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CATCH RESULTS PER EFFORT (CPUE) AND MAXIMUM SUSTAINABILITY YIELD (MSY) ANALIZYS OF SELAR FISH (*Selaroides* spp.) AT THE DONGGALA REGENCY WATERS

Analisis Hasil Tangkapan Per Upaya (Cpue) Dan Potensi Maksimum Lestari (Msy) Ikan Selar (*Selaroides* spp.) Di Perairan Kabupaten Donggala Sulawesi Tengah

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ABSTRACT

The potential of Selar Fish (*Selaroides* spp.) caught by fishermen in the waters of Donggala Regency requires in-depth study to support sustainable management and ensure its sustainability in the future. This research aims to analyze catch per unit effort (CPUE) as well as the maximum sustainable potential of trevally (*Selaroides* spp.) in the region. The research location covers three administrative areas, namely Labean Village (Balaesang District), Ogoamas Village (North Sojol District), and Labuan Bajo Village (Banawa District). The research results show that the average trevally production during the 2017-2023 period reached 5,019.06 tons per year, with an average fishing effort of 2,479.66 trips per year. The average catch per attempt (CPUE) was recorded at 2,394.92 tons/trip. Based on analysis using the Schaefer model, the maximum sustainable potential (hMSY) is obtained with a maximum biological production of 6,238 tons per year. Maximum economic profit is achieved at a hMEY production level of 6,152 tons per year, while the equilibrium condition for fisheries in open access (hOAY) occurs at a production level of 2,579 tons per year. In terms of fishing effort, the biologically optimum number of efforts (EMSY) is 3,175 trips per year, economically (EMEY) it is 2,803 trips per year, while in open access conditions (EOAY) it reaches 5,606 trips per year. This data indicates that MEY-based management is more advisable to maximize economic benefits while maintaining the sustainability of trevally resources. These findings can be a basis for policy makers in establishing sustainable fisheries management strategies in the waters of Donggala Regency.

Keywords: Catch Per Effort, Donggala Regency, Maximum Sustainable Potential, Selar.

ABSTRAK

Potensi Ikan Selar (*Selaroides* spp.) yang ditangkap oleh nelayan di perairan Kabupaten Donggala memerlukan kajian mendalam untuk mendukung pengelolaan yang berkelanjutan dan memastikan kelestariannya di masa depan. Penelitian ini bertujuan untuk menganalisis hasil tangkapan per upaya (catch per unit effort/CPUE) serta potensi lestari maksimum ikan selar *(Selaroides* spp.) di wilayah tersebut. Lokasi penelitian mencakup tiga wilayah administrasi, yaitu Desa Labean (Kecamatan Balaesang), Desa Ogoamas (Kecamatan Sojol Utara), dan Kelurahan Labuan Bajo (Kecamatan Banawa). Hasil penelitian menunjukkan bahwa rata-rata produksi ikan selar selama periode 2017-2023 mencapai 5.019,06 ton per tahun, dengan rata-rata upaya penangkapan sebanyak 2.479,66 trip per tahun. Rata-rata tangkapan per upaya (CPUE) tercatat sebesar 2.394,92 ton/trip. Berdasarkan analisis menggunakan model Schaefer, potensi lestari maksimum (hMSY) diperoleh dengan produksi hayati maksimum sebesar 6.238 ton per tahun. Keuntungan ekonomi maksimum tercapai pada tingkat produksi hMEY sebesar 6.152 ton per tahun, sementara kondisi keseimbangan perikanan dalam akses terbuka (hOAY) terjadi pada tingkat produksi 2.579 ton per tahun. Dalam hal upaya penangkapan, jumlah upaya optimum secara biologis (EMSY) adalah 3.175 trip per tahun, secara ekonomi (EMEY) adalah 2.803 trip per tahun, sedangkan dalam kondisi akses terbuka (EOAY) mencapai 5.606 trip per tahun. Data ini mengindikasikan bahwa pengelolaan berbasis MEY lebih disarankan untuk memaksimalkan manfaat ekonomi sambil menjaga keberlanjutan sumber daya ikan selar. Temuan ini dapat menjadi dasar bagi pengambil kebijakan dalam menetapkan strategi pengelolaan perikanan yang berkelanjutan di perairan Kabupaten Donggala.

Kata Kunci: Kabupaten Donggala, Lestari Ikan Selar, Potensi Maksimal, Tangkapan Perusaha

INTRODUCTION

Large and small pelagic fish resources in Indonesian waters have enormous potential. According to Rabani *et al*., (2023) several types of small pelagic fish, such as sardines, mackerel, tuna, selar, and anchovies, have become the main commodities in capture fisheries and have made a major contribution to the Indonesian economy with a total of 2,423,000 per year, both for domestic consumption and export. Fitriyana, (2020) added that the potential for capture fisheries can develop rapidly in the current era. The Ministry of Marine Affairs and Fisheries (2022) stated that small pelagic fish contribute greatly to the total fishery catch, with an estimated potential for fish resources in Indonesia reaching around 12.01 million tons per year, where small pelagic fish contribute around 50% of the total. Although Indonesia has great potential, the management of pelagic fish resources still faces a number of challenges, such as overfishing due to excessive and uncontrolled fishing, revealing that many waters in Indonesia have experienced a decline in pelagic fish catches due to fishing that exceeds the capacity of fish regeneration (Asmawati & Nasir, 2017; Santoso, 2016). The use of fishing gear such as trawls can cause even higher overfishing impacts (Gani & Widodo, 2021; Yuliana & Fitriyana, 2023).

Donggala Regency, Central Sulawesi Province, which directly borders the Makassar Strait, has small pelagic fish resources, such as scad (*Selaroides* spp.), mackerel (*Rastrelliger* spp.), and lemuru (*Sardinella* spp.). According to the Central Statistics Agency of Donggala Regency (2023), the total capture fisheries production in the last year was recorded at 31,375.70 tons per year, with the largest contribution coming from small pelagic fisheries, according to Tanod *et al.*, (2024) which contributed more than 60% of total production. This production is mostly carried out by small-scale fishermen using fishing gear such as gill nets and purse seines. The scad in the waters of Donggala Regency is known to have abundant potential.

The concept of Maximum Sustainable Yield (MSY) refers to the maximum catch that can be obtained from a fishery resource without reducing the fish population sustainably (Sari & Nurainun, 2022). MSY is based on an analysis of fish landings and the type of fishing gear used, thus allowing the determination of the optimal level of exploitation to achieve sustainable catches (Pauly & Froese, 2021). If a fish resource utilization activity is not managed properly, it will have an impact on less than optimal production growth and can trigger excessive fishing exploitation, thus threatening the sustainability of these fish resources (Hasrun *et al*., 2021). Therefore, it is important to conduct an analysis of the catch per effort and the maximum sustainable potential, especially for scad (*Selaroides* spp.) in the waters of Donggala Regency, Central Sulawesi. The purpose of this study was to analyze the CPUE trend and estimate the MSY of scad (*Selaroides* spp.) to evaluate the stock status and potential for sustainable fishing in the waters of Donggala Regency.

METHODS

Place and Time

The research was conducted for three months, namely from August to October 2024. The research location covered two sub-districts and one village, namely Balaesang District (Labean Village), Sojol Utara District (Ogoamas Village), and Banawa District (Labuan Bajo Village) of Central Sulawesi Province.

Tools and Materials

The tools used in this study were fishing gear in the form of Purse Seine (*ring seine*) and *Gill Net (gill net*), FAO ICLARM Stock Assessment Tool application, and ASPIC (A Surplus Production Model Incorporating Covariates). Materials used Data on the catch of trevally from fishermen in Donggala Regency during the period 2017-2023, and environmental data.

Sampling

This study uses a purposive sampling technique, which is a sampling technique based on certain considerations, such as the characteristics of the research subjects that are relevant to the research objectives (Sugiyono, 2016). Respondents were selected intentionally with consideration of their ability to communicate well, in order to ensure the quality of the data obtained from the questionnaire. The sample of this study was limited to fishermen who used purse seine and gill net fishing gear at the PPI/TPI of Donggala Regency, chosen because they were considered representative of the population of fishermen who used these fishing gear in the research area.

Data Analysis

Standardization of Fishing Gear

To obtain accurate CPUE calculation results, it is necessary to standardize fishing gear before calculation. The formula used to standardize fishing effort is as follows (Wang *et al*., 2020):

$$FPI = \frac{CPUE_i}{CPUE_s} \quad \text{.....(1)}$$

Where:
FPI : *Fishing Power Index*
CPUEi : *CPUE of fishing gear to be standardized (kg per trip*)
CPUEs : *CPUE of standard fishing gear (kg per trip*)

$$f_s = FPI \times f_i \quad \text{.....(2)}$$

Where:
f_s : effort to capture standardization results (trip)
f_i : fishing effort to be standardized (trip)

***Catch per Unit Effort* (CPUE)**

To find out the abundance and level of utilization of fish resources in a waters, we need to calculate Catch Per Unit Effort (CPUE). This calculation requires production data (total catch) and fishing effort (number of trips or days at sea). The formula used to calculate the CPUE value (Wang *et al*., 2020) is as follows:

$$CPUE = \frac{Catch_t}{Effort_t} \quad \text{.....(3)}$$

Where:
CPUE : The catch per trip of mackerel in year t (kg/trip)
$Catch_t$: Total catch of mackerel in year t (kg)
$Effort_t$: Number of trips to catch scad in year t (trip)

Maximum Sustainability Yield (MSY)

Determination of the maximum sustainable catch potential (MSY) of scad (*Selaroides* spp.) in the waters of Donggala Regency through Schaefer and Fox modeling. The formula used (Garcia *et al*., 1989; Martell & Froese, 2013) is as follows:

1) Schaefer Equilibrium Method (1957)

$$ht = qKE\left(\frac{q^2K}{r}\right) \times E_t^{\,2} \quad \text{.....(4)}$$

2) Disequilibrium Schaefer Method (1957)

$$\left(\frac{U_{t+1} - U_{t-1}}{2U_t}\right) = r - \frac{r}{Kq}U_t - qE_t \quad \text{.....(5)}$$

3) Algoritma Fox Method (1975)

$$z = \left[\left(-\frac{\alpha}{\beta}\right) - \left(\frac{U_t + U_{t+1}}{2}\right)\right] \quad \text{.....(6)}$$

$$x = \left[\left(\frac{z}{U_t}\right) + \left(\frac{1}{\beta}\right)\right] \quad \text{.....(7)}$$

$$y = \left[\left(\frac{z}{U_{t+1}}\right) + \left(\frac{1}{\beta}\right)\right] \quad \text{.....(8)}$$

RESULT

Standardization of Fishing Gear

In this study, standardization of fishing gear was carried out by calculating the number of trips per year for each type of fishing gear (purse seine and gill net) used in catching trevally. This aims to ensure a fair comparison between the two fishing gears. According to Kurniawan *et al*., (2019) standardization aims to make fishing gear a reliable measure to assess the utilization capacity of each fishing gear. By setting standards, it can be measured how effective a fishing gear is in utilizing fish resources. Susanto *et al*., (2015) added that standardization helps in the management of fishery resources by providing the data needed to set limits on fishing and through standardization, fishermen can find out which fishing gear provides the best results (CPUE). Analysis of the diversity of productivity of trevally between purse seine and gill net fishing gear in the waters of Donggala Regency during the period 2017-2023 is presented in Table 1.

Table 1. Analysis of the diversity of productivity of trevally between purse seine and gill net fishing gear in the waters of Donggala Regency during the period 2017-2023

Years	Production (Ton)			*Effort* (Trip)		CPUE		FPI JI	Effort JI SDT	Effort SDT
	PS	JI	Total	PS	JI	PS	JI			
2017	3.463,16	384,80	3.847,95	1.085	135.583	3,015	0,004	0,0014	191	1.276
2018	3.789,51	421,06	4.210,56	1.245	141.956	2,875	0,004	0,0015	220	1.465
2019	4.749,23	527,69	5.276,92	1.298	106.026	3,456	0,007	0,0022	229	1.527
2020	3.556,97	889,24	4.446,22	1.298	191.824	2,912	0,003	0,0012	229	1.527
2021	4.280,75	755,43	5.036,18	2.877	106.588	1,488	0,007	0,0048	508	3.385
2022	5.290,50	933,62	6.224,11	3.675	88.213	1,440	0,011	0,0074	649	4.324
2023	5.177,76	913,72	6.091,48	3.276	78.183	1,581	0,012	0,0074	578	3.854
Average	**4.329,70**	**689,36**	**5.019,06**	**2.108**	**121.196**	**2,395**	**0,007**	**0,0037**	**372**	**2.480**

Catch per Unit Effort (CPUE)

The production of scad fish experienced a fairly rapid increase trend from 2017 to peak in 2022. Production increased from 3,847.95 tons in 2017 to 6,224.11 tons in 2022. However, in 2023 there was a slight decrease in production to 6,091.48 tons. This increase in production is in line with the increase in the number of fishing trips which rose from 1,276 trips in 2017 to 4,324 trips in 2022, before decreasing to 3,854 trips in 2023. The CPUE graph of scad fish in the waters of Donggala Regency in 2017-2023 is presented in Figure 1.

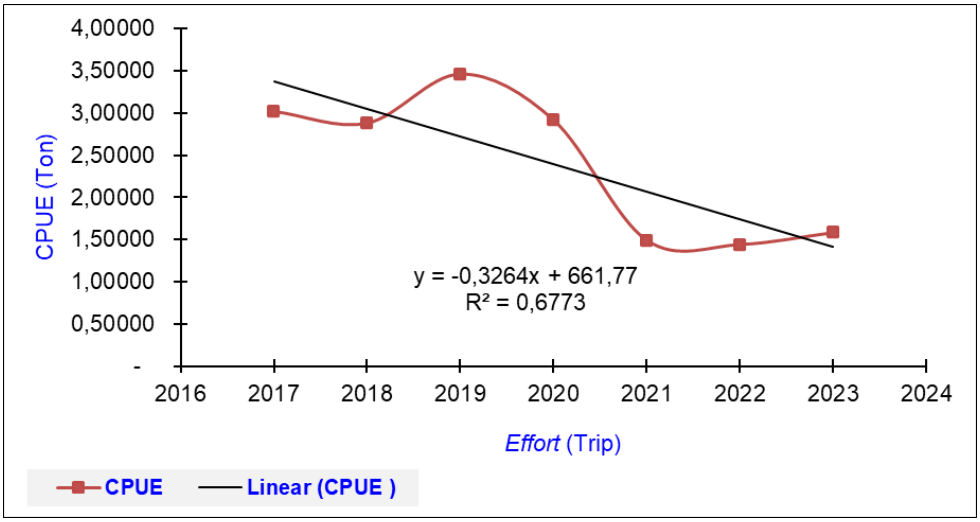

Figure 1. CPUE graph of mackerel in Donggala Regency waters 2017-2023.

Maximum Sustainability Yield (MSY)

Based on the Gordon-Schaefer model, the maximum potential of scad fish resources in Donggala Regency is 6,238 tons per year which can be achieved with 3,175 fishing trips. However, from an economic perspective, the optimal fishing rate is 6,152 tons per year with 2,803 trips, where the profit obtained is maximum. On the other hand, in open access fishing conditions, the fishing rate tends to be excessive, reaching 2,579 tons with 5,606 trips, which can threaten the sustainability of resources. Analysis of the economic value of scad fish management in Donggala Regency is presented in Table 2.

Table 2. Analysis of economic value in scad fish management in Donggala Regency

Parameter	Unit	Selar SDI Management Model			AKTUAL
		MEY	MSY	OAY	
Biomass (x)	Ton	17.841	15.971	3.740	0
Production (h)	Ton	6.152	6.238	2.579	5.019
Effort (E)	Trip	2.803	3.175	5.606	2.480
Economic Rent (π)	Million/Rp	69.803	68.575	-	55.673

DISCUSSION

Standardization of Fishing Gear

Based on the research, the production of scad fish in Donggala Regency showed a significant increasing trend from 2017 to peak in 2022. Production increased from 3,847.95 tons in 2017 to 6,224.11 tons in 2022. However, in 2023 there was a slight decrease in production to 6,091.48 tons. This increase in production was in line with the increase in the number of fishing trips which rose from 1,276 trips in 2017 to 4,324 trips in 2022, before decreasing to 3,854 trips in 2023. The fishing gear that produced the most scad fish catches in Donggala Regency in 2023 was the purse seine, which was 5,177.76 kg, while the gillnet fishing gear caught less, which was 913.72 kg. Standardization of effort during the period 2017-2023, the fishing gear with the greatest effort is the purse seine, which is 2,480 kg/trip, while the gillnet fishing gear is an average of 372 kg/trip. Rema, (2022) argues that in selecting fishing gear, technical, environmental, social and

economic aspects must be considered and must be developed and optimized so that fisheries development can run well.

Catch per Unit Effort (CPUE)

The CPUE value in 2017 which reached 3.01452 tons shows that at the beginning of the study period, each fishing effort produced quite high results. However, as the intensity of fishing (effort) increased from year to year, fishing efficiency actually decreased drastically, reaching its lowest point in 2022 with a CPUE value of 1.43959 tons. This phenomenon indicates that fish stocks may have been overexploited, so that greater fishing efforts are needed to obtain the same results. The average production during the 2017-2023 period was 5,019.06 tons with an average effort of 2,479.66 trips and a CPUE of 2.49492 tons. This downward trend in CPUE is an early warning signal that if there are no better fisheries management efforts, the potential for a decline in fisheries production in the future will be even greater. This condition can occur due to the inefficient use of fish resources and the absence of a sustainable fisheries resource management strategy (Kartini *et al*., 2021).

Maximum Sustainability Yield (MSY)

In the Maximum Economic Yield (MEY) management model, the optimal production of scad (*Decapterus* spp.) is estimated at 17,841 tons per year, which can be achieved with a fishing effort of 2,803 trips. In this condition, the optimal catch of scad is 6,152 tons, resulting in the highest economic profit of 69,803 million rupiah. The MEY model reflects the most efficient management of fisheries resources from an economic perspective, because it produces maximum profit with relatively low operational costs. Therefore, MEY is often considered an ideal target in fisheries management to maximize economic benefits while maintaining the sustainability of fish resources. Meanwhile, in the Maximum Sustainable Yield (MSY) condition, the highest sustainable production of scad is projected to reach 15,971 tons per year, with a fishing effort of 3,175 trips. This condition results in a maximum catch of 6,238 tons, with a slightly lower economic profit compared to MEY, which is 68,575 million rupiah. The MSY management model describes the conditions under which fish stocks are exploited at the maximum level that still allows the resource to be maintained in the long term without reducing its reproductive capacity and sustainability. Estimation of biological parameters carried out using the Fox Algorithm estimation model approach shows that the intrinsic growth rate of scad (r) is 0.781101 tons per year, with a catch coefficient (q) of 0.000123 tons per trip. The environmental carrying capacity (K) of the Donggala Regency aquatic ecosystem is estimated to reach 31,942.57 tons per year. This parameter indicates that each increase in fishing effort units (trips) will result in an additional catch of 0.000123 tons per trip. In addition, the results of this estimation also indicate that the Donggala Regency aquatic ecosystem has the capacity to support the production of scad fish resources of 31,942.57 tons per year under optimal conditions.

CONLUSSION

Based on the CPUE trend of scad fish, it indicates that fishing efficiency decreases along with increasing fishing effort, which may be a sign that the scad fish stock has been overexploited. MEY-based management is more recommended to maximize economic benefits while maintaining the sustainability of scad fish resources.

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