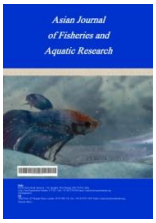

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Gillnet Selectivity on the Narrow-barred Spanish Mackerel (*Scomberomorus commerson*) Fishery in Pangandaran Waters

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Authors' contributions

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

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ABSTRACT

Analyzing the selectivity of gillnet fishing gear using two different mesh sizes, namely 3.5 and 4 inches. Gillnets of these mesh sizes are commonly used by fishermen in Fish Landing Base (PPI) Cikidang, Pangandaran Regency, West Jawa. A total of 8 fishing trips were conducted at the coastal waters around PPI Cikidang, Pangandaran Regency, West Java from August 2018 to January 2019 using gillnet fishing gear As for each trip, 2-3 times the operation of the tool is carried out. The operation of the fishing gear is carried out with the help of vessels measuring 2-3 Gross Tonnage (GT). The catch obtained was differentiated based on the main catch and bycatch and the amount is calculated for analysis of the proportion of the catch. Mackerel (Scomberomorus commerson) is caught as the main catch, the fork length was measured for analysis of the length frequency distribution and selectivity curves. The operation of gillnets with a mesh size of 3.5 inches obtained a higher proportion of bycatch compared to gillnets with a mesh size of 4 inches.

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In addition, the length distribution of mackerel caught by gillnets with a mesh size of 3,5 inches is smaller (27-49 cm FL) compared to a mesh size of 4 inches (40-55 cm FL). Based on the distribution of length distribution, gillnets with a mesh size of 3.5 inches are more dominant in catching mackerel in a smaller size class interval than gillnets with a mesh size of 4 inches. Meanwhile, based on the selectivity curve for the length of mackerel with a 50% chance of being caught, it shows that gillnets with a mesh size of 3.5 or 4 inches are selective in catching mackerel, this is because the chances of catching fish at more than L50 are high.

Keywords: Gillnet; mackerel; mesh size; selectivity.

1. INTRODUCTION

Fishing is a process of obtaining fish resources from aquatic ecosystems, both freshwater and marine., Various ways are used to obtain them either actively or passively with the help of fishing gears [1]. Fishing gear is used in a fishing activity aimed at optimizing the fishing effort with the minimum possible effort and obtaining the maximum possible catch [2].

Various types of fishing gears are used in fishing activities. The selection of fishing gear will be adjusted to the intended catch target [3]. In tropical countries such as Indonesia, the use of a fishing gear often is for the capture of multispecies and or multigears are used to target a single species. These two terms are common phenomena in tropical waters that have a variety of catches in their fisheries resources [4].

Responding to these two phenomena, FAO includes the criteria for selective fishing gear as one of nine important criteria that must be owned by an environmentally friendly fishing gear [5]. Selectivity of fishing gear is a term intended to describe the ability of a fishing gear to obtain catches with certain intended characteristics. These characteristics can divide the definition of selectivity into several categories such as species selectivity, size and sex of the catch obtained [6].

Furthermore, FAO implies the mandate given to the world of capture fisheries to be able to develop increasingly selective fishing technologies to achieve sustainable capture fisheries [5]. In responding to this, various researchers have begun to develop innovations in the form of improving design, construction, methods and tools in the development of fishing gears. Various forms of research that analyze the level of selectivity of a fishing gear have also been developed to assess the level of environmental friendliness of fishing gear commonly used by fishermen [7].

Gillnet is one type of fishing gear that is commonly used by fishermen in Indonesia. Gillnets are used in the small-scale to industrial-scale capture production levels. Gillnet is also one of the most widely used fishing gear by fishermen in Pangandaran Regency, West Java [8].

Fishermen in Pangandaran Regency, West Java generally carry out fishing operations with gillnets at night or early morning. This fishing gear is used to catch various types of fish, one of which is mackerel (*Scomberomorus commerson*) [9]. Mackerel is one of the target commodities from the operation of gill nets by fishermen in Pangandaran Regency. Mackerel is one of the top ten fish catch commodities that have high economic value and are in great demand by market share both on a local and export scale [10]. However, the level of selectivity of deepgill net fishing gear to the size of mackerel catches in Pangandaran Regency is not known with certainty.

This study was conducted to determine the level of selectivity of gillnet fishing gear on mackerel fishing in Pangandaran Regency, West Java. The selectivity category used is the size of the catch. The selectivity level of catches based on size is intended to assess whether a fishing gear obtains certain types of fish catches in a specific size range. Furthermore, biological aspects can be included where the specific size range of the target fish catch must be below the length of the first gonad maturity $L_{50.}$ This is intended to assess the level of environmental friendliness of a fishing gear that is selective in capturing catch targets at a certain size above the size of the first gonad maturity.

2. MATERIAL AND METHODS

This research was conducted in the coastal waters around the Cikidang Fish Landing Base (PPI), Pangandaran Regency, West Java. The study was conducted from August 2018 to

January 2019. The experimental fishing method was carried out by operating the gillnet directly in the fishing area. gillnets of mesh sizes 3.5 and 4 inches were used. The selection of these two types of mesh sizes is based on the number of fishermen in PPI Cikidang who use these two types of mesh sizes.

The gillnet operation was carried out 8 times during the research period. As for each trip, the operation of fishing gear was carried out 2-3 times. Ships with a size of 2-3 GT were used in the fishing operation. The catch is then identified to determine the type. Each catch identified is differentiated into main catch and bycatch and the amount is calculated. For the main catch of mackerel, the fork length using what? was measured for selectivity analysis.

2.1 Catch Proportion Analysis

The catch proportion was calculated to describe the structure of the catch and distinguish between the main catch and bycatch. The proportion analysis was carried out for both of mesh sizes. The proportion of the catch is calculated by the modified formula as follows [11].

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

The length frequency distribution was calculated to see the length distribution of mackerel (*Scomberomorus commerson*) caught by gillnets with mesh sizes of 3.5 and 4 inches. Through this analysis, it can be seen the mode of fork length of the dominant mackerel caught using the two mesh sizes used. The mode of the length class interval of the dominant fish caught can be compared with the size of the first gonad maturity of the fish to determine its selectivity to the biological aspects of the target fish. The length size distribution begins with the calculation of the number and class intervals that are used as the basis for grouping length classes. Calculation of the number and interval of class length is calculated by the following formula [12]:

$$K = 1 + 3.32 \log(n)$$
$$C = W/K$$

Exp.:
K : number of classes
n : amount of data
C : class interval
W : area (the maximum data - the minimum data)

2.3 Selectivity Analysis

The gillnet selectivity analysis was calculated using the Holt model (1957) [13]. This model estimates the optimum length of fish caught and its standard deviation using two gillnets with different mesh sizes. Both nets are installed to catch fish in an area at the same time, while what is observed is the number caught by length group. The data used in the holt model is fish fork length data. The formula used to analyze the selectivity of gill nets with the Holt model is:

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

With :

$$Lm = SF \times m \longrightarrow Lma = SF \times ma ;$$
$$Lmb = SF \times mb$$
$$s^2 = SF \times \frac{mb - ma}{b}$$
$$SF = \frac{-2 \times a}{b \times (ma + mb)}$$
$$\ln\left(\frac{Cb_L}{Ca_L}\right) = a + (b \times L)$$

Where

S(L)m is the 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

3. RESULTS AND DISCUSSION

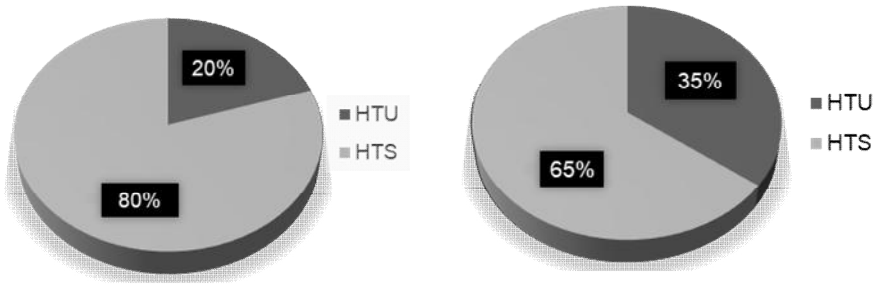
3.1 Proportion of Catch

The proportion of catch obtained from gillnet operations is presented in Fig. 1. The operation of gillnets using a mesh size of 3.5 inches obtains a larger proportion of catch (80%) compared to a mesh size of 4 inches (65%). These results indicate that increasing the mesh size can increase the selectivity of the catch by species. This is because fish in certain species that have an average length below the mesh size are be allowed to escape [14]. In tropical waters, the proportion of by-catch often exceeds the proportion of the main catch. This is related to multispecies and multigear events in fishing activities in tropical waters. Tropical waters have a variety of types of fish resources contained in them. This makes one fishing gear able to catch multispecies and one species can be caught by various fishing gear (multigear) [15]. However, in this study the findings are different since this was a single gear fishery.

3.2 Length Frequency Distribution of Mackerel Caught

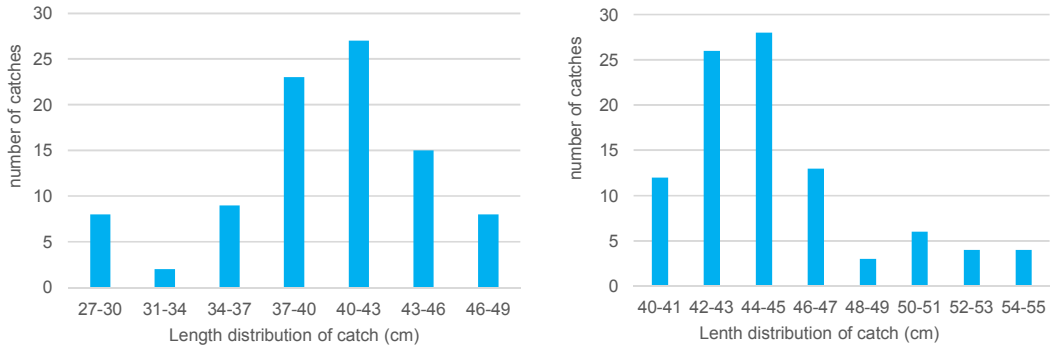
The size distribution of fish lengths is in a range of different sizes in the operation of the 3.5 to 4 inch mesh sizes. In for the gillnets with a mesh size of 3.5 inches, the size of mackerel caught was distributed in sizes 27-49 cm with the highest mode being in the length class of 40-43 cm fork length. The size of mackerels caught by gillnet with a mesh size of 4 inches ranged from 40-55 cm with the highest mode being in the length class 44-45 cm fork length (Fig. 2).

These results indicate that the increase in mesh size can affect the size of the fish caught. In larger net sizes, smaller fish can escape through the meshes. This makes the option of increasing the mesh size widely used in the management of fisheries resources in various regions [16].



(a) (b)

Fig. 1. Proportion of the number of main catch (HTU) and bycatch (HTS) on gillnets with a mesh size of 3.5 (a) and 4 inches (b).



(a) (b)

Fig. 2. The length frequency distribution of mackerel caught by gillnets with a mesh size of 3.5 (a) and 4 inches (b).

The length of the first gonad maturity of mackerel is generally at 42,34 cm fork length [17]. Based on this, it is known that the use of nets with a mesh size of 4 inches is more selective in catching mackerel above the mature size of the gonads. The use of selective mesh size nets in catching fish above the length of the first gonad maturity is very important to maintain the sustainability of fish resources and avoid growth overfishing [18].

3.3 Selectivity

The results of the calculations in this study obtained the intercept (a) and slope (b) values for the two mesh sizes were -19.3 and 0.5. Based on the values of a and b, the selection factor (SF) value of 11.1 can then be calculated. The SF value indicates that the gillnet studied has a low level of selectivity in its operation so that there is still a possibility for small fish to be caught [19]. This is in accordance with the range of fork lengths of mackerel that were caught in this study, namely that there were still small mackerel fish caught. What is meant by small-sized mackerel is mackerel whose length is below the optimum length of fish that can be caught in the mesh (Lm).

The calculation of the optimum length of fish that can be caught (Lm) shows that the optimum length of fish that can be caught on a gillnet with a mesh size of 3,5 inches (Lma) is 38.9 cm and for a mesh size of 4 inches (Lmb) is 44.5 cm. The results of the gill net selectivity analysis using the Holt model are shown in Fig. 3 for 3.5 and 4 inch mesh sizes.

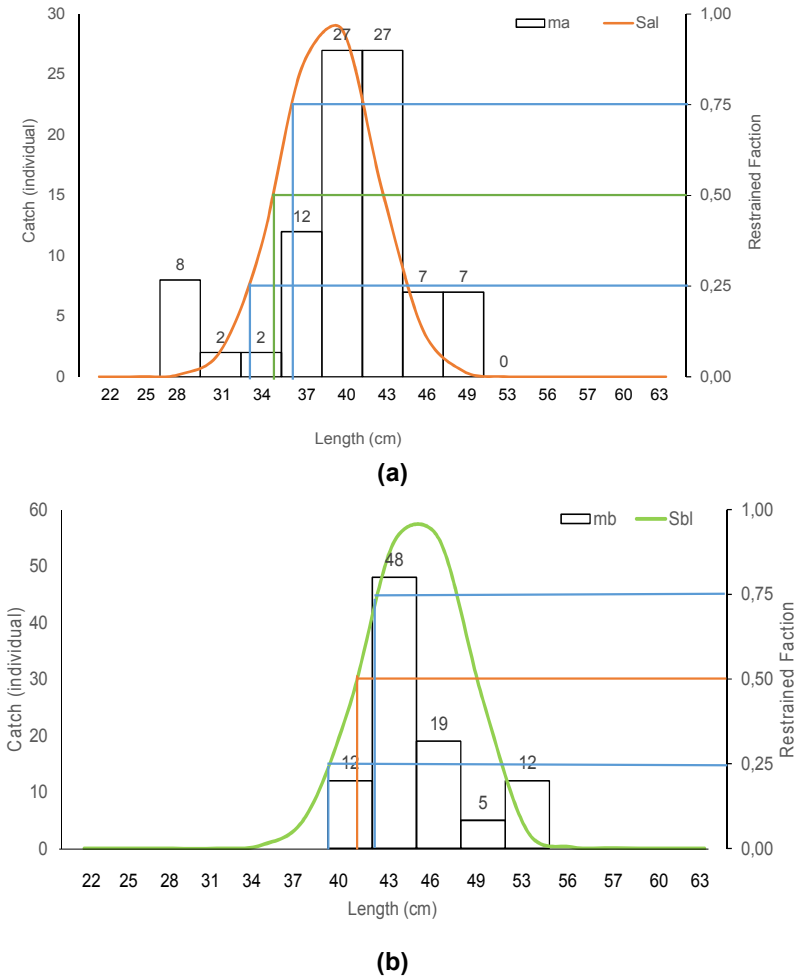


Fig. 3. Selectivity curve for mackerel fishing using gillnets at mesh sizes 3.5 (a) and 4 inches (b)

The two figures show groups of fork lengths for mackerel caught and effective fork length of mackerel that can be caught by gillnets (Lm). The two factors have a relationship to show the level of selectivity of the gillnet. If the value of the group length of the most caught fish (LC) is greater than the effective length of fish caught (Lm), then the gill nets are said to be selective and vice versa [20].

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 [20]. In Fig. 3 (a) it can be seen that the mackerel with a 50% chance of being caught is found at a length with a midpoint of 34 cm, which means that the length of the fish is in the 33-35 cm long group. This shows that mackerel with a length of 33-35 cm has a 50% chance of being caught by gillnets with a mesh size of 3.5 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 40 cm, which means that the length of the fish is in the 39-41 cm long group. This shows that mackerel with a length of 39-41 cm has a 50% chance of being caught by gillnets with a mesh size of 4 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.

The length of fish caught on gillnets with a mesh size of 3.5 inches is in the length class 40-43 cm with an Lma of 38,9 cm. This shows that the length of the fish caught is larger than the effective length of the fish caught by a 3.5 inch mesh size, so gillnets with a 3,5 inch mesh size are selective when viewed from the number of fish caught the most. Meanwhile, the length of fish caught using gillnets with a mesh size of 4 inches was in the 42-44 cm length class and 44.5 cm Lmb. This shows that the length of the fish caught is smaller than the effective length of fish caught by a 4 inch mesh size, so gillnets with a 4 inch mesh size tend to be less selective when viewed from the number of fish caught the most.

4. CONCLUSION

Based on the length distribution of mackerel caught by gill nets with a mesh size of 3,5 inches is smaller (27-49 cm FL) compared to a mesh size of 4 inches (40-55 cm FL). The distribution of length, gillnets with a mesh size of 3,5 inches are more dominant in catching mackerel in a smaller size class interval than gillnets with a mesh size of 4 inches. Meanwhile, based on the selectivity curve for the length of mackerel with a 50% chance of being caught, it shows that gillnets with a mesh size of 3,5 or 4 inches are selective in catching mackerel, this is because the chances of catching fish at more than L50 have a higher number of catches.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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