water surface smoother
5. Moving floor
6. Motor D.C 22KW
7. Impeller

Figure 3: The Diagram of flume tank

2.2. Speeds of testing:

In fact, trawl fishing usually uses the speed of trawling ranging from less than 2.0 knots to more than 3.0 knots, so in this study, the author in turn tested the net at speeds from 0.46 m/s to 1.08 m/s, this is equivalent from1.5 knots to 3.5 knots in the field for full-scale net (see detail in Table 2).

Table 2: Trawling speeds was tested in the experiment

No	Speed in experience (m/s)	Speed in reality (Knot)
1	0.46	1.5
2	0.62	2.0
3	0.77	2.5
4	0.93	3.0
5	1.08	3.5

2.3. Measurement method:

The vertical opening of the trawl was observed at three locations, including the net head, net mouth and the codend (Figure 4).

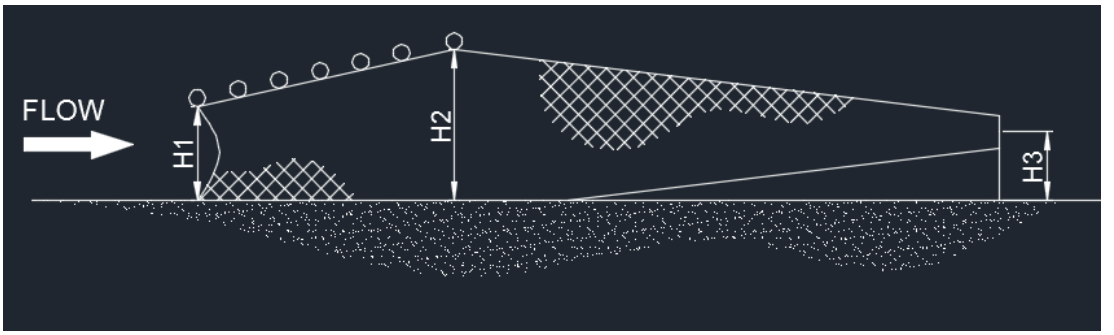


Figure 4. Three vertical openings were measured

All three parameters are measured among different trawling speeds by laser light and measurement (Figure 5). In this experiment, the horizontal opening of the net is fixed.

Flow speed parameters are measured by a sensor that is connected to the computer (Figure 6).

Figure 5. Measuring by laser light

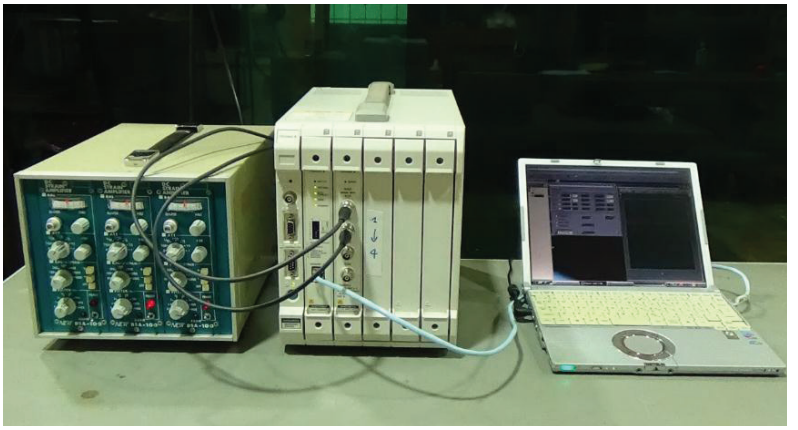


Figure 6. Calculations and display flow rate system

III. RESULTS AND DISCUSSION

The experimental results showed that when the trawling speed increased, the openness of all three positions of the net decreased. See details in Table 3 and Figure 7.

Table 3. Results of model observation and conversion to full scale

Speed		Model			Full scale (= 8*model)		
Knot	m/s	H1 (cm)	H2 (cm)	H3 (cm)	H1 (m)	H2 (m)	H3 (m)
1.50	0.46	17.50	27.50	11.20	1.40	2.20	0.90
2.00	0.62	16.20	23.40	9.00	1.30	1.87	0.72
2.50	0.77	16.00	20.80	8.60	1.28	1.66	0.69
3.00	0.93	15.50	18.90	9.60	1.24	1.51	0.77
3.50	1.08	15.30	18.60	10.00	1.22	1.49	0.80

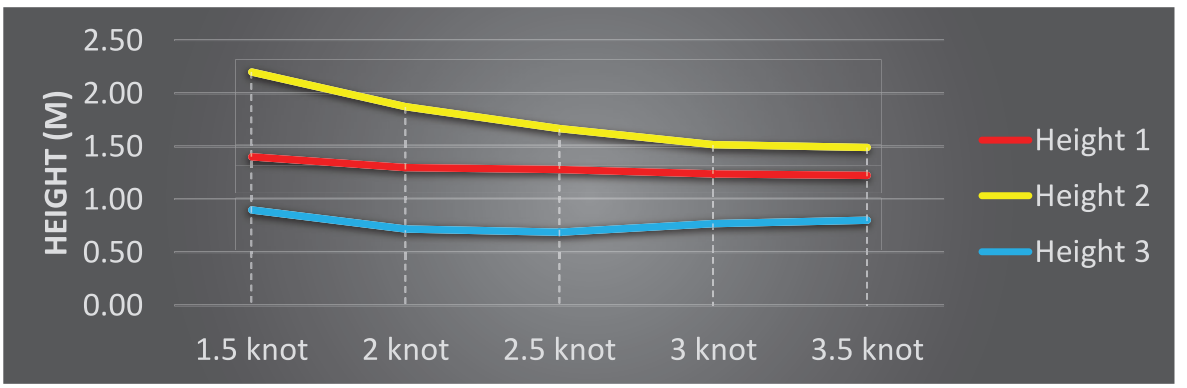


Figure 7. Chart of vertical opening changes as the drag speed changes

In Table 3 and Figure 7, the vertical opening of the mesh mouth is always higher than the two vertical openings in the other two positions (H1 and H3) at any mesh speed. At 1.5 knots, H1 = 1.4m, H2 = 2.2m and H3 = 0.9m. As the trawling speed increases, all observed heights decrease, at a rate of 3.5 knots, H1 drops to 1.22m, H2 = 1.49m and H3 = 0.8m.

Figure 8. Some pictures of model experiences

H2 is the vertical opening of the trawl net, which is an important parameter that impact on the catch efficiency of the net. It is clear that H2 is the most degraded parameter as trawling speed increases. The results of monitoring and analysis of H2 change are shown in Figure 9.

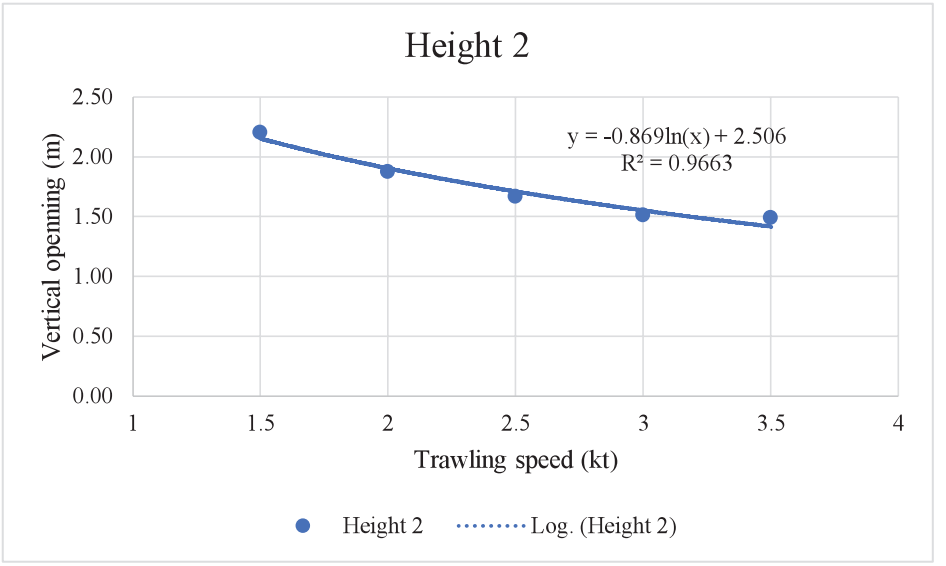


Figure 9. Chart of vertical opening changes as the drag speed changes

The regression result from Figure 9 shows that H2 decreases with the logarithm of trawling speed: H2 = -0.869ln(speed) + 2.506 with correlation coefficient $R^2 = 0.9663$.

The vertical opening at the mouth H2 at 1.5 knot trawling speed is 2.2m. As the trawling speed increased to 3.0 knot, the vertical opening of the H2 dropped sharply to 1.51 m (down by more than 31%). As the trawling speed increases from 3.0 to 3.5 knots, the H2 opening decreases slowly to 1.49m (just over 1%).

The results of this study are completely consistent with previous field studies done in the world. Typically, the study "Trawl Designs and Techniques used be Norwegian research vessels to sample fish in the Pelagic zone" in 1973 by two scientists J.W. Valdemarsen and O.A. Misund at the Marine Research Institute, Norway. In this study, when the trawling speed increased from 3.0 knots to 4.2 knots, the opening of the trawl mouth decreased by nearly 10% for the 150m warp rope, down nearly 23% for 450m warp rope [6]. Also related to this issue, in the study named "Bottom and Pelagic Sampling Trawls in Lake Victoria (Kenya)", conducted in 2013 by Fredrick Otieno Okello - Kenya Marine and Fisheries Research Institute, Kenya, also give results when considering the trawling speed from 0.5 knot to 6 knots, the vertical opening of net mouth decreases from 8.5m to 1 meter (down 88%) [5].

IV. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

As the trawling speed increases, all the vertical opening at the three observations decrease, but not identical. In three observation positions, the vertical opening at the mouth H2 dropped sharply as the trawling speed increased. This opening was reduced by more than 31% as the speed increased from 1.5 knots to 3.0 knots. H2 is also an important factor affecting catching efficiency. This change follows the law of the logarithmic function of the variable speed of trawling.

2. Recommendations

According to the test results, it is necessary to calculate the equipment used to add lead buoys when adjusting the speed of trawling the net to catch different fish species in different seasons. In addition, for fishing slow-speed species (squid, crab, …), the speed of trawling is low, so it is not necessary to equip too many floats. However, in certain seasons, switch to larger species of fish (Largehead hairtail, Shortfin saury, ...), vessel have to pull trawl net faster, so it should be equipped with additional buoyancy for the net to ensure the verticel openning.

It is necessary to undertake studies on the application of pressure sensors in the determination of vertical openning and provide adequate floatation for different types of trawls.

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