Selectivity of Gillnet to Catch Silver Pomfret (*Pampus argenteus*) in Pangandaran Waters, Indonesia

Izza Mahdiana Apriliani[1*], Herman Hamdani[1], Yuniar Mulyani[1], Heti Herawati[1] and Dear Frans Lyandre Simanjorang[1]

[1]*Department of Fisheries, Faculty of Fisheries and Marine Science, Universitas Padjadjaran, Indonesia.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

The purpose of this research was to determine the most selective mesh size of gillnet fishing gear for *Pampus argenteus* in coastal waters of Pangandaran Regency, West Java. Research on the selectivity of gillnet fishing gear was carried out in the coastal waters of Pangandaran, West Java Province, from August 2018 to January 2019. The method used in this research is experimental fishing, namely operating gillnet fishing gear directly in the fishing area with fishermen. The primary data collected was the measurement of the catch (fish weight, number, fork length, how the fish was caught, circumference (girth opercullum, maximum body girth). Meanwhile, the secondary data collected were supporting data from the Pangandaran District Fisheries and Marine Service, and literature study. In determining the sampling, the method used is the purposive sampling method. The operation of gillnets using 4.5 inches obtained a higher proportion of main catch (75%) than gillnets with a mesh size of 5 inches (44%). Gillnet with a mesh size of 4.5 inches, the silver pomfret caught was distributed between 17-22 cm in size with the highest mode in the 19 cm fork length. Unlike the gillnet fishing gear with a mesh size of 5 inches, the silver pomfret caught was distributed in the fork length range of 17-25 cm with the highest mode in the length class 19

Corresponding author: Email: izza.mahdiana@unpad.ac.id;

cm fork length. mesh size 4.5 inches has a hanging ratio value of 0.51. Meanwhile, the 5 inch mesh size has a hanging ratio value of 0.54. Based on the length distribution, gillnets with a mesh size of 5 inches were more dominant in catching silver pomfret in a larger size class interval than gillnets with a mesh size of 4,5 inches. Based on the L50 value, both selective gillnets caught more fish at 50% second chance. The selectivity curve shows that gillnet fishing gear with a mesh size of 5 inches has more selective results than gillnets with a mesh size of 4.5 inches.

1. INTRODUCTION

Fishing activities are sources of income for the community, especially in coastal areas [1]. Most of the people who live on the coast have livelihoods as traditional fishermen[2]. Pangandaran Regency is one of the areas that have high fishery potential in Indonesia, including the marine tourism sector and the capture fisheries sector. Capture fisheries in Pangandaran Regency are able to support regional development or growth [3].

In Pangandaran Regency, various fishing gears are used by fishermen in carrying out fishing operations. One of the fishing gear that is widely used by fishermen is a gillnet. Gillnet is a fishing tool made of net material that has a rectangular shape and is operated permanently in waters. This fishing gear can be used for various types of fish. Silver pomfret (*Pampus argenteus*) is one of the demersal fishery commodities that has important economic value and is mostly caught in gill nets [3].

Capture fisheries activities in an effort to utilize fisheries resources refer to the rules of responsible fisheries resource management, so in practice they must also be carried out responsibly [4]. In terms of utilization, it is necessary to use environmentally friendly fishing gear. The criteria for environmentally friendly fishing gear are high selectivity of fishing gear, do not damage fish habitat, fishing gear is able to obtain good quality catches, fishing gear operation does not endanger fishermen, catch products are safe for consumers, minimum bycatch, small impact on biodiversity, no catching or endangering protected fish and fishing gear is socially acceptable [4].

The level of the ability of fishing gear to prevent the escape of fish after encountering and direct contact with fishing gear is the term for selectivity of fishing gear [5]. One of the methods used in determining the selectivity of fishing gear is by directly comparing various fishing gears one by one in a certain area. The catch obtained is represented as a standard in comparing all types of fishing gear [6].

This research was conducted to determine the level of selectivity of gillnet to white pomfret fishing in Pangandaran Regency. The selectivity category in this study is the size of the catch obtained. This is intended to assess whether a fishing gear can catch target fish at a specific size. Furthermore, the biological aspect can be related where the specific size range of a target fish must exceed the length of the first gonad maturity so that this fishing gear can be said to be selective [7].

In this study, the selectivity of fishing gear will focus on differences in the size of the gillnet meshes that are widely used by fishermen at the Cikidang Fish Landing Base (PPI), Pangandaran Regency. The purpose of this research is to determine the most selective mesh size for silver pomfret.

2. METHODOLOGY

Research on gillnet selectivity was carried out in Pangandaran coastal waters from August 2018 to January 2019. The fishing period is from August to December 2019. The method used in this study was experimental fishing, namely operating gillnet fishing gear directly in the fishing area with fishermen. The primary data collected was the measurement of the catch (fish weight, number, fork length, method of fish caught, girth opercullum, maximum body girth). Meanwhile, secondary data collected are supporting data from the Pangandaran Regency Fisheries and Marine Service, the Central Statistics Agency, and literature studies. In determining the sampling, the method used is the purposive sampling method.

The fishing gear used in this study was a gillnet with different mesh sizes of 4.5 inches and 5 inches with the target of catching silver pomfret (*Pampus argentus*). The ships used are 2-3 GT

in size. Fishing activities are carried out one day fishing with 2 operations. Data collection was carried out for 6 trips from the research range. Analysis of the data used in this study consisted of the proportion of catch, length frequency distribution, Hanging Ratio (HR) of gillnet fishing gear, catch proportion, gillnet selectivity analysis.

2.1 Catch Proportion Analysis

The catch proportion is calculated to describe the structure of the catch and distinguish between the main catch and bycatch. The proportion analysis was carried out for both types of fishing gear mesh size. The proportion of the catch is calculated by the modified formula as follows[8].

a. Proportion of main catch (PHTU)

$$P_{HTU} = \frac{n_{HTU}}{n_{HTU} + n_{HTS}} \times 100\%$$

b. Proportion of bycatch (PHTS)

$$P_{HTS} = 100\% - P_{HTU}$$

Exp.:
PHTU : proportion of main catch
PHTs : proportion of bycatch

2.2 Length Frequency Distribution

Calculation of the length frequency distribution to determine the length distribution of silver pomfret (*Pampus argentus*) caught on gillnets with a mesh size of 4.5 inches and 5 inches. Through this analysis, we can find out the mode of the fork length of the white pomfret that is caught the most using the two mesh sizes used. The results of these will be compared with the size of the first maturity of the fish gonads to determine their selectivity to the biological aspects of the target fish. The distribution of the size of the length of the fish begins with the calculation of the number and class intervals that are used as the basis for grouping the length size class with the following formula [9].

$$K = 1 + 3.32 \log(n)$$

$$C = W/K$$

Dimana:
Exp.:
K : number of classes
n : amount of data

C : class interval
W : area (the maximum data - the minimum data)

2.3 Hanging Ratio (HR)

Hanging ratio is the comparison value between the length of the net after and before it is installed. The hanging ratio value ranges from 0-1. The closer to 1 indicates the condition of the net being kicked perfectly during the fishing process. The hanging ratio calculation can be done by measuring the mesh size of the gillnet with the following formula [10].

$$E = \frac{L}{L_o}$$

Exp : E : *Hanging ratio*
L : Long after the nets installed (m)
L_0: Long before the nets installed (m)

2.4 Selectivity Analysis

Selectivity calculations can use long midpoint intervals such as L25, L50, L75 which means that the probability of catching fish is 25%, 50%, and 75% at the midpoint of the length of the fish obtained. The greater the percentage of the value of L, the fishing gear used can be said to be more selective. Data on the length of silver pomfret caught can be analyzed using the following[5].

$$S(L)m = \exp\left(-\frac{L - Lm^2}{2s^2}\right)$$

With :

$$Lm = SF \times m \longrightarrow Lma = SF \times ma \; ; \; Lmb = SF \times mb$$

$$s^2 = SF \times \frac{mb - ma}{b}$$

$$SF = \frac{-2 \times a}{b \times (ma + mb)}$$

$$\ln\left(\frac{Cb_L}{Ca_L}\right) = a + (b \times L)$$

Exp.:

S(L)m : probability of a fish of length L caught on a gillnet with a mesh size of m

Lm : maximum fork length of fish fork caught by mesh size m

L : fork length of fish caught by mesh size m

s^2 : variant

ma : mesh size a

mb : mesh size b

SF : selection factor

Ca_L : catch at mesh size a

Cb_L : catch at mesh size b

a : intercept

b : slope

In addition to knowing the percentage of L values in determining whether the fishing gear is selective or not, selectivity can be determined by knowing the probability or selectivity (S) values (in this case, the probability of catching white pomfret) at a certain mesh size. Probability is a value used to measure probability or probability can be expressed as a decimal (such as 0.75) or it can be a fraction such as 75/100. The probability value ranges from 0 to 1, where if the S value is closer to 0, the fishing gear used is less selective. Conversely, if the S value is close to 1, the fishing gear can be said to be selective in catching target fish [11].

3. RESULTS AND DISCUSSION

3.1 Catch Proportion

The catch can be categorized into 2 types, namely the main catch (HTU) and by-catch (HTS). HTU are all species that become target fish in fishing operations and have high economic value. Meanwhile, bycatch or better known as bycath are all species that are not the target of the catch. Generally, HTS or bycath has a lower economic value than HTU[12]. The proportion of catch obtained from the operation of gillnet fishing gear is presented in Fig. 1. The operation of gillnets using 4.5 inches obtained a higher proportion of catches (75%) than gillnets with a mesh size of 5 inches (44%).

Bycatch fish can be caught because they have a larger body circumference than the mesh size of the net [13]. In addition, the diversity of species caught can also be caused because the fishing area is a habitat for target and non-target fish [14].

3.2 Length Distribution of Catch

The size distribution of the length of the pomfret caught is in a different range in the 4.5 inch and 5 inch mesh sizes. In the operation of gillnets with a mesh size of 4.5 inches, the pomfret caught were distributed in sizes 16-22 cm with the highest mode being the median value of the 19 cm fork length class. Unlike the gillnet fishing gear with a mesh size of 5 inches, the pomfret caught was distributed in a fork length range of 17-25 cm with the highest mode being the median value of 19 cm fork length and 40 fish. This shows that the difference in mesh size will affect the size of the catch obtained. (Fig. 2).
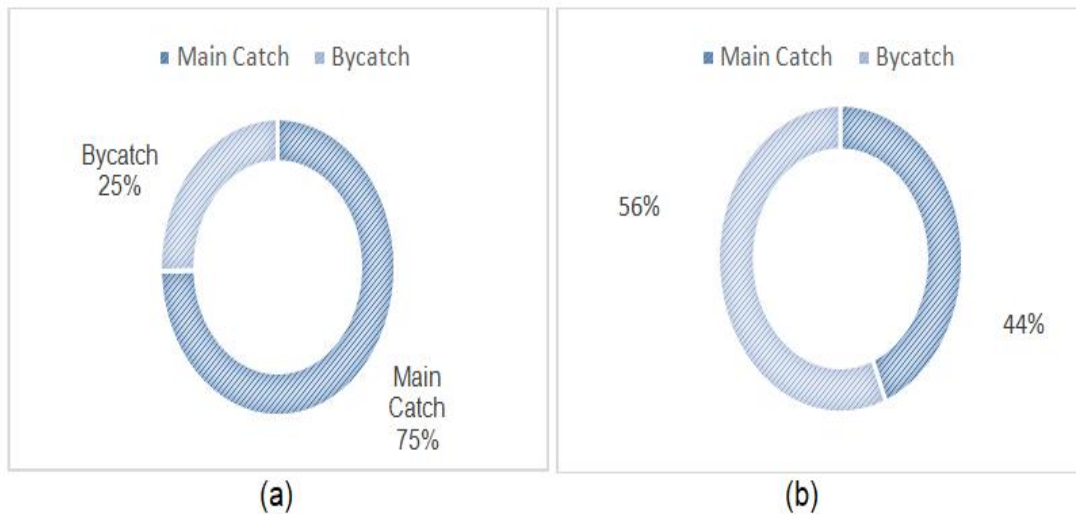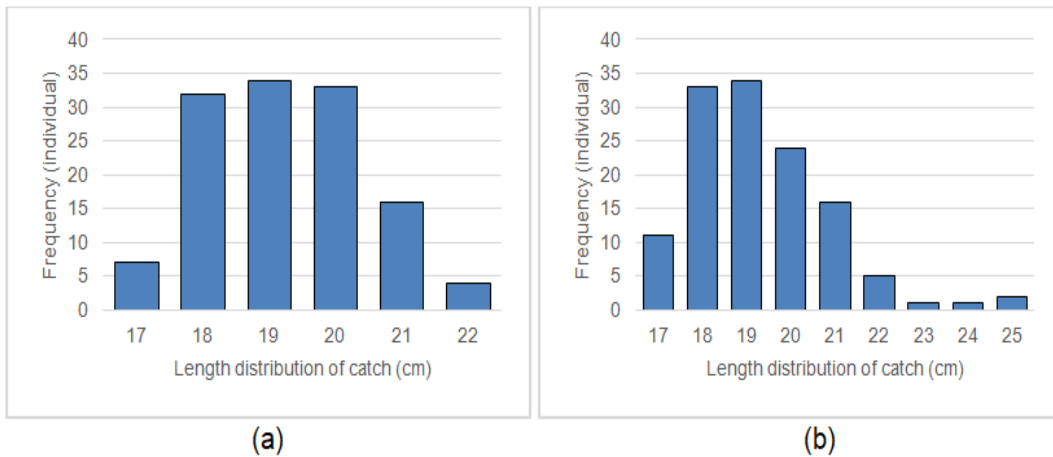

Fig. 1. The proportion of the main catch and bycatch on gillnets with a mesh size of 4.5 (a) and 5 inches (b)

Fig. 2. Length distribution of catch silver pomfret caught on gillnets with a mesh size of 4.5 (a) and 5 inches (b)

The length of the first maturity of the silver pomfret gonads generally has a size of 15.98 cm fork length [15]. Based on these results, gillnet fishing gear with a mesh size of 4.5 and 5 inches is included in the selective fishing gear in catching white pomfret above the mature size of the gonads. The regulation of mesh size is commonly used in the management and regulation of sustainable fisheries commodities [10].

3.3 Hanging Ratio

The results showed that the gillnet used by fishermen with a mesh size of 4,5 inches had a hanging ratio value of 0.51. Meanwhile, the 5-inch mesh size has a hanging ratio value of 0.54. Based on these results, it can be concluded that the mesh size gillnets with sizes of 4,5 and 5 inches are classified as selective fishing gear for catching silver pomfret based on the hanging ratio. hanging ratio for the criteria of selective gillnet fishing gear has a value of 0.5. Determination of selectivity of fishing gear can be measured based on the mesh, hanging ratio, visibility, elongation, net thread, body shape and behavior of the main catch fish. A smaller hanging ratio will have an impact on lower mesh openings with a higher level of slack. Meanwhile, the higher hanging ratio will result in wider mesh openings [16].

3.4 Gillnet Selectivity

Selectivity is closely related to fish body size, both length and circumference of the fish body. In addition, the characteristics of the net in

fishing operations become a benchmark in determining the level of selectivity of the fishing gear. Gillnet is a fishing gear that can be said to be selective because the fish caught with this fishing gear have a size that exceeds the mesh size. Meanwhile, fish that have a body size below the mesh size can escape easily [17]. Therefore, it is necessary to know the fork length data of silver pomfret to identify the selectivity of gillnets.

The results of the calculation of selectivity analysis obtained intercept (a) and slope (b) values for both mesh sizes. The intercept (a) and slope (b) values of each value were obtained -2.618 and 0,119. This value is then used to obtain the selection factor (SF), Lm and S2 (variant) values. The SF score is 4.621. Meanwhile, Lm for mesh size a (4.5 inches) and Lmb for mesh size b (5 inches) are 20.795 and 23.105, respectively. Meanwhile, the S2 score was 19.375. Next, the values of Lm and S are substituted into the gillnet selectivity formula. The results of this calculation are then described by means of a gillnet selectivity curve for silver pomfret catches in 4,5-inch and 5-inch nets.

The selectivity curve is the relationship between the length of silver pomfret to the number of catches shown by a bar chart. Furthermore, the line diagram shows the selectivity of fishing gear based on L25, L50, L75. The LC (Length Cact) value is used to determine the length of fish that have a probability of being caught by 25%, 50% and 75%. Generally, in determining the use of mesh size, it is L50 [18].

Fig. 3 also shows the L50 value, which is a value that shows the length of the fish that has a 50%

chance of being caught and a 50% chance of escaping. The L50 value is usually used as a criterion for determining the use of mesh size [18]. In Fig. 3 (a) it can be seen that the silver pomfret with a 50% chance of being caught is found at a length with a midpoint of 15 cm. This shows that mackerel with a length of 15 cm has a 50% chance of being caught by gillnets with a mesh size of 4.5 inches. Meanwhile, Fig. 3 (b) shows that the mackerel with a 50% chance of being caught is found in the length of the fish with a midpoint of 18 cm. This shows that mackerel with a length of 18 cm has a 50% chance of being caught by gillnets with a mesh size of 5 inches. The chance of being caught is more than 50% (> L50) in both mesh sizes, which has more catches than the chance of being caught < 50%. This shows that the two mesh sizes used by fishermen are selective fishing gear.
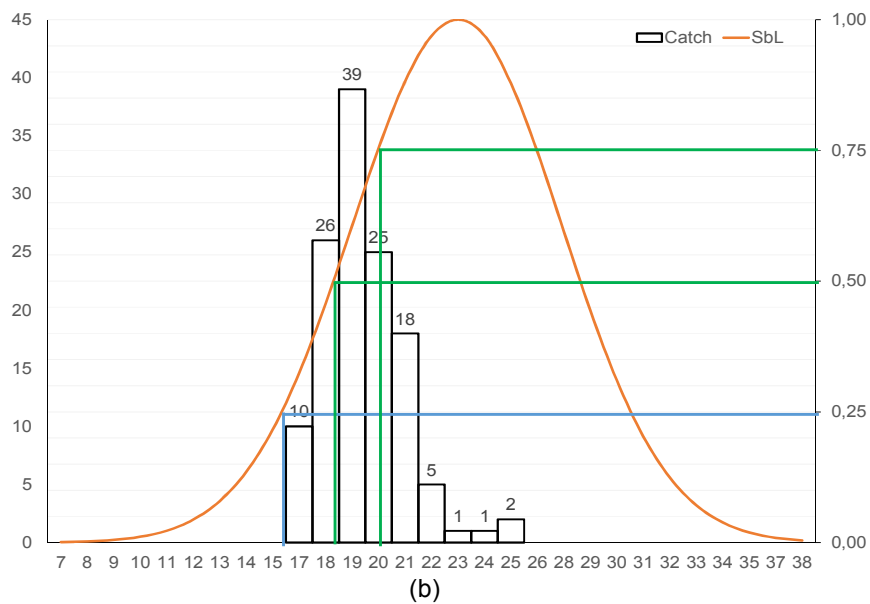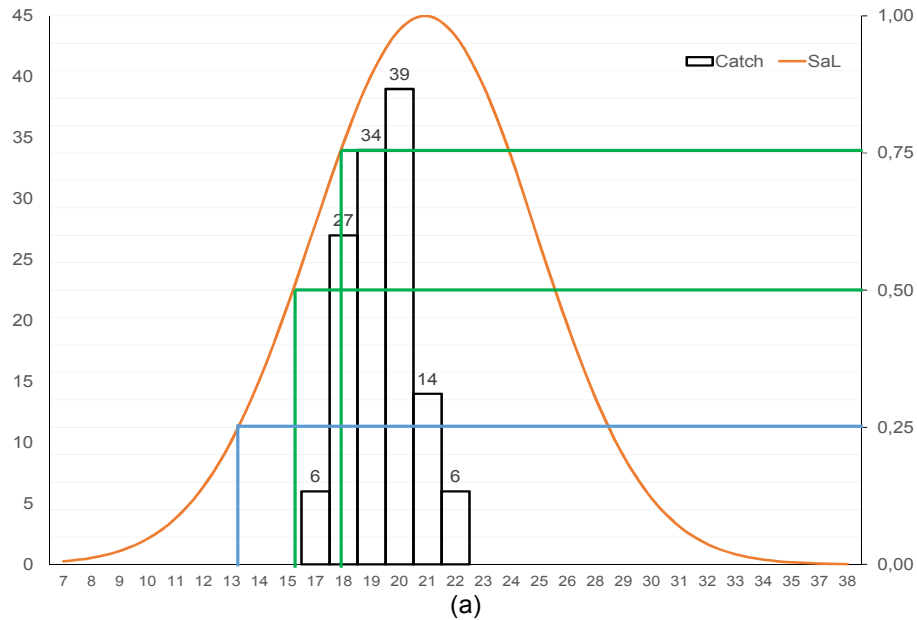
Fig. 3. Selectivity curve for silver pomfret fishing using gillnets at 4.5 inch (a) and 5 inch mesh sizes

The two images show groups of fork lengths for silver pomfret caught and effective fork length for silver pomfret that can be caught by gillnet fishing gear. These two factors are very related in determining the selectivity of gillnet fishing gear. If the value of the group length of the most caught fish (Lc) is greater than the effective fork length of the fish that can be caught (Lm), the gillnet fishing gear can be said to be selective. However, if the value of Lm> Lc then the fishing gear is not selective [19].

Based on Prihatiningsih et al. [15] The silver pomfret fish is 15.9 cm long. The length of the most caught fish (Lc) on a gillnet with a mesh size of 4.5 inches is at a median value of 20 cm, this value (Lc) is greater than Lm so that this fishing gear can be said to be selective. While the L50 value is at the median value of 15 cm and is smaller than the Lm value, based on the gillnet selectivity curve it is said to be less selective. The length of fish caught in the 5-inch mesh size is the median value of 19 cm, this value (Lc) is greater than Lm. The L50 value on a 5 inch mesh size is 18 cm and is greater than the Lm value of white pomfret. Thus, based on the selectivity curve, the 5-inch gillnet is more selective.

4. CONCLUSION

Based on the length distribution, gillnets with a mesh size of 5 inches were more dominant in catching silver pomfret in a larger size class interval than gillnets with a mesh size of 4.5 inches. Based on the L50 value, both selective gillnets caught more fish at 50% second chance. The selectivity curve shows that gillnet fishing gear with a mesh size of 5 inches has more selective results than gillnets with a mesh size of 4.5 inches.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Estevo M, Lopes P, Junior J, Junquera, Santos A, Lima JA, Malhado AC, Ladle R, Silva J. Immediate Social and Economic Impact of Major Oil Spill on Brazilian Coastal Fishing Communities. Marine Pollution Buletin. 2021;164:1-9

2. Zheng S, Wang S, Xu W, Liu Q. Research on the job transfer pathway of chinese marine fishermen and its driving factor. Marine Policy. 2021;129: 1-10

3. Nurhayati A. Analysis of the sustainable potential of capture fisheries in the Pangandaran area. Jurnal Akuatika. 2013;4(2):195-209.

4. Food and Agriculture Organozation. Code of Conduct for Responsible Fisheries. FAO. Rome;1995.

5. Sparre P, dan *Venema* SC. Introduction to Tropical Fish Stock Assement. Part/Manual 1. FAO Fisheries Technical Paper. Roma(IT);1998.

6. Hout A, Paighambari S, Eighani M, Broadhurst M, Bayse S. Utility of Gillnets for Selectivity Targeting Penaids off Iran. 2021;1-6.

7. Krebs CJ. Ecological Methodology, 3rd Edition. New York (USA): Addison Wesley Education Publisher; 2014.

8. Maclennan DN. Fishing Gear Selectivity: an Overiview. *Fisheries Research*. 1992;13:201-204.

9. Walpole. Introduction to Statistics. Jakarta (ID): Gramedia Pustaka Utama; 1995.

10. Machiels M, Klinge M, Lanters R, Densen W. Effect of Snood Length And Hanging Ratio on Efficiency and Selectivity of Bottom-Set Gillnets for Pikeperch, *Stizostedion lucioperca* L., and Bream, *Abramis brama*. Regional studies in marine science. 1994;19(3):231-239.

11. Indah NM. 2014. *Descriptive and Inductive Statistics*. Yogyakarta (ID): Graha Ilmu; 2014.

12. Grimaldi E, Herrmann B, Jacques, Kubowicz S, Cerbule K, Larsen R, Vollstad. The Effect of Long-Term Use on The Catch Efficiency of Biodegradable Gillnets. Fisheries Research. 2020; 161: 1-8

13. Grimaldo E, Herrmann B, Su B, Fore H, Vollstad J, Olsen L, Larsen R, Tatone I. Comparison of Fishing Efficiency Between Biodegredable Gillnets and Conventional Nylon Gillnets. Fisheries Research. 2019;213: 67-74.

14. Humphries AT, Gorospe KD, Carvalho PG, Yulianto I, Kartawijaya T, Campbell SJ. Catch Composition and Selectivity of Fishing Gears on a Multi-Species Indonesian Coral Reef Fishery. Frontier in Marine Science. 2019;6(378): 1-9.

15. Prihatiningsih, Mukhlis N, Hartiati ST. Parameters of Silver Pomfret (*Pampus argenteus*) Population in Tarakan Waters, East Kalimantan. Bawal. 2015;165-174.

16. Samaranayaka A, Engas A, Jorgensen T. Effects of Hanging Rasio Depth on the

Catch Rates of Drifting Tuna Gillnets in Sri Lanka Waters. Fisheries Research. 1997;29:1-12.

17. Ford J, Maxwell D, Muiruri E, Catchpole T. Modifying selectifity to reduce unwanted catches in an english trammel net and gillnet common sole fishery. Fiseries Research. 2020; 227: 1-9.

18. Hommik K, Flitzgerald C, Kelly F, Shephard S. Dome-shaped Selectivity in LB-SPR: Length-Based Assessment of Data-Limited Inland Fish Stocks Sampled with Gillnets. Fisheries Research. 2020;229:1-15.

19. Anggreni AP, Astuti S, Miftahudin I, Novita P, Wiadnya G. Selectivity Test of Millennium Gillnet Fishing Gear on Mackerel Catch (*Rastreliger brachysoma)*. Jounal of Fisheries and Marine Science. 2017; 1(1): 24-30.