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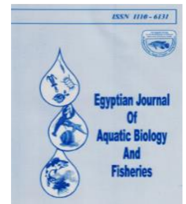

Trammel Net Selectivity for Croaker Fish in Musi River Estuary of South Sumatra: A Quantitative Analysis

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ABSTRACT

Trammel nets are one of the effective fishing gears widely used in small-scale fisheries. Understanding their selectivity is crucial for fisheries management in determining appropriate mesh sizes that optimize the capture of target species while reducing bycatch and discards. This study aimed to evaluate the selectivity of trammel nets with different mesh sizes (1.75 and 2 inches) for capturing the croaker species (*Otolithoides pama* and *Panna microdon*) in the Musi River Estuary, South Sumatra, Indonesia. Experimental fishing was conducted to collect total fish length data, resulting in 248 specimens across 16 species. Holt's Model (normal location model) was applied to estimate the trammel net selectivity, while the size distributions were compared using the two-sample Kolmogorov-Smirnov (K-S) test. The results indicated that smaller mesh sizes caught a greater number of fishes, but larger mesh sizes obtained catches with a greater total length. The K-S test revealed significant differences in length-frequency distributions for *P. microdon* (P=0.023<0.05) and combined croaker species (P=0.019<0.05), but no significant differences for *O. pama* (P=0.068>0.05). The optimal catch sizes for both croaker species were above the length at first maturity recorded for *O. pama*. Accordingly, the trammel nets with 1.75 and 2-inch mesh sizes are still suitable for capturing mature croaker fish in the Musi River Estuary and may help reduce the capture of immature fish. These findings would provide valuable empirical evidence for fisheries management to determine appropriate inner-panel mesh sizes for the sustainable exploitation of both croaker species under study.

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INTRODUCTION

The Banyuasin coastal regions of South Sumatra rely heavily on fisheries for their economy. One of the most important local fisheries areas is the Musi River Estuary **(Agustriani *et al.*, 2020)**, which is rich in biodiversity and resources **(Fauziyah *et al.*, 2019a, 2019b, 2020)**. On the other hand, the trammel nets are one of the most important fishing gears in these waters for capturing various demersal species **(Fauziyah *et al.*, 2018)**. Indeed, trammel nets are a commonly used fishing gear in small-scale fisheries around the world **(Erzini *et al.*, 2006; Lucchetti *et al.*, 2020)**. However, these fishing gears catch many non-target species both by-catch and discarded species **(Fauziyah *et al.*, 2018)**. The total number of discards produced by these gears should not be overlooked, even though they are thought to be more selective in terms of size and species, as well as having a low to moderate discard rate, and being less harmful to habitats and stocks compared to the towed gears operated in large-scale fisheries **(Huse *et al.*, 2000; Stergiou *et al.*, 2002; Kelleher, 2005; Adamidou *et al.*, 2023)**. Therefore, selecting appropriate fishing gear is crucial since it helps maintain ecological balance and ensure sustainability of fishes in future **(Bhanja *et al.*, 2024)**.

The concept of fishing gear selectivity is fundamental for the sustainable management of fisheries **(El-Far *et al.*, 2020)**. The use of fishing gear capable of targeting only certain species will minimize bycatch, of other fish species, and this is essential for sustainable fishing and minimizing effects on local livelihoods and ecosystems **(Sánchez-González & Casals, 2022)**. Gear selectivity theories recommend more selective gears to help maintain fish populations by decreasing the capture of undersized or unwanted catches **(O'Neill *et al.*, 2019; Maynou *et al.*, 2021)**. Previous studies have shown that various factors such as gear design, mesh size, and operational techniques affect gear selectivity **(Lemke & Simpfendorfer, 2023)**. One strategy for reducing undesired catches is to modify the selectivity of fishing gear **(Ford *et al.*, 2020)**.

Fish can be caught using the trammel net by gilling and entangling, just like with traditional gill nets, as well as trapping large fish within the inner netting bags **(Karakulak & Erk, 2008)**. Consequently, it is generally thought that these gears are less selective in size compared to gill nets **(Olguner & Deval, 2015)**. In other words, once in contact with the trammel net, only a few fish can escape **(Erzini *et al.*, 2006)**. Unfortunately, despite these trammel nets being one of the top priority fishing gears in the Musi River Estuary, research on their selectivity in these waters is limited. In Indonesian seas, the published studies on trammel net selectivity were also relatively few, such as in Takalar waters and Tegal City waters **(Pratama, 2004; Jamal, 2015)**.

These limited selectivity studies do not include any specific studies on gear selectivity for croaker fish (*Otolithoides pama* and *Panna microdon*) in the Musi River, which is a major limitation of management, as the size selectivity of trammel nets is a significant fisheries management tool, by regulating the minimum mesh size of these gears and the minimum landing size of the targeted species **(El-Bokhty, 2022)**. Both species are the two most commonly found croaker fish in these waters **(Rais *et al.*, 2017)** and are considered one of the economically important fishery resources **(Sirait *et al.*, 2022)**. Consequently, existing trammel net selectivity studies do not have adequate empirical evidence to guide local fisheries management decisions. Thus, this study aimed to produce detailed information and empirical evidence that emphasizes the selectivity of two trammel nets (1.75 and 2 inches) for two croaker fish in these waters. These findings will serve as a guide to better fishery management and conservation policies not only in the Musi River but also in other similar areas faced with these challenges.

MATERIALS AND METHODS

The experimental fishing

This research was conducted on 27 December 2022 – 05 January 2023 at the Musi River Estuary, Banyuasin II District, Banyuasin Regency, South Sumatra Province (Fig. 1). The study employed an experimental fishing approach.

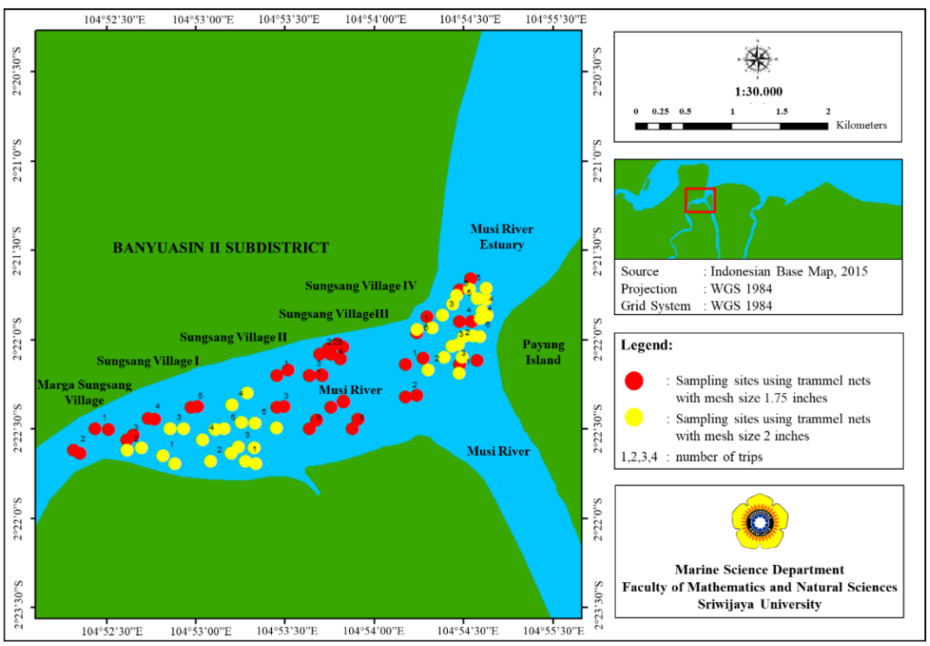

Fig. 1. Map of the study area showing the sampling sites in the Musi River Estuary of Banyuasin Regency, South Sumatra, Indonesia. The red circles indicate sites where trammel nets with a 1.75-inch mesh size were used, while the yellow circles represent sites with a 2-inch mesh size. The numbers next to the red and yellow circles represent the first, second, third, and fourth days of fishing trips conducted at the study site

The data were collected through direct participation in trammel net fishing, over four one-day fishing trips. Referring to the mesh sizes most used by local fishermen, the inner trammel nets in this study had mesh sizes of 1.75 and 2 inches, respectively (Table

1). Both inner panels were made from PA monofilament with a 0.20mm diameter and a hanging ratio of 0.55, with the smaller mesh size targeting smaller fish, while the larger mesh size was suited for slightly larger fish. The outer panels of both trammel nets had a 5-inch mesh size and were constructed from 0.25mm PA monofilament. While these trammel nets were similar in material, height, length, and hanging ratio, they differed in their inner mesh size and vertical slack. All fish caught during fishing trips were measured for total length to the nearest half centimeter. The fishing experiment assumed that fish were distributed randomly around the net, encountered the net randomly, and that the probability of fish encountering the net was independent of the fish size.

Table 1. Detailed specifications of the trammel nets used in the study. Net A represents the smaller mesh gear, and Net B represents the larger mesh gear

Specifications	**Type of trammel nets**	
	A	**B**
Inner panel		
• Mesh size (inch)	1.75	2
• Diameter (mm)	0.20	0.20
• Material	PA Monofilament	PA Monofilament
Outer panel		
• Mesh size	5	5
• Diameter	0.25	0.25
• Material	PA Monofilament	PA Monofilament
Height of trammel nets	1.5 m	1.5 m
Length of trammel nets	1,300 m	1,300 m
Hanging ratio	0.5	0.5
Vertical slack	1.46	1.67

Selectivity analysis

In terms of selection curves, there is considerable consensus for gill nets but not for trammel nets **(Erzini *et al.*, 2006)**. Therefore, some researchers **(Bolat & Tan, 2017; Aydın *et al.*, 2018; El-Bokhty, 2022)** used Holt's Model (gillnets selectivity model) to estimate the trammel net selectivity. According to **Sparre and Venema (1998)**, Holt's Model is expressed by the following equations:

$$S_L = exp\left[-\frac{(L - Lm)^2}{2s^2}\right] \quad (1)$$

Where, S_L is the selectivity curve, L is the interval midpoint for fish length, Lm is the optimum length for being caught, and s is the standard deviation of the normal distribution.

Holt's Model suggested an experiment to determine Lm and s by using different mesh sizes (m_a and m_b) and both mesh sizes should be such that their selection curves overlap each other **(Sparre & Venema, 1998)**. In this context, both nets were set to catch fish in the same water area and observations were conducted in the catch numbers by fish length group. The assumptions of this method, such as (1) the *Lm* (the top of the bell-shape selection curve) were proportional to the mesh size; (2) the two selectivity curves had the same standard deviation; (3) both nets had the same fishing power. The *Lm* values can be estimated using the following formulas:

$$Lm = SF * m \quad (2)$$

$$Lma = SF * m_a \quad (3)$$

$$Lmb = SF * m_b \quad (4)$$

$$SF = \frac{-2\alpha}{\beta(m_a + m_b)} \quad (5)$$

$$ln(C_b/C_a) = \alpha + \beta L \quad (6)$$

Where, *Lma* is the optimum length for the smaller meshed gear, *Lmb* is the optimum length for the larger meshed gear, m_a is the smaller mesh size in cm, m_b is the larger mesh size in cm, *SF* is the selection factor, C_a is the numbers caught by length group for the smaller meshed gear, C_b is the numbers caught by length group for the larger meshed gear, α is the intercept, and β is the slope.

The common standard deviation (*s*) was estimated from Equation 7. Furthermore, the points of selectivity curves were found by inserting values of L into Equation 8 or 9, as below:

$$s^2 = \frac{-2\alpha(m_b - m_a)}{\beta^2(m_a + m_b)} = SF\frac{(m_b - m_a)}{\beta} \quad (7)$$

$$Sa(L) = exp\left[-\frac{(L - Lma)^2}{2s^2}\right] \quad (8)$$

$$Sb(L) = exp\left[-\frac{(L - Lmb)^2}{2s^2}\right] \quad (9)$$

Where, Sa(L) is the selectivity curve for the smaller meshed gear, and Sb(L) is the selectivity curve for the larger meshed gear.

Statistical analysis

The two-sample Kolmogorov-Smirnov (K-S) test with a significance level of 95% **(Aydın *et al.*, 2015)** was applied to compare the size distributions of the total length datasets obtained from the two trammel nets fishing with different mesh sizes. Both the length frequency distributions and K-S test were analyzed using SPSS 21.0, while selectivity curves were calculated and plotted by using the Microsoft Excel program.

RESULTS

A total number of 248 specimens (16 species) were caught during the experimental trammel nets (Table 2). The main catch contributed 34.7% of the total catch in number, while the by-catch and discard species constituted 61.7 and 3.6%, respectively. Among the species captured during these experimental fishing, the croaker fish *O. pama* was the most abundant species (22.2% of the catch in number), followed by 14.0% anchovy *Setipinna taty* and 12.5% croaker fish *P. microdon*. The total catches obtained from 1.75 and 2-inch trammel nets were 181 (73%) and 67 (27%) specimens, respectively. Smaller mesh sizes were the most efficient in terms of catch numbers, whose abundance decreased as the mesh size increased. However, the smaller mesh sizes resulted in higher numbers of by-catch specimens (63.6%) compared to the larger mesh sizes (56.7%). On the other hand, both smaller and larger mesh sizes obtained relatively equal numbers of discarded specimens.

The mean-catch sizes, selectivity parameters, the K-S test (the two-sample Kolmogorov-Smirnov tests), and the length at first maturity are shown in Table (3). In catch sizes terms, the mean value of total length for *O. pama* captured by 1.75 and 2-inch mesh sizes of trammel nets were 22.39 and 25.63cm, respectively. For *P. microdon*, the calculated mean values of total length were 20.33 and 25.13cm for the same trammel nets. Accordingly, the mean sizes for both croaker species which were caught from both mesh sizes were 21.7 and 26.7, respectively. The results of K-S tests revealed that length frequency distributions of *P. microdon* and combined croaker species caught by different trammel nets were statistically significant ($P < 0.05$). Conversely, no significant difference in length frequency distributions of *O. pama* was observed for larger meshed gear ($P > 0.05$).

The optimal catch sizes for *P. microdon* obtained by both smaller and larger mesh sizes were 23.33 and 26.66cm, respectively, while for *O. pama* were 28.79 and 32.90cm, respectively. Overall, the optimal catch size for the combined croaker species captured by both smaller and larger meshed gears was 27.71 and 31.67cm, respectively. All optimum catch sizes of the croaker fish obtained using both smaller and larger mesh sizes were above the value of length at first maturity for *O. pama* (19.6cm), suggesting that the catch sizes from both meshes are not necessarily destructive and may help reduce the capture of immature fish.

Table 2. Catch composition (number and percentage by species) of trammel nets with 1.75-inch (m_a) and 2-inch mesh sizes (m_b)in the Musi River Estuary of Banyuasin Regency, South Sumatra, Indonesia

No	Scientific Name	Local Name	Catch Numbers m_a	Catch Numbers m_b	Catch % m_a	Catch % m_b	Total Fish Numbers (%)
Main catch							
1	*Otholithoides pama*	Gelamo	39	16	21.5	23.9	55 (22.2)
2	*Panna microdon*	Gelamo	23	8	12.7	11.9	31 (12.5)
	Subtotal		**62**	**24**	**34.2**	**35.8**	**86 (34.7)**
By-catch							
3	*Setipinna taty*	Sampa	24	17	13.3	25.4	41 (16.5)
4	*Dorosoma petenense*	Permato	19	2	10.5	3.0	21 (8.5)
5	*Cynoglossus lingua*	Lidah	13	8	7.2	11.9	21 (8.5)
6	*Setipinna breviceps*	Pirang Bujang	10	7	5.5	10.4	17 (6.9)
7	*Hexanematichthys sagor*	Duri	15	0	8.3	0.0	15 (6.0)
8	*Polynemus longipectoralis*	Janggut	10	0	5.5	0.0	10 (4.0)
9	*Pseudorhombus arsius*	Sebelah	8	0	4.4	0.0	8 (3.2)
10	*Parastromateus niger*	Bawal Hitam	7	0	3.9	0.0	7 (2.8)
11	*Odontamblyopus rubicundus*	Ploso belut	2	4	1.1	6.0	6 (2.4)
12	*Coilia lindmani*	Bulu Ayam	3	0	1.7	0.0	3 (1.2)
13	*Pangasius polyuranodon*	Juaro	2	0	1.1	0.0	2 (0.8)
14	*Plotosus canius*	Sembilang	2	0	1.1	0.0	2 (0.8)
	Subtotal		**115**	**38**	**63.6**	**56.7**	**153 (61.7)**
Discard							
15	*Carcinoscorpius rotundicauda*	Belangkas	4	4	2.2	6.0	8 (3.2)
16	*Triacanthus nieuhofii*	Tunjang Langit	0	1	0.0	1.5	1 (0.4)
	Subtotal		**4**	**5**	**2.2**	**7.5**	**9 (3.6)**
	Total		**181**	**67**	**100**	**100**	**248 (100.0)**

Table 3. Regression and selectivity parameters for two trammel nets with mesh size 1.75 inches (4.45 cm) and 2 inches (5.08 cm) for capturing the croaker fish in the Musi River Estuary of Banyuasin Regency, South Sumatra, Indonesia

Species	Mean length (cm) m_a	Mean length (cm) m_b	Regression α	Regression β	Regression R^2	Optimal catch size (cm) Lma	Optimal catch size (cm) Lmb	SF	s	K-S test (p-value)	Length at first maturity (cm)
O. pama	22.39	25.63	-3.34	0.11	0.70	28.79	32.90	6.48	6.16	0.068	19.6[a]
P. microdon	20.33	25.13	-10.40	0.42	0.65	23.33	26.66	5.25	2.83	0.023*	-
Overall	21.62	25.46	-3.86	0.13	0.95	27.71	31.67	6.23	5.52	0.019*	-

Note: m_a = the smaller mesh size; m_b = the larger mesh size; α = intercept, β = slope R^2 = coefficient of determination which can indicate the goodness of fit of a model; Lma = optimum catch size for the smaller meshed gear; Lmb = optimum catch size for the larger meshed gear; SF = selection factor; s = standard deviation; K-S = two-sample Kolmogorov-Smirnov; * = significant difference in catch size between both smaller and larger meshed gear (α = 0.05); [a] = referring to **Bhakta *et al. (*2021)**.

Fig. (2) presents three bar graphs comparing the percentage of catch processes using two different trammel net mesh sizes for *O. pama*, *P. microdon,* and the overall catch composition. For *O. pama* (Fig. 2a), both mesh sizes captured a significant portion of fish through entanglement, with 43% for the smaller mesh and 60% for the larger. In the case of *P. microdon* (Fig. 2b), the smaller mesh showed the highest entanglement rate at 87%, compared to 60% for the larger mesh. Overall, the smaller mesh consistently resulted in higher entanglement rates across species, while the larger mesh performed slightly better in the snagged and wedged categories (Fig. 2c).

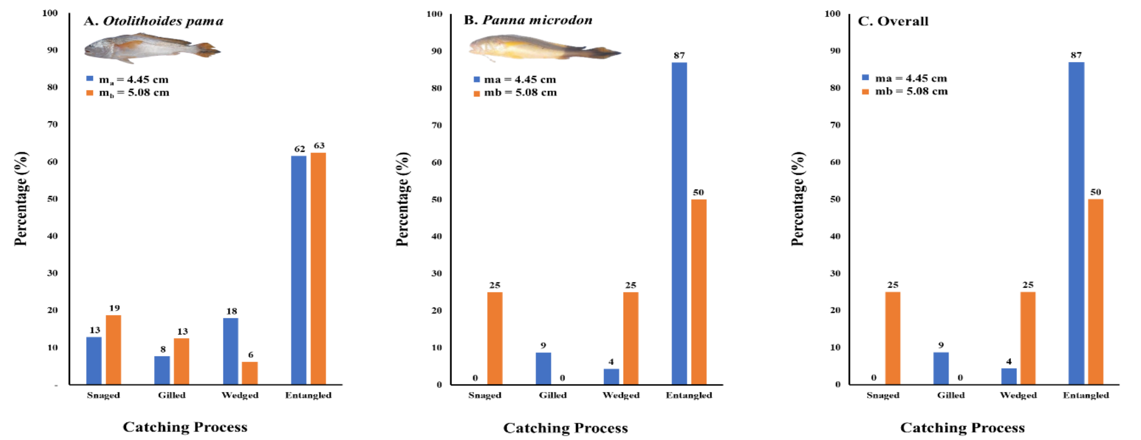

Fig. 2. The catching process of trammel nets with the smaller (m_a) and larger mesh size (m_b) for targeting the croaker fish operated in the Musi River Estuary of Banyuasin Regency, South Sumatra, Indonesia: (A) *Otolithoides pama*; (B) *Panna microdon*; and (C) overall croaker fish

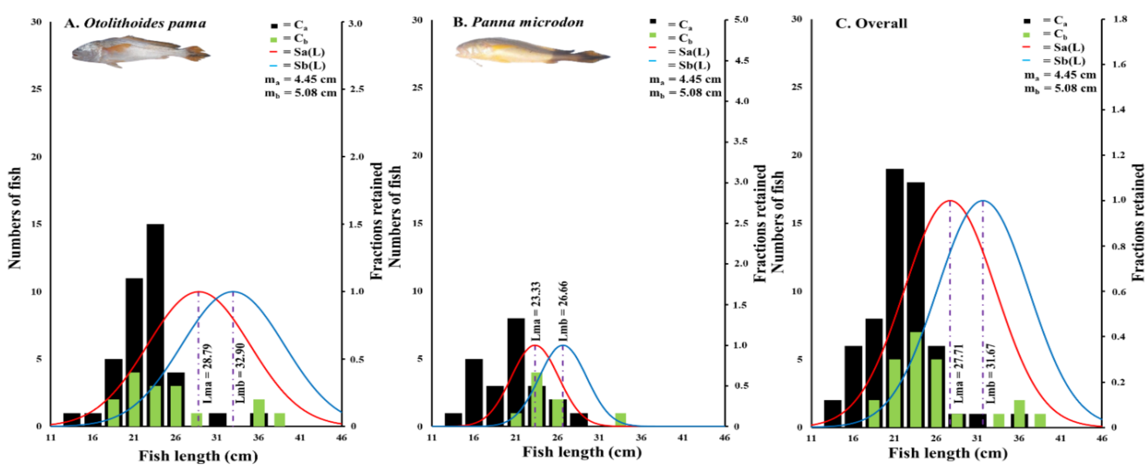

Fig. 3. Selection curve of trammel net for targeting the croaker fish operated in the Musi River Estuary of Banyuasin Regency, South Sumatra, Indonesia: (A) *Otolithoides pama*; (B) *Panna microdon*; and (C) overall croaker fish. Lma is the optimum catch size for the smaller meshed gear, Lmb is the optimum catch size for the larger meshed gear, ma is the smaller mesh size, and mb is the larger mesh size

The selectivity curves of the two trammel nets in different mesh sizes for the croaker species are displayed in Fig. (3). The size-frequency distributions of *O. pama* (Fig. 3a), and *P. microdon* (Fig. 3b) caught by different mesh sizes indicated that increasing mesh size caused the mean value of total length to shift to the right. The same pattern of selectivity curves also resulted in the combined croaker species (Fig. 3c).

DISCUSSION

Trammel nets are specially designed gillnets constructed by combining three parallel sheets of netting where one inner sheet is made of netting, with a much smaller mesh size than the other two outer sheets of netting. Accordingly, fish can be caught using this gear design in two different ways: (1) gilling and entangling, as is the case with traditional gillnets; and (2) capturing large fish that are "trammeled" or "pocketed" when the whole fish is enveloped in the fine mesh inner net after passing through the large mesh outer panels. Consequently, these trammel nets tend to be less size-selective compared to traditional gill nets. According to **Erzini *et al.* (2006)**, both the optimum selectivity model and length frequency distribution range were determined by the caught processes (gilled, wedged, trammeled, and pocketed). **Olguner and Deval (2015)** stated that these capture processes corresponded in the size distribution shapes (multi-modal, bi-modal, or skewed to the right). In the present study, the obtained size distributions were skewed to the right. Smaller fish tend to be caught through gilled or wedged mechanisms while larger sizes correspond to trammeling or pocketing mechanisms **(Erzini *et al.*, 2006)**. In this study, similar trends were observed in the catches of both target species, with smaller specimens being more frequently captured through gilling and wedging, while larger individuals were associated with trammeling or pocketing methods.

Selectivity aims to determine the optimum mesh size that can help in increasing the targeted fish proportion while at the same time minimizing by-catch and discards for reaching sustainable fishing **(Hamley, 1975; Fabi *et al.*, 2002; Saber *et al.*, 2020)**. Therefore, information on the size selectivity of trammel nets was essential for regulating their gear use (minimum inner mesh size), the minimum legal size of their targeted species, and the management of sustainable fishing appropriately **(Saber *et al.*, 2020, 2022)**. In this study, trammel nets with mesh sizes of 1.75 and 2 inches which are commonly used by small-scale fisheries in these waters were proven to result in the optimum catch sizes (*O. pama* and *P. microdon*) more than the length at first maturity. On the other hand, the mean length of *P. microdon* was smaller than *O. pama* also recorded in this study. According to **Bhakta *et al.* (2021)**, the length at first maturity for *O. pama* was 19.6cm for females and 18.3cm for males. Therefore, both mesh sizes facilitate the capture of mature target fish; however, the overall impact on the population will also depend on factors such as fishing effort and mortality rates. Unfortunately, the number of bycatch specimens obtained by smaller mesh sizes was also higher compared to larger mesh sizes, although the discarded catch was almost the same in specimen number. However, as the most abundant bycatch obtained from both meshed gears, *Setipinna taty* is an essential commercial fish due to its delicious taste **(Li *et al.*, 2012)**.

These findings revealed that the mean lengths of both targeted fish increased with increasing mesh size, which is consistent with the results of previous studies, such as the study in the Sakarya River of Turkey **(Aydın *et al.*, 2015)**, the Red Sea of Saudi Arabia **(Gabr & Mal, 2016)**, and Finike Bay of Turkey **(Bolat & Tan, 2017)**, Suez Bay of Egypt **(Saber *et al.*, 2020, 2022)**, Strymonikos Gulf of the northern Aegean Sea **(Adamidou *et al.*, 2023)**, and Lake Nasser of Egypt **(Saber & Aly, 2023)**. The target fish length distribution shifted to the right indicating an increase in the mean total length of entangled fish, thereby increasing the gear selectivity **(Saber *et al.*, 2020)**. In this current study, the size selectivity of trammel nets was estimated based on the mesh size of the inner panels only. While, the mesh size of the outer panels commonly had no significant influence on their size selectivity, as reported by **Erzini *et al.* (2006)**, **Stergiou *et al.* (2006)** and **Adamidou *et al.* (2023)**. The inner-panel mesh size can be used in regulating the size selectivity of this fishing gear, as highlighted by **Losanes *et al.* (1992)**, **Erzini *et al.* (2006)** and **Saber *et al.* (2020)**.

The variation in fishing methods' selectivity could be caused by several factors such as species type, size range of the fishing ground, sample size, and gear-related aspects including twine size and type, as well as mesh sizes **(Saber & Aly, 2023)**. In contrast, the vertical slack of trammel nets (the ratio between the height of the inner and the outer-panel net) had no significant impact on their selectivity curves **(Koike & Matuda, 1988; Losanes *et al.*, 1992)**. However, vertical slack plays a crucial role in determining the extent of "pocketing," which can affect fish capture. While the fish's ability to escape or be caught is influenced by whether they can pass through the meshes, vertical slack can also contribute to how effectively fish are ensnared within the netting **(Erzini *et al.*, 2006)**. Nonetheless, there were minimal variations on the descending parts of the selectivity curve for the vertical slack values higher than 1.5 **(Koike & Matuda, 1988; Losanes *et al.*, 1992)**. Unfortunately, this study did not examine the effect of vertical slack on the catch efficiency of the target species.

Currently, the minimum landing sizes have not been established for these two species of croaker fish, including regulating the minimum mesh size of trammel nets in these waters. The novelty of this study lies in providing the first empirical evidence on the optimal catch sizes for two species of croakers using trammel nets, including recommendations for minimum landing sizes and mesh sizes of this fishing gear to achieve sustainable fishing. **Saber *et al.* (2022)** stated that implementing the minimum landing size is the most effective technique for increasing reproductive results. By applying a robust selectivity analysis, this study offered scientifically validated data that can serve as an important basis for establishing minimum landing sizes and mesh size regulations for trammel nets. In addition, the findings also offered both localized insights and broader implications for fisheries management in other regions facing similar regulatory challenges.

Despite its contributions, this study has several limitations detailed in the following lines. (1) The research was conducted in a specific geographic area with a limited range of species, which may affect the generalizability of the findings to other regions or ecosystems; (2) this study focused on two mesh sizes of trammel nets for capturing croaker species, thus this limitation may restrict the applicability of the results to other fishing scenarios with different gear specifications; (3) the environmental factors such as water temperature, salinity, and current, which may affect the fish behavior encounter the nets and net efficiency, were not controlled or analyzed in this study, potentially affecting the results and their interpretation; and (4) the relatively small number of fish captured during the study may limit the robustness of the selectivity analysis. Nevertheless, the implications of these findings are significant, particularly in the context of small-scale fisheries that rely on local fish stocks for livelihood. Both mesh sizes of the trammel nets they commonly use have been scientifically proven to be appropriate for sustainable fishing in exploiting these croaker species, thereby securing the long-term sustainability of these communities. From a policy perspective, the results support the need for clear regulations that balance ecological sustainability with economic viability. This could involve establishing minimum mesh size requirements or providing incentives for fishermen to adopt gear that aligns with sustainable practices. Additionally, the study highlighted the responsibility of managing fish resources through preventing overfishing and ensuring the continued availability of these resources for future generations.

CONCLUSION

This study provided essential information regarding the size-selectivity of trammel nets with different mesh sizes in the Musi River Estuary, South Sumatra. Based on the size-selectivity analysis, the trammel nets commonly used by local fishermen have captured mature croaker fish (*O. pama* and *P. microdon*). However, while these gears may contribute to sustainable fishing practices, further assessment of fishing effort and mortality rates is essential to fully understand their impact on fishery. The trammel net with an inner-panel mesh size of 1.75 inches could be recommended as the minimum mesh size for capturing these croaker fish. Therefore, these findings are expected to provide scientific information in supporting sustainable fisheries management, especially in determining the minimum landing size and appropriate mesh sizes of trammel net for the exploited stocks. On the other hand, future research should aim to address expanding the geographic scope and including a broader range of species to enhance the generalizability of the findings. Experimental fishing with a wider variety of mesh sizes and other gear modifications could provide a more comprehensive understanding of trammel net selectivity. Other selectivity models, including bi-normal and logistic should also be tested, as other studies have shown that uni-modal selectivity models may not be the most appropriate for trammel nets.

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