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Exploitation level of shortfin scads fish (*Decapterus macrosoma*) caught with purse seine in Bulukumba waters, South Sulawesi.

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Abstract.   Shortfin scads fish is a pelagic fish that has an important role in the economic sector of fishermen in South Sulawesi waters. In the last five years, there has been a decline in catch resulting from uncontrolled exploitation. However, there is no control instrument for the exploitation of shortfin scads fish to date, hence, there is a concern that the sustainability of shortfin scads fish resources will be threatened. This study aimed to determine the exploitation level of shortfin scads fish *(Decapterus macrosoma)* caught with a purse seine. The research was carried out in the waters of Bulukumba Regency, South Sulawesi, from April to August 2018. The method used was direct observation. Data on catches were recorded based on the fish species caught at the time of hauling. Data time series of shortfin scads fish and effort data tabulated from fisheries statistical data. Maximum sustainable yield (MSY) of shortfin scads fish in Bulukumba waters in 2016-2017 exceeded the maximum sustainable production (MSY) of 10,739 tons/year (overfishing). The regression analysis between effort and CPUE Schafer model, showed the estimation parameter intercept value (a) 42.38620491, slope (b) -0.041823411. The equality relationship interpreted as the fishing effort for f units per year will reduce the production value (CPUE) of shortfin scads fish by 42,386 tons/year. The estimation of sustainable potential value (MSY) of shortfin scads fish in Bulukumba waters was 10,739 tons /year, while the optimum fishing effort (f_{opt}) was 507 units /year and the total allowable catch (TAC) 8,591 tons/year**.**

1. Introduction
Fisheries management is a dynamic effort not only aimed at preserving fisheries resources and environmental conditions but also benefits the economy of resources. South Sulawesi has a fairly large water area, causing a high level of community dependence on marine resources. As a result of this level of dependence, all activities of coastal communities related to meeting their daily needs are carried out by exploiting these marine resources. The coastal waters for fishing areas in the West and South Makassar Strait, are Makassar, Barru and Bulukumba waters. The coastal area is the center of capture fisheries development activities, including shortfin scads fish, hence the potential for future degradation tends to increase.

    Shortfin scads fish is a pelagic fish resources that have a major role in the economic sector of fishermen in the waters of South Sulawesi. It is shown from fishing gear catches of pelagic fish such as purse seine, chart, gill net, and Scottish seine net, where the catches of shortfin

scads fish in 2013 in South Sulawesi reached 202.8 tons [1]. Productivity and availability of shortfin scads fish are varied from year to year with changes in the conditions of the marine environment and these conditions cannot be avoided so that capture fisheries are unpredictable or uncertain. Uncontrolled fishing efforts along with economic growth, capture fisheries will experience a decline in productivity.

Fishers catch shortfin scads fish ranging in size from small to considerable ranging in length from 3 cm to 29.8 cm [2]. Other than used for human consumption, shortfin scads fish are also used as bait for local and foreign longline tuna fishing. The utilization level of shortfin scads fish in Makassar strait waters was 80% from MSY [3]. But there is no control instrument for the exploitation of shortfin scads fish until now, hence, there is a concern that the sustainability of shortfin scads fish resources will be threatened.

2. Materials and methods
This research was conducted in Bulukumba Regency, South Sulawesi for two months in 2018. The research was located in Bulukumba Fish Landing (PPI) (figure 1). The data used are secondary data collected from the Department of Fisheries and Marine of Bulukumba Regency.
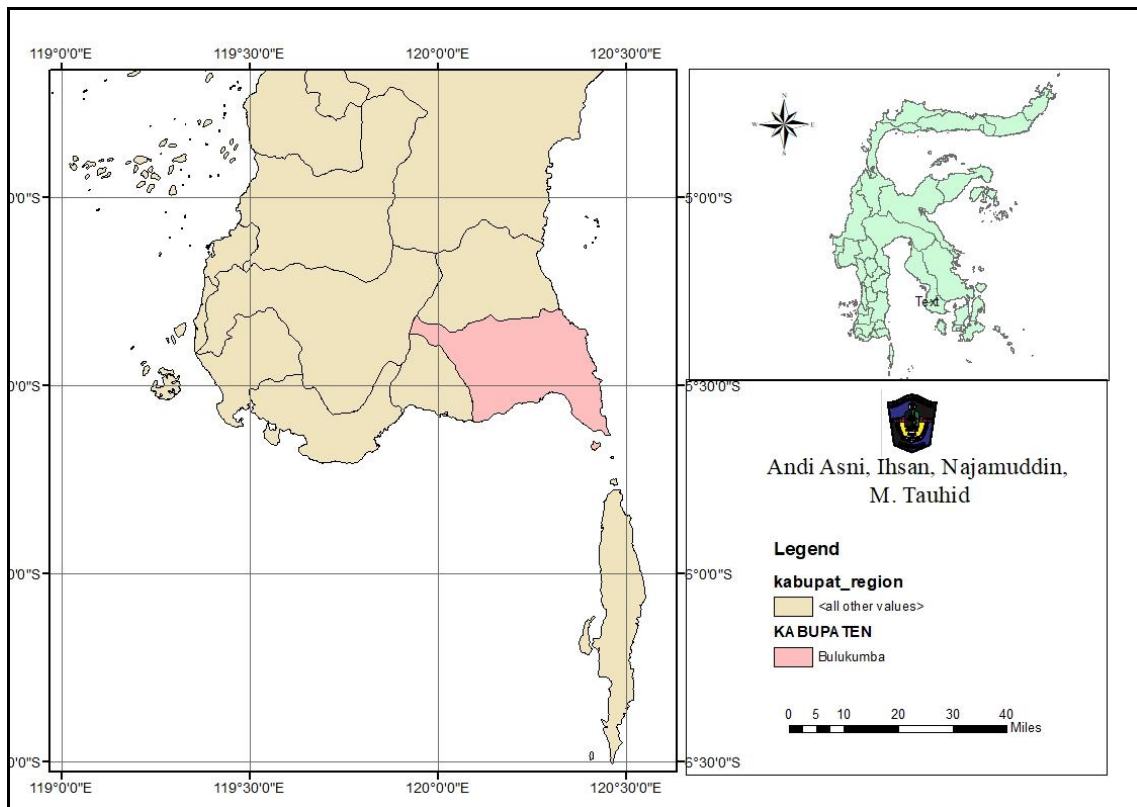

Figure 1. Research location map

2.1. Data collection
This study used a survey method to get a picture that can represent the potential and exploitation level of flying fish in Bulukumba waters, South Sulawesi. Data collected in the study were secondary data obtained from the Department of Fisheries and Marine of Bulukumba Regency. These data were an estimation of catches and efforts of shortfin scads fish in waters using statistical data on 10 years-catch during 2008 - 2017.

2.2. Data analysis
The data analysis used in this study was a surplus production method (Schaefer model). The model was used to calculate the value of MSY. The result of MSY can then be calculated for

the total allowable catch (TAC). The data used were the fishing effort of purse seine fishing gear and shortfin scads fish caught on land at Bulukumba fish landing sites.

The productivity of fishing gear can be predicted by looking at the relationship between catch and effort, i.e. catch per unit of effort (CPUE). The data used in the Surplus Production method were catches and effort. Data were then processed through the Schaefer Model approach. The Schaefer model is a regression analysis model of CPUE for total effort. The analyses were performed using Microsoft Excel. The estimation of utilization level and effort were done by presenting the number of catches in a given year with a maximum potential sustainable value (MSY).

The catch per-unit effort can be calculated by dividing the number of catches by fishing effort. The formula used (Gulland 1983) was:

$$CPUE = \frac{c_i}{f_i}$$

Where:
CPUE = catch per-unit effort in year i (ton/trip)
i = 1,2,3,…, n
ci = Catches in a year i (ton)
fi = Catching effort in year / (trip)
Then it is assumed by the alleged function, that is:

$$\hat{Y} = a + bx$$
So that, $e = Y - \hat{Y}$

$$\Sigma e2 = (Y - \hat{Y})^2$$

From the above equations, we can find the following values: relationships between CPUE and catching effort (f) as follows:

$$CPUE = a\text{-}b\,f$$

The relationship between catch (c) and catching effort (f) is as follows:

$$c = af \text{ - } bf^2$$

The optimum catching effort (f_{opt}) was obtained by equating the first derivative of the catch to the catch effort equal to zero.

Analysis of the total allowable catch (TAC), states that the total allowable catch (TAC) is 80% of sustainable potential. Therefore, TAC can be calculated using the following formula:

$$TAC = MSY \text{ x } 80\,\%$$

3. Results and discussions

3.1. Sustainable potential (MSY) and optimum effort (f_{opt})
Data on shortfin scads fish production for the last 10 years 2008-2017 caught in the waters of Bulukumba Regency (table 1).

Table 1. Shortfin scads fish production (tons), effort (units) and CPUE (tons/units) caught in Bulukumba Waters in 2008-2017.

Year	Production (tons)	Effort (units)	CPUE (tons/units)
2008	8507.1	225	37.81
2009	7308	230	31.77
2010	7618	230	33.12
2011	3170.5	230	13.78
2012	4350.5	155	28.07
2013	8289.1	150	55.26
2014	8289.1	150	55.26
2015	2046.4	241	8.49
2016	12181.7	430	28.33
2017	12139	699	17.37
Average value (x)	7389.940	274.000	30.927
Standard deviation (s)	3399.895	169.696	15.752
Intercept (a)			42.38620491
Slope (b)			-0.041823411
MSY			10739
FMSY			507

Catch per unit effort (CPUE) of shortfin scads fish in 2008-2017 caught in the waters of Bulukumba showed a trend of fluctuations every year (Table 1). This is consistent with what was obtained in the study of [4] on shortfin scads fish caught in Aceh waters. It showed that decreasing efforts resulted in increased production, i.e. the percentage of CPUE trends decreasing will result in shortfin scads fish populations will decline and decrease. The decrease in productivity is influenced by a decrease in production volume, where fishing activities are greater than the ability to recruit shortfin scads fish stocks in fishing areas in that year [5].

The productivity of fish catches shows the size of fish stocks that can be utilized sustainably. [6] explains that the population dynamics of fish stocks found in waters can be affected by birth, death, immigration, and emigration. [7] explains the increase and decrease in fish stocks in the waters affecting fish stock. Increased stock is influenced by growth and recruitment.

Decreased stock is influenced by natural mortality and catches. The productivity of shortfin scads fish catches can be determined by dividing the amount of catch production with the amount of fishing effort carried out. [8] explained that the recruitment of fish stocks can occur if there are fish left to mature, whereas the recruitment of fish stocks in the waters cannot occur if no fish is left to grow up and spawn. [9] explained that the length of fish caught in trawl ring units (32%) was dominated by shortfin scads fish with a size of 14-21 cm long. [10] stated that the length of the shortfin scads fish at first spawn was 18 cm with a maximum length of 35 cm. Based on the statement, it can be explained that the length of fish affects the stock dynamics and productivity of shortfin scads fish in the waters because if the length of the fish reaches the length of an adult fish, the bodyweight of the fish will also increase. Government policy in terms of regulating fishing time needs to be done so that the productivity of shortfin scads fish in fishing areas can be controlled sustainably.

Fisheries resource management is carried out through management principles continuously and in a sustainable state and the fish population does not experience extinction in the context of long-term utilization. Recognizing the importance of preserving fisheries resources means the management of fisheries and marine resources is directed to refer to the principles of responsible use and management of fish resources
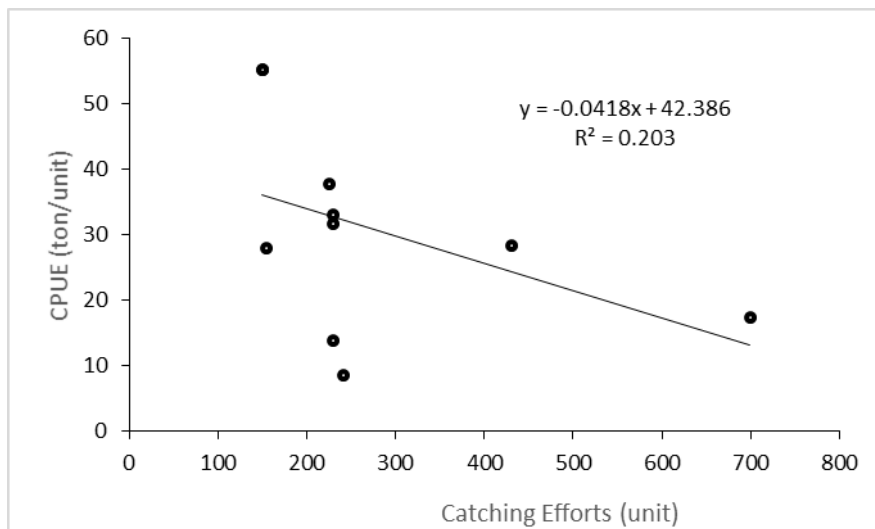
Figure 2. Relationship between Catching Efforts (units/year) and CPUE (tons/year) of shortfin scads fish caught on Bulukumba Waters

Based on figure 2, the results of the regression analysis between effort and CPUE of the Schafer model, the estimated parameter values obtained were: Shortfin scads fish caught in Bulukumba waters with an intercept value (a) 42.38620491, slope (b) -0.041823411. Thus, forming the equation Ln CPUE = -0.0418x + 42.386. The relationship of this equation can be interpreted that if catch effort is made for f units per year it will reduce the production value (CPUE) of shortfin scads fish by 42,386 tons/year. By knowing the value of intercept (a) and slope (b), the estimation of sustainable potential value (MSY) of shortfin scads fish in the Bulukumba Sea of South Sulawesi was 10,739 tons/year, while the optimum fishing effort (f_{opt}) was 507 units/year. The results of the study [9] the sustainable potential of shortfin scads fish in the eastern waters of Southeast Sulawesi showed that MSY of shortfin scads fish was 5,747.61 tons/year. and the amount of TAC is 4,598 tons/year.

MSY is the most balanced catch that can be maintained throughout the period at a certain intensity of fishing which results in biomass of fish stocks at the end of a certain period equal to the preparation.
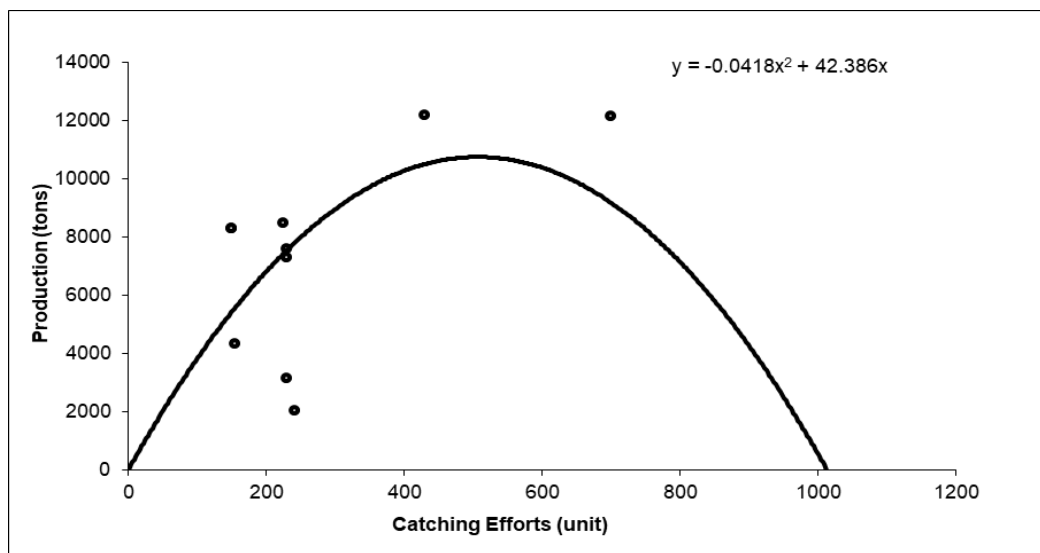

Figure 3. Relationship between catching efforts and production (tons/year) of shortfin scads fish caught on Bulukumba waters

Based on the analysis of Maximum Sustainable Yield (MSY), shortfin scads fish in Bulukumba waters in 2016-2017 exceeded the Maximum Sustainable Yield (MSY) of 10,739 tons/year or overfishing has occurred. Based on this, it is necessary to regulate management. Efforts to manage shortfin scads fish resources can be carried out through the regulation of fishing efforts in the form of both trips and the number of fishing gear used in exploiting and catch quota arrangements, to avoid overexploitation that can cause biological overfishing because it can pass the maximum sustainable yield (MSY) value. Where according to [11], that biological overfishing will occur when the level of fishing effort in a particular fishery has exceeded the level needed to produce maximum sustainable yield (MSY) potential but can be prevented by regulating fishing efforts and fishing patterns. The utilization status of shortfin scads fish resources in the waters of the Flores-South Sulawesi Sea has been categorized as dense exploitation. So that is the necessary prudence in efforts of utilization [12].

3.2. The maximum sustainable yield (MSY) and the total allowable catch (tac) of shortfin scads fish

The MSY is a fishing effort that can produce the maximum catch sustainably without affecting long-term stock productivity [8]. Determination of the maximum sustainable catch can be done using a surplus production model. Calculation of surplus production models in this study is based on CPUE values of shortfin scads fish and fishing efforts for ten years in trawl ring capture units. The total allowable catch (TAC) of shortfin scads fish can be determined based on the MSY value of the shortfin scads fish. The TAC value is calculated based on the assumption of maximum utilization of 80% of the MSY value [12].

The number of TAC shows that the number of shortfin scads fish production that can be utilized is 80% of the sustainable potential of shortfin scads fish every year, by observing the preservation of these species through recruitment in fishing areas [7]. The TAC value of shortfin scads fish in Bulukumba ton/year is calculated based on the assumption of maximum utilization of 80% of the MSY value. Based on the TAC value obtained, it can be explained that if the number of fish catches that can be utilized is 80% with 8591 tons/year, then 20% or 2147 tons/year from the MSY value of shortfin scads fish can regenerate in the waters of Bulukumba Regency, South Sulawesi.

4. Conclusion

The production of shortfin scads fish in the waters of Bulukumba Regency, South Sulawesi in 2016-2017 has exceeded the maximum potential sustainable value (MSY) or overfishing and utilization of elevated fish resources have been categorized as exploitation, so caution is needed in the effort to utilize it. The maximum sustainable potential yield (MSY) of shortfin scads fish reaches 10,739 tons/year, and the total allowable catch (TAC) of shortfin scads fish is 8,591 tons/year.

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