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Analysis of sustainable biological aspects of Scottish seine net in the waters of Majene, Indonesia

Najamuddin[1], Mahfud Palo[1], Andi Assir[1] and Hardianti[2]

[1]Faculty of Marine Science and Fisheries, Hasanuddin University, Indonesia
[2]Alumni of Fishery Science Study Program, Graduate School of Hasanuddin University

Email: najamuddin@unhas.ac.id; najaunhas@gmail.com

Abstract. Ministry of Marine Affair and Fisheries decree No.2 of 2015 states that the Scottish seine net is one of the fishing gears that is prohibited because the size of the fish catches were not suitable for catching. The purpose of this study was to evaluate the Scottish seine net fishing gear on the technical and biological aspects. The method used in this research is the survey method on the Scottish seine net and direct measurement of fork length and body circumference at dorsal fin base. The analysis used in this study is a description equipped with a graph, gonad maturity levels were analysis morphologically, determination of the first gonad maturity size using the Udupa method. The shortfin scads fish is the dominant fish caught in the Majene waters. The results showed that most of the scads caught by the Scottish seine net were fit for catching. The size of the fish that is suitable for catching depends on the position of the fishing area. The further away the fishing area is from the coastline, the larger portion of fish suitable for catching. The first gonads mature of shortfin scads fish in Majene waters in the fork length range of 205 – 208 mm for males and 211 – 216 mm for females. In order to catch shortfin scads fish that is suitable for catching, the minimum mesh size is 59.5 m for gill nets, and 39.7 mm for fishing gear that does not entangle.

1. Introduction

The attention of the Government of Indonesia towards sustainable culture fisheries management continues to be increased. One of the most interesting is the issuance of Minister of Marine Affairs and Fisheries Regulation (PERMEN-KP) No. 2 of 2015 concerning the prohibition on the use of Hela Trawls and Seine nets in the Fisheries Management Area of the Republic of Indonesia, one of the fishing gear banned according to Permen KP No.2 of 2015 article 2 and article 4 paragraph (2) letter (d) Scottish seine net. Based on the results of research on the feasibility of fishing with Scottish seine net fishing gear PERMEN KP No. 2 of 20 concerning the prohibition on the use of Scottish seine net fishing gear is resulting in a decrease in fish resources and threatens the environmental sustainability of fish resources.

Fishery Potential Majene Regency has abundant marine and fishery resources because it is supported by natural conditions, namely in a coastal area with a length and area of water reaching 1,000 km2 as many as 461 units with 10,447 fishing gear units [1]. One of the fishing gears that is widely used is the Scottish seine net fishing gear. According to Sudirman (2013), Scottish seine net is a bag trawl that is used to catch hordes of surface fish (pelagic fish) where the two wings function to frighten or surprise and lead fish into the bag.

The prohibition of using Scottish seine net fishing gear in the PERMEN KP No.2 of 2015 is because the fishing gear produces fish that are not suitable for catching Sriayu et al (2016). While the results of Ulpa's (2006) research on Scottish seine net fishing gear, one of the dominant fish caught, shortfin scads fish, shows that the shortfin scads fish (*Decapterrus macrosoma*) caught in the Scottish seine net fishing gear in Majene waters is 200 mm [2], according to Dahlan (2015) that the shortfin scads fish the size for the first time to spawn was 195 mm, so that it is based on the case for fish fit to be caught in Majene waters on Scottish seine net fishing gear, which is to produce catchable fish [3]. Then based on observations in the field that the problems between Scottish seine net fishing gear in other water areas have differences according to their characteristics, several previous studies, one of which is Simbolon (2011) at the port of Ratu, stated that Scottish seine net fishing gear has a relatively small mesh size compared to with a catching target (fit to be caught) so that it does not produce suitable fish; catch [4]. Then Sutono (2016) in the coastal waters of Tegal, the operation of catching Scottish seine net is carried out near the coast within 1 - 2 miles so that the fish caught are predominantly small fish, this can cause fish resources to decrease due to overfishing and not fit to catch the catch.

Seeing the state of the difference in the size of the fish catch in the Scottish seine net fishing gear in the territory of Indonesia, a research will be carried out on the use of Scottish seine net fishing gear, especially in the waters of Majene Regency by looking at several aspects, namely technical aspects and biological aspects, so that it can be known the sustainability of Scottish seine net fishing gear in particular. in the area of Majene Regency, West Sulawesi. The purpose of this study is to evaluate the Scottish seine net fishing gear in the review of the PERMEN KP No.2 of 2015 and to analyze the technical and biological aspects of the Scottish seine net fishing gear in Majene waters, West Sulawesi.

Methods

This research was carried out in the waters of Majene Regency, West Sulawesi, precisely in Pangaliali Village, Majene Harbor, the research was carried out in May - November 2019. The method used in this study was the census method of all populations of Scottish seine net fishing gear, and measurement of fish catches. Data collection was carried out by following the operation; fishing for 30 trips of catching FADs far, medium and near. The measurement of the catch was carried out by using a stratified random sampling method of 1,170 shortfin scads fish, fish observation was carried out by measuring the length and weight of the fish and looking at the sex and GML of the fish, the measurement of the total length of the fish using a ruler with the smallest scale of 1 mm. The required data is obtained after the ship has landed its catch at TPI Pangaliali waters, Majene Regency.

The samples of the fishermen's catch of *D. mcrosoma* were taken randomly. Measurement of the fork length (FL) of the sample using a measuring ruler with a accuracy of 30 cm, body weight and gonad weight were weighed using a digital scale with an accuracy of 0.01 g. The sex and gonad maturity level (GML) of the gonads were determined, first the sample was dissected using surgical tools (surgical scissors, scalpels and tweezers). GML observations were carried out macroscopically morphologically using the Gonad Maturity Level Scale from Mansoor in Wudianto (2002).

2.1. Analysis of gonad maturity level

The basis used to determine the maturity level of the gonads is, among others, the observation of macroscopic morphological features, namely shape, length, weight, color and development of gonad contents. The criteria for the level of maturity of the gonads used the Cassie method modified by Effendie (1997) [5]. The estimation of the size of the first maturity of the gonads was analyzed using the Sperman-Karber method [6] as follows:

$$\log m = X_k + \frac{X_i}{2} - (X \sum p_i)$$

Where: Xk = logarithm of the last mean value when the fish is 100% cooked; X = the average difference of the class mean logarithms; Xi = logarithm of the mean class value; pi = ri / ni; ri = number of cooked gonad fish in class i; ni = number of fish in class i; qi = 1 – pi

$$Variance = X^2 \sum \left[\frac{pi*qi}{ni-1}\right] \qquad \text{Confidence interval 95\%: } m \pm Z_{\alpha/2}\sqrt{variance}$$

In principle, this method is in line with the sigmoid curve method, only in this method the size range is calculated mathematically, so that it is more convincing in determining the reference size. The criteria for gonad maturity are GML 3, 4 and 5 [7].

2.2. Analysis of minimum net mesh size

The relationship between body circumference and fork length is used simple linear regression (Steel and Torrie, 1991) with the following equation:

$$Y_i = \alpha + \beta X_i + \varepsilon_i$$

Where : Yi = fish length (mm), Xi = circumference behind operculum (mm), α = intercept population, β = slope of the regression line, εi = random effect, i = 1, 2,…. n, observational data

3. Results and discussions

3.1. Gonad maturity level (GML)

Gonad maturity level (GML) is a certain stage of gonad development before and after spawning fish [8]. To determine the level of gonad maturity in female fish, what is observed is the shape, size, color, smoothness, and filling of the ovaries in the body cavity as well as the size, clarity of shape, and color of the eggs in the ovaries. On the other hand, the male fish observed were the shape, size, color and filling of the testes in the body cavity. Based on the observations there were two FADs that got ripe fish gonads, namely medium FADs and distant FADs against shortfin scads fish and the gonad maturity levels obtained were divided into five stages, namely GML I immature (not yet developed), GML II maturing (early development), GML III is mature (mature gonads), GML IV is fully mature (late development), and GML V resting (spawn).

The GML measurement results of shortfin scads fish based on morphology obtained GML of male and female shortfin scads fish as shown in Figure. The results showed that the shortfin scads fish 14-15 cm were classified as GML I (Immature) with the characteristics of Ovary clear reddish color (translucent). And from the length of the body cavity, whitish color. Shortfin scads fish 15 - 17 cm are classified as GML II Maturing (development) Orange yellow ovary (translucent) Egg granules are not visible to the naked eye. Shortfin scads fish 19-20 cm are classified as GML III Ripening (Maturation) Ovaries with blood vessels on the surface. There are no translucent eggs and cream-white testicular cavities. Shortfin scads fish measuring 20-22 cm are classified as GML IV Ripe. Ovaries are orange-pink with blood vessels on the surface. Seen large eggs, transparent / translucent, ripe eggs. And the testicles are creamy-white, soft. white-cream testicles. Shortfin scads fish measuring 22-24 cm are classified as GML V with resting (spawning) thick walls. In the ovary there may remain opaque and ripe eggs that have disintegrated due to spreading, dark or translucent, and the testes are flaccid.

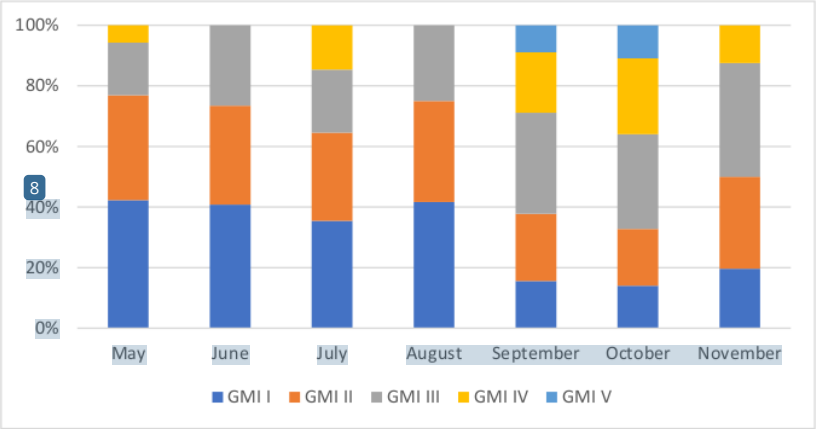

Figure 1. The frequency of gonad maturity level of shortfin scads fish (male) based on the moderate FAD observation time.

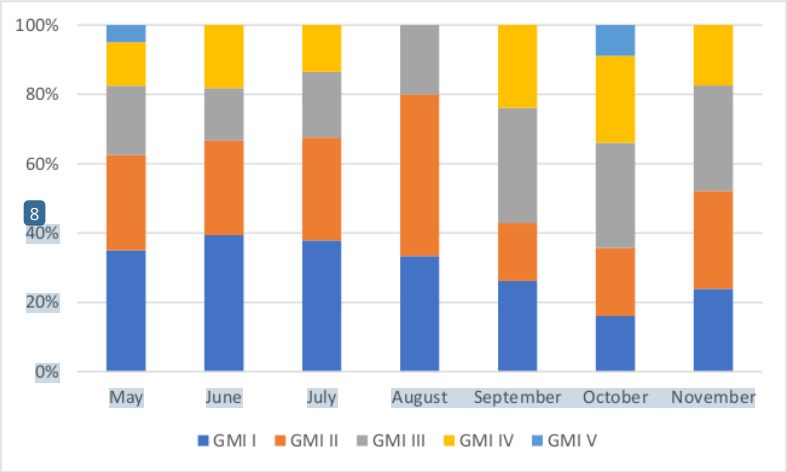

Figure 2. The frequency of gonad maturity level of shortfin scads fish (female) based on the moderate FAD observation time.

The moderate frequency distribution of FADs based on the length of male shortfin scads fish shows that the mature size groups GML III GML IV and V dominate or are mostly caught in September (20%) October (30%) and November (16%) and May June, July and August. There is a frequency of May (10%) June (9%) July (14%) August (9%). Whereas for female shortfin scads fish gonads at GML III, IV and V dominate in September (25%) October (29%) and in November (17%) then the frequency obtained in May (11%) June (8 %) July (10%) and August (4.50%). Then the frequency of gonad maturity levels obtained in distant FADs can be seen in the figure below.

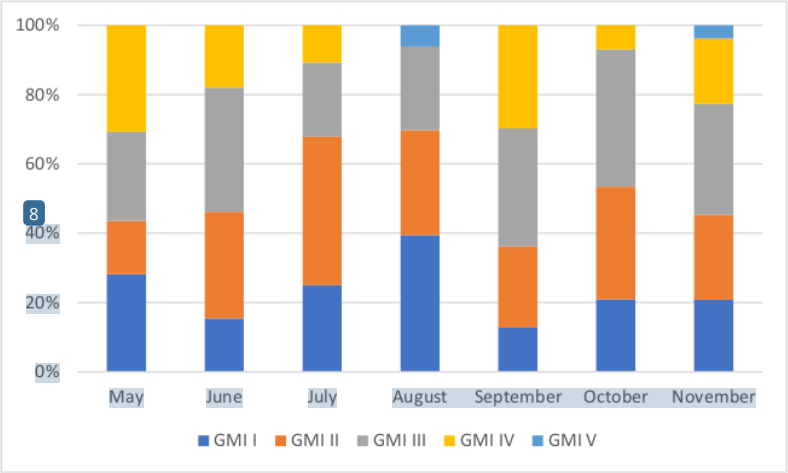

Figure 3. The frequency of gonad maturity level of shortfin scads fish (male) based on the observation time of far FADs.

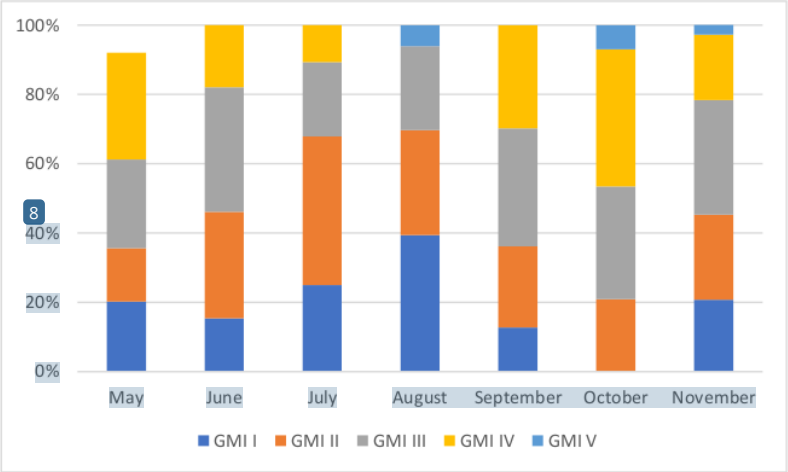

Figure 4. The frequency of gonad maturity level for shortfin scads fish (female) based on the observation time of far FADs.

The frequency distribution based on long FAD lengths of female shortfin scads fish shows that the mature size groups GML III GML IV and V dominate or are mostly caught in September (20%) October (31%) and November (19%) and May, June, July and August there is a frequency of May (14%) June (17%) July (15%) August (8%). Whereas for male shortfin scads fish, the size of the fish that ripe gonads at GML III, IV and V dominate in September (26%) October (33%) and in November (21%) then the frequency obtained in May (12%) June. (10%) July (12%) and August (9%) Appendix 3. The maturity level of the shortfin scads fish gonads identified during the study showed that all samples were included in the GML I, II, III and IV categories. V.

The Gonad Maturity Level (GML) of shortfin scads fish (*Decapterrus Macrosoma*) varied at each observation time. Male and female shortfin scads fish GML III and IV were found at any time, namely

in May - November, the relative frequency of shortfin scads fish on medium FADs was at GML III, IV and V from May, July, September, October, and November, while the shortfin scads fish for distant FADs The relative frequency of GML III, IV and V from May, June, July, September, October, November The highest relative frequency of females and males was in May, September, October and November. same. The number of shortfin scads fish fecundities obtained during the study varied between one female kite and another. According to research by Arifin et al. (2015) in Barru waters, the highest percentage of deles shortfin scads fish that have matured gonads was found in July and September, for both male and female fish, while in October the fish caught were dominated by immature gonad fish [9].

The average length of the caught and first maturity of the gonads can be a reference in determining efforts to prevent the continuous and irresponsible use of fish resources. Uncontrolled use can lead to a reduction in the population of fish resources in the future, because it is possible that the fish caught are fish that have not been spawned and will be spawning. The form of prevention can be in the form of selecting selective fishing gear with mesh sizes adjusted to the target size of Heri's catch (2017).

The composition of the Gonad Maturity Level (GML) of shortfin scads fish (Decapterus macrosoma) is a scale I to V. Scales I - III are found in each sampling month. This shows that the shortfin scads fish spawning occurs every month so that it can be said that shortfin scads fish have a year-round spawning season. Meanwhile, GML IV received gonad deaths every month and GML V was obtained in May, September, October and November although the numbers were relatively small but this proved that the fish found in Scottish seine net fishing gear in Majene waters got tagged when the fish were ripe gonads. and spawn.

Suwarso and Sadhotomo (1995), estimates that the large fish caught in relatively small numbers as they leave the fishing area to the spawning ground so that they are not caught in Scottish seine net fishing gear [10]. This group is likely to be in late maturing and / or egg maturity. Tamsil (2000) states that generally fish gonads will continue to grow and will reach a maximum value at GML IV, then decrease when entering GML V, because the fish have spawned [11].

Fish caught by Scottish seine net fishing gear in Majene waters are dominated by individuals in the maturing and ripening stages, meaning that they have reached length - at first maturity and length - at - first spawning. This shows that shortfin scads fish that have GML III occupy the highest percentage and are almost always found at every time of observation and this shows that gonad ripe shortfin scads fish are often found every month. This assumption needs to be clarified with the results of continuous observations of gonad maturity. Based on observations of gonad maturity, in Majene waters based on the results obtained, the spawning season is September and the peak of shortfin scad fish spawning is October. Previous research found that the spawning season for shortfin scads fish in the waters of the South China Sea lasts from the end of the eastern season (August) and continues until the transitional season 2 (September to November). According to Atmaja et al. (2003), shortfin scad usually spawn between May – December, while shortfin scads between May – November and peak spawning shortfin scads is estimated to occur between September – December [12].

Raje (1997) states that the spawning season for shortfin scads fish in India is November-May [13]. It is different from Balasubramanian and Natrajan (2000) and Manojkumar (2005) who state that the shortfin scads fish spawning season in Malabar is November-December and March-December, respectively [14]. However, in anisa's research (2019) it is suspected that the spawning season for shortfin scads fish in the Sunda Strait is in May-July with the peak of spawning in July. The different spawning season shows that shortfin scads fish are continuously breeding. Even though the ovaries are in a mature state, shortfin scads fish only lay eggs at a certain time. At that time, there was a variation from one place to another, depending on the environmental conditions in the area. Therefore, this is thought to be the cause of the differences in spawning seasons from studies conducted by various researchers [15].

The average condition factors for the shortfin scads fish *D. macrosoma* fluctuated every month. According to Oshimo et al. (2014), *D. macrosoma* in the East China Sea spawned from May to August, meanwhile *D. macrosoma* in the South Indian Sea spawned from February to June then October to

December [16]. According to Weatherly and Gill 1987, apart from being able to describe the conditions of reproductive activity, the value of the condition factor also describes the condition of abundance of food in Nature [17]. Furthermore (Hukom et al. 2006) also stated that the increase in the value of fish conditions is closely related to the level of gonad maturity [18].

3.2. Size at first gonads maturity

The size of the initial maturity of the gonads is one of the important parameters in determining the smallest size of fish to be caught or that can be caught. Estimating the size of the first maturity of gonads is one way to determine population development in a waters. The decline in fish population in the future can occur because the fish caught are fish that will spawn or fish that have not spawned, so that precautionary measures require the use of selective fishing gear such as the size of the mesh used must be adjusted to the type of target fish, so that the utilization of shortfin scads fish resources. can be sustainable and guaranteed its sustainability.

A total of 1,170 shortfin scads fish in Majene waters were measured and observed, consisting of 669 males and 504 females. Female shortfin scads fish have a length range of 14-24 cm, while males have a length range of 14-23 cm. Based on the difference in the length range between male and female fish, it can be seen in the table. There were 331 males that were ripe for gonads and 238 females that were ripe for gonads.

The results of calculations with a 95% confidence interval on moderate FADs showed that male shortfin scads fish first matured gonads at a size of 205 cm with a length range of 20.54 - 20.80 mm. Gonadal ripe female kite with a fork length of 216 cm with a confidence interval of 21.61 mm - 22.09 mm.

The size distribution of male and female *D. macrosoma* fish has the smallest size of 140 mm to the largest of 250 mm, the size of fish that is fit to catch is in the male and female fish class intervals of 190 - 200 mm and the female class intervals of 210 - 220 mm. Based on the observation data of male shortfin scads fish with a fork length <20.05 mm, 362 of the total 659 male fish were observed, while 287 female kites with a fork length <21.01 mm were observed from a total of 504 female fish. immature gonads. This shows that the percentage of fish that reached the first maturity of gonads was dominated by fish that had not yet matured gonads but the numbers did not really have a big difference between those that had metang gonads and those that had not. Percentage of fish size fit for capture and not fit for capture can be seen in the image below

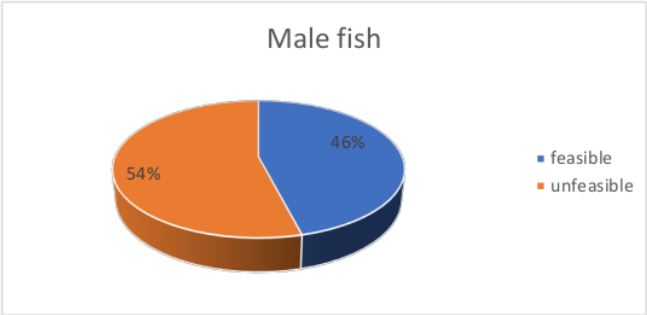

Figure 5. Percentage of feasible and unfeasible sizes for catching shortfin scads (Male) in Majene Waters

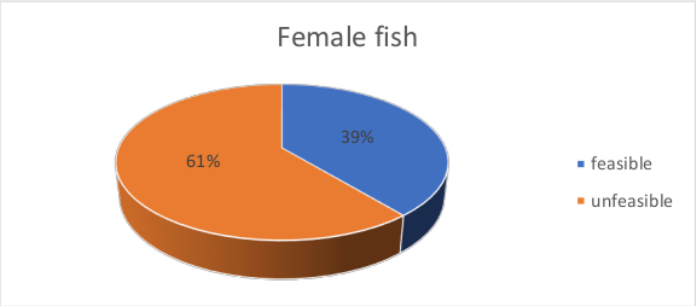

Figure 6. Percentage of feasible and unfeasible sizes for catching shortfin scads (females) in Majene Waters

Based on the picture, the catch size of the shortfin scads in Majene Waters through the morphological approach to the male shortfin scads fish is 46% feasible and 54% unfit to catch, while the female fish getting a catch size 39% is not suitable to catch 61%. Mallawa, et al. (2013) the percentage of catchable and unfit size is due to the level of fishing gear selectivity and the conditions of the fishing area [19]. FADs, the distance between the fishing base and the fishing ground is only around 1 - 2 miles so that this causes the size of the fish obtained, namely the small fish that are not cooked gonads. Meanwhile, medium and distant FADs were found to be suitable for catching sizes.

The results of observations on the number of shortfin scads fish that mature gonads in Majene waters obtained various body lengths which indicate that male and female shortfin scads reach maturity of fish gonads for the first time, namely 205 - 208 mm male shortfin scads fish, while the first size of female shortfin scads gonads ripe. namely 216 - 220 mm. The same thing with the research of Dahlan et al., (2015) on male *D. macrosoma* fish in Bone Bay waters, males are 195 mm in size and females are 210 mm in size [3]. Najamuddin et al. (2004) reported male deles shortfin scads fish (*D. macrosoma*) first matured gonads in the fork length range between 19[4]201 mm and 198-203 mm for female fish [7], according to Balasubram[18]an and Natarajan (2000) the size of the first maturity of the Layang fish gonads (D. macrosoma) male and female at a size o[32]53 mm and 158 mm [14], and a study conducted by Henny (2015) found that the first mature sizes of male and female gonads[4] (*D. macrosoma*) were 247 mm and 250 mm, and the research was conducted in Ambon Bay found the size of the first maturity of the [5]onads in the total length of *D. macrosoma* males of 163 mm and females of 155 mm [20].

The first size of male and female shortfin scads fish (*D. macarellus*) gonads found in this study could be larger or smaller when compared to the same or different species of shortfin scads fish in several shortfin scads fishing ground locations. In a different study by Muhammad (2017), it was obtained that the first size of gonad ripening of male shortfin scads fish was 224 mm or a range of 207-243 mm and females at a size of 188 mm or a range of 180 - 197 mm [21]. similar to Arniati's research (2013) found that the average gonad ripening of male shortfin scads fish in Bone Bay was 250 mm in length an[35]45 mm in female fish [3]. The same thing was also obtained by Yusra (2013) on the Deles Flyfish in the waters of Barru Regency, South Sulawe[2], male shortfin scads fish maturing gonads at 239 mm size and 237 mm female shortfin scads. gonads at a total length of 163 mm and females of 155 mm [22].

The difference in the first size of the gonad ripening of several different shortfin scads fish species can be caused by differences in the physiological conditions of each shortfin scads fish species, due to differences in the conditions of the aquatic environment where the fish were caught. This has been widely explained by researchers about the size of the maturity of [11] gonads of aquatic biota, especially fish. For example, the statement of Dahlan et al. (2015), that the [30]e and age of fish when gonads first matured were not the same between one species and another [3]. In fact, fish that are in the same species will also be different if they are in different conditions and geographic locations [3].

The dif[2]rence in catch is also caused by, among other things, the method approach used and the difference in length. In this study the fork length was used, while the previous study used the total length.

The use of fork length was chosen in this study with consideration of accuracy in measurement [12]. According to Sulistiono et al. (2009), the size of each fish which ripens the gonads for the first time is different, even the same species but different sizes, the habitat of the gonads ripens too [22]. The size at first maturity of the gonads has a relationship with growth and the influence of the environment on growth and reproductive strategies.

The number of male kite fish is more than the female kite fish, so that the sustainability of the shortfin scads fish population in Majene waters can be said to be disturbed. Female shortfin scads fish reach gonad maturity faster than male shortfin scads with the first maturity size of gonads ranging between 205 mm and 216 mm, respectively. The time of spawning for shortfin scads fish in Majene waters is thought to have occurred in May to September with the peak of spawning in October.

This is possible because most of the fish caught are small fish, which allows growth overfishing to occur. Growth overfishing is fishing before it grows to a certain size resulting in a shrinkage of the stock because the fish have not had time to balance their population / reproduction [23]. This differs from the limitation on the size of the fish that can be caught. Limiting the size of the fish that can be caught in addition to producing lower numbers but also the fish caught have undergone reproduction. Thus from the biological point of view, resources are better preserved, or the approach to limiting the size of the fish that can be caught provides greater biological benefits, because it is feared that there will be recruitment overfishing. Recruitment overfishing occurs when fishing activities catch a lot of fish that are ready to spawn (spawning stock).

The equation of the relationship between fish length (X) and body circumference (Y) is obtained Y = - 1.78998 + 0.5594 X. From the calculation of the size of the first maturity of the gonads, the fork length ranges from 211 to 216 mm for female fish and 205 - 208 mm for male fish. As a precautionary factor and population safety, the determination of the mesh size refers to the upper limit (maximum) of 216 mm. From this length is substituted in the regression equation and a body circumference of 119 mm is obtained. Mesh size for the gill net is 59.5 mm and for fishing gear that does not trap 39.7 mm.

4. Conclusion

Shortfin scads fish caught on the Scottish seine net were dominated by the size of the fish that were not yet fit to catch. The size at first maturity of gonads ranges between 205 mm and 220 mm. The minimum recommended mesh size for the gill net is 59.5 mm and for fishing gear that does not trap 39.7 mm.

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